Value of Air Cargo: Air Transport and Global Value Chains

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Foreword

Global trade has played a key role in fostering economic development and making countries more competitive and productive – thus supporting income growth and poverty reduction. As a share of global output, trade is now at about three times the level it was in the early 1950s. In 2015, airlines transported 52.2 million metric tons of goods valued at USD 5.6 trillion. Air cargo is key in supporting the current global trading system, with an estimated 35% of value of global trade carried by air, even though it covers less than 1% by volume. The role of air cargo is even greater for trade in advanced industrial, high value goods, and other sectors that rely on rapid, reliable and secure transport.

The increase in trade has mostly been driven by non-commodity exports, made possible by trade liberalization and subsequent distribution of production processes beyond national borders. The latest estimates from the World Trade Organization indicate that Global Value Chain trade has grown faster than trade overall - increasing its share from 36% in 1995 to 49% in 2011. That means about half of global trade now takes place as part of Global Value Chains.

From an economic policy perspective, it is critical to better understand the factors that enable countries, particularly developing ones, to join Global Value Chains, and move up to higher value added activities. The area remains relatively under-researched. To enhance knowledge in this field IATA designed a research project that combined aviation, border management and trade expertise with the aim of shedding light on the role played by air cargo in supporting integration into the global trading system.

As part of this research project, IATA commissioned Developing Trade Consultants to undertake this study that, for the first time, quantifies the relationship between air cargo connectivity and participation in global trade. As part of the study, two air cargo specific indices – the Air Trade Facilitation Index (ATFI) and eFreight Friendliness Index (EFFI) – were developed to assess effectiveness of smart border regulation, customs services and logistics chain. This report also examined the challenges and opportunities of integrating into Global Value Chains across six case studies of specific sectors in six countries.

The findings in this report can serve as evidence in support of policy deliberations on improving the trade facilitation environment and helping countries integrate into Global Value Chains. It highlights that countries with well-developed air cargo connections combined with good quality customs services and smart borders, are better at integrating into Global Value Chains.

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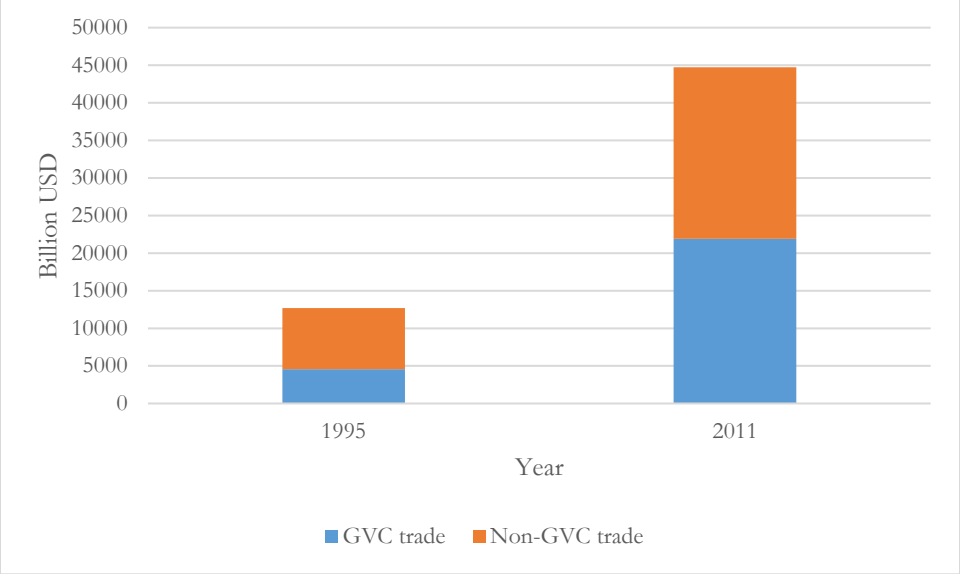
EXECUTIVE SUMMARY

Global trade has played a key role in supporting economic development and making countries become more productive – supporting income growth and poverty reduction. Although air cargo only accounts for less than 1% of world trade shipments by volume, it makes up around 35% by value.

Global Value Chains (GVCs) represent a new trade and development paradigm. They enable countries to specialize in narrowly defined tasks, such as component production, research and development, or assembly. Tasks originating in a variety of countries are then combined through a complex network of trade and investment links, to produce finished goods—like cars, computers, cellular phones, and even aircraft. The World Trade Organization estimates that almost half of global trade now takes place within GVCs—and GVC trade has been growing more rapidly than other types of trade since the 1990s (see figure).

Figure: GVC and non-GVC trade in goods and services, 1995 and 2011, billion USD.



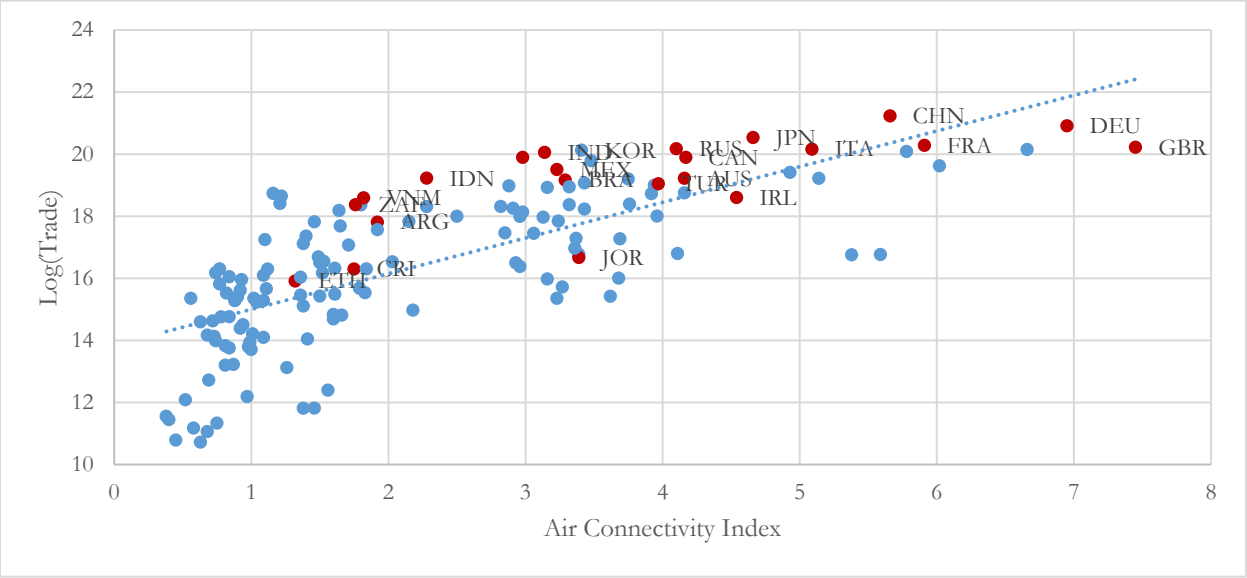
Source: World Trade Organization.

Air cargo plays a particularly important role in enabling countries to integrate and move up GVCs. Cross-border movements of component parts is a key element of the business model. These components are often relatively small, but high value. This characteristic makes them well suited to air transport. The speed, reliability, and security of air cargo enable GVC participants to keep inventories low, and rapidly bring together components for final assembly.

GVCs and Air Cargo

This report uses a range of data sources to examine the linkages between air cargo and GVC trade. Countries that have better air cargo connectivity (measured by the Air Connectivity Index) also engage in more trade in value terms. The figure below shows that there is a strong association between a higher ACI score—which means stronger air connections to more countries—and a higher total trade value - one percent increase in air cargo connectivity is associated with a 6.3% increase in total exports and imports.

Figure: Association between the Air Connectivity Index and trade, 2012.



Source: Arvis et al. (Forthcoming); and UN Comtrade.

Air cargo is a critical enabler supporting integration of countries into GVCs. Countries that have well developed air cargo connections combined with good quality customs services and smart borders are better integrated into global value chains. The study developed measures of key quality parameters of customs services through two indexes – the Air Trade Facilitation Index (ATFI) and the eFreight Facilitation Index (EFFI). Countries that performed better on these indexes also were more integrated into GVCs – a one percentage point increase in the ATFI and EFFI was each associated with a 0.3 percentage point increase in GVC participation.

Key Findings

The report has a number of findings that will be of interest to the industry and policymakers alike:

1. Air connectivity is strongly positively associated with the total value of trade. As an indicative order of magnitude, a one percent increase in the ACI is associated with a 6.3% increase in total exports and imports. Air connectivity is strongly positively associated with GVC participation. A one point increase in the ACI is associated with a 2.9 percentage point increase in GVC participation.
2. Air cargo trade facilitation as measured by the ATFI is also positively associated with the value of trade: a one percentage point increase in the ATFI is associated with a 2.3% increase in the value of trade. In addition, a one percentage point increase in the ATFI is associated with a 0.3 percentage point increase in GVC participation.
3. eFreight Friendliness as measured by the EFFI is also an important determinant of trade performance and GVC participation. A one percentage point increase in the EFFI is associated with a 2.5% increase in the value of trade. Moreover, a one percentage point increase in the EFFI is associated with a 0.3 percentage point increase in GVC participation as measured by the proportion of backward and forward linkages in total exports.
4. Countries that perform particularly well on air connectivity—like most of the case study countries—tend also to perform very well on metrics of GVC connectivity. Industry makes extensive use of air cargo linkages whenever possible. Sectors that can potentially benefit from the linkages examined in this report vary considerably in terms of sophistication and capital intensity. They include textiles and clothing, electrical goods, and pharmaceuticals.
5. In addition to GVC participation, there is also evidence that air cargo performance is positively associated export unit values, which are a common proxy for price. This finding suggests that air cargo can be a force for helping firms "move up" GVCs to higher value added activities.

In addition to the global quantitative evidence marshalled in the report, there are also six case studies of specific countries and sectors. The cases cover a variety of GVC sectors in the manufacturing industry, and deal with developed and developing countries, at a range of income levels. The table below summarizes the most important enabling factor in each case, which has made GVC integration possible.

Table 1: Key GVC enabling factors in the case study countries.

Country/Sector	Key Enabling Factor
Costa Rica – Medical Equipment	Strong air connectivity, particularly to the US market, with 20,000 flights to 42 destinations in 2015.
Ethiopia – Textiles and Apparel	Development of air cargo capacity at Addis Ababa airport, an important African hub, in close proximity to manufacturers. Strong connections through Ethiopian Airlines.
Ireland - Pharmaceuticals	Strong connectivity: 100,000 flights to 175 destinations in 2015. Development of controlled environment cargo movements for sensitive pharmaceuticals.
Jordan - Pharmaceuticals	Strong connectivity through two international airports. 2014 inauguration of an eFreight system, which links directly with electronic systems at Customs for rapid border clearance.
Turkey – Textiles and Apparel	Strategic connectivity with end markets (Eastern Europe) and processing locations with Turkish investments (Africa and Asia). Use of speed, reliability, and security in a sometimes turbulent region where land border closures can occur.
Vietnam – Electrical Machinery	Location of export processing parks very close to air cargo facilities. Although facing challenges in terms of connectivity, it performs better than other countries at a similar income level.

Policy Priorities

Many countries have enjoyed considerable success in moving forward on air cargo, and in particular its trade facilitation environment. There is room for improvement in some cases, however. There is need to develop the policy framework environment in some countries by incorporating important international instruments into domestic law. Particular legislative priorities are the ratification/accession and implementation of:

(i) 1999 Montreal Convention
(ii) Bali Trade Facilitation Agreement of the World Trade Organization
(iii) Revised Kyoto Convention.

Beyond the policy framework, there is also work to do on the implementation side. Trade facilitation initiative emphasize cutting red tape and unnecessary formalities to speed up border processing and make it more reliable. Doing so allows air cargo to capitalize on its key advantage of speed. Key interventions that are needed specific to air cargo are:

(i) facilitation of electronic processing, through eAWBs and eFreight
(ii) implement "single window" processing
(iii) Coordinated border agency procedures to reduce duplicative controls
(iv) Implementation of risk management controls at border to combat illicit activities and facilitate compliant traders
(v) put in place processes to approve release of shipments in advance of their actual arrival.

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CONTENTS

Foreword i
Executive Summary ii
Acknowledgements v
Contents vi
1 Introduction and Project Overview 1
2 Air Cargo, Value Chains, and Development 5
2.1 What is a Global Value Chain? 5
2.2 GVCs and Sustainable Development 8
2.2.1 GVCs and Economic Development 9
2.2.2 Social Aspects of GVCs 12
2.2.3 GVCs and the Environment 13
2.2.4 Bringing it All Together: Economic, Social, and Environmental Development 14
2.3 Linking Firms to GVCs: The Role of Air Cargo 14
3 Measuring Air Cargo Performance: Empirical Evidence on Air Cargo and GVCs 19
3.1 The Air Connectivity Index 19
3.2 The Air Trade Facilitation Index 22
3.3 The eFreight Friendliness Index 26
3.4 Comparing the ATFI and the EFFI 29
3.5 Air Cargo and GVC Integration: Quantitative Evidence 30
4 Country Value Chain Case Studies 41
4.1 Medical Devices in Costa Rica 42
4.1.1 Country Profile 42
4.1.2 Sector Background 42
4.1.3 Evidence of the Sector's Integration into and Moving Up in GVCs 43
4.1.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain 45
4.1.5 Policy Recommendations 48
4.2 Textiles and Apparel in Ethiopia 48
4.2.1 Country Profile 48
4.2.2 Sector Background 48
4.2.3 Evidence of the Sector's Integration into and Moving Up in GVCs 49
4.2.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain 51
4.2.5 Policy recommendations 53
4.3 Pharmaceuticals in Ireland 54
4.3.1 Country Profile 54
4.3.2 Sector Background 54
4.3.3 Evidence of the Sector's Integration into and Moving Up in GVCs 55

4.3.4 Role of Air Cargo in GVC Integration and Moving up the Value Chain 57
4.3.5 Policy recommendations 59
4.4 Pharmaceuticals in Jordan 59
4.4.1 Country Profile 59
4.4.2 Sector Background 59
4.4.3 Evidence of the Sector's Integration into and Moving Up in GVCs 60
4.4.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain 62
4.4.5 Policy recommendations 64
4.5 Textiles and Apparel in Turkey 64
4.5.1 Country Profile 64
4.5.2 Sector Background 64
4.5.3 Evidence of the Sector's Integration Into and Moving Up the Value Chain 65
4.5.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain 68
4.5.5 Policy Recommendations 71
4.6 Electrical Machinery in Vietnam 71
4.6.1 Country Profile 71
4.6.2 Sector Background 71
4.6.3 Integration Into and Moving Up in GVCs 71
4.6.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain 74
4.6.5 Policy recommendations 76
5 Conclusions and Policy Implications 77
References 79
Appendix 1: Air Connectivity Index 83
Appendix 2: Air Trade Facilitation Index 87
Appendix 3: E-Freight Friendliness Index 90
Appendix 4: Interpretation of Scatter Plots and Trend Lines 94
Appendix 5: Country Codes Used in Figures 96
Appendix 6: Abbreviations Used in the Report 97

1 INTRODUCTION AND PROJECT OVERVIEW

Global Value Chains (GVCs) are becoming increasingly important in the world trading economy. Initially studied in the context of industries like transport equipment and electrical goods in East and Southeast Asia, the GVC model is now becoming increasingly common in other regions and sectors as well. Indeed, the perspectives for specialization and trading in tasks that GVCs offer are giving rise to a new paradigm in many developing countries: rather than building full supply chains in manufacturing sectors, they can instead enter GVCs at particular points, most typically assembly, and then gradually upgrade production into higher value added tasks, like component production, research and development, and marketing. Of course, this kind of "moving up" is not automatic, and depends on having the right settings in a variety of policy areas. But there is evidence that some developing countries are successfully leveraging GVCs to support sustained gains in productivity and per capita income, which are the hallmarks of economic development.

From an economic policy perspective, it is important to better understand the factors that enable countries, particularly developing ones, to join GVCs, and move up to higher value added activities. The area remains relatively under-researched, but it has been established that trade facilitation is a particularly important factor in promoting GVC-based trade (e.g., Saslavsky and Shepherd, 2014). The reason is that firms participating in GVCs retain very low inventory levels as a cost reduction measure, and instead rely on moving goods quickly, reliably, and at reasonable cost across borders. GVCs need to bring together components from sources in different countries at the assembly point, so that the final product can be manufactured. Streamlining customs and border procedures, as well as, more generally, reducing trade costs, are important policy priorities for countries looking to participate more fully in GVC trade.

In light of the need of GVCs to move goods quickly, air cargo looms large as a facilitating mechanism for participation and moving up (Memedovic et al., 2008). Moving goods by air is, of course, much faster than maritime shipping, and is favored by express carriers, and manufacturers moving high value-to-weight ratio goods, such as highly specialized component parts. For example, Sydor (2011) notes that in 2008, air cargo shipments accounted for around 25% by value of total Canadian trade, but around 80% in GVC-intensive sectors like scientific equipment, electrical goods, and aerospace, where movement of intermediate goods is extensive. In addition to helping firms maintain low inventories, the speed, reliability, and security of air cargo are also beneficial in cases when surface transport is disrupted, due to natural or social factors.

Based on these insights, the purpose of this project is to better understand, and highlight to the business and policy communities, the relationship between development of air cargo and participation in GVCs.

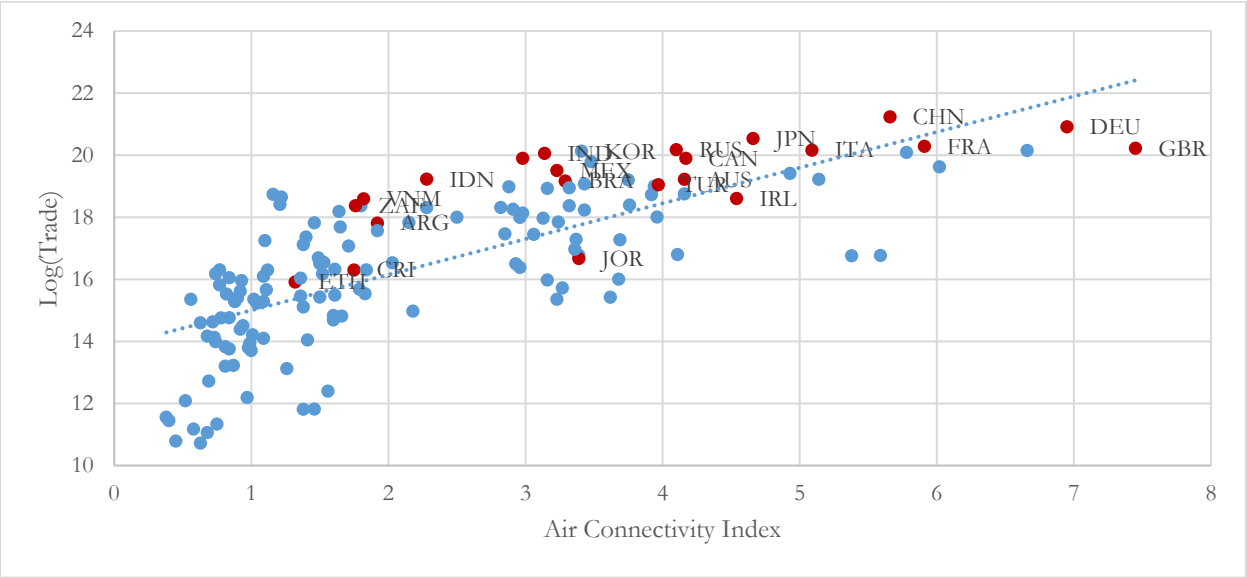
The project can be divided into two parts, which have been advanced concurrently. The first part is a data-based policy discussion of the links between air cargo and GVCs. It mobilizes existing data on GVC participation and air connectivity, as well as developing new indices on Air Trade Facilitation and eFreight Friendliness. The objective is to develop some simple but incisive measures showing that improving air cargo, and in particular mobilizing information and communication technologies within that context, can help countries participate more fully in GVC trade. Against that background, the second part of the project develops six case studies of particular GVCs, and shows the way in which air cargo has made it possible for countries to develop these sectors. Together, the two parts of the project provide a convincing rationale for developing air cargo capabilities as one way of promoting GVC extension and development, particularly in lower income countries eager to capitalize on the opportunities presented by world markets.

The substantive sections of the report provide detail on the ways in which air cargo can help boost GVC participation. That is one way in which air transport and trade are connected. But better air connectivity can also help open up new markets for a country's exports, and new sources for its imports. By facilitating trade, air cargo can help make it easier for firms to reach consumers, as well as to form links with each other that allow them to disperse production processes across countries in an optimal way.

Before delving into novel metrics and data, it is useful to exploit existing sources to show how air connectivity more generally is important for international trade. The Air Connectivity Index (ACI; Arvis and Shepherd, 2016; Arvis et al., Forthcoming) uses network analysis to calculate an index that summarizes a country's ability to connect to global air transport flows. Figure 1 shows that there is a strong positive association with trade, measured as the total value of exports and imports, excluding agriculture and mining (which are mostly bulk commodities shipped by sea). The interpretation of this figure is that countries that are better connected in terms of global air transport tend to trade more. Concretely, a one percent increase in the ACI is associated with a 6.33% increase in trade. (Appendix 4 contains important information on the interpretation of scatter plots and trend lines, including some significant caveats that need to be kept in mind.)

Intuitively, this finding stands to reason: air cargo accounts for a significant proportion of global trade in value terms, including transport by dedicated cargo and express services, as well as belly cargo traveling on passenger flights. As a result, the ability to connect to distant markets quickly, reliably, and at reasonable cost—which is what the ACI captures—can have a profound impact on a country's ability to engage fully with the world trading economy. As will be shown later in the report, the connection is particularly important in the context of trade in high value to weight ratio goods, including parts and components that circulate within GVCs and cross borders multiple times for processing and incorporation in other goods, before the final product is shipped to the consumer. Air transport is equally important for perishable goods, such as agribusiness products that circulate in emerging processed food and horticulture GVCs. The key characteristics of air transport—speed, reliability, and security—make it an attractive choice for exporters in sectors where those qualities are highly valued. The case studies presented below set out concrete examples of countries and sectors where the links are highly apparent.

Figure 1: Association between the Air Connectivity Index and trade, 2012.



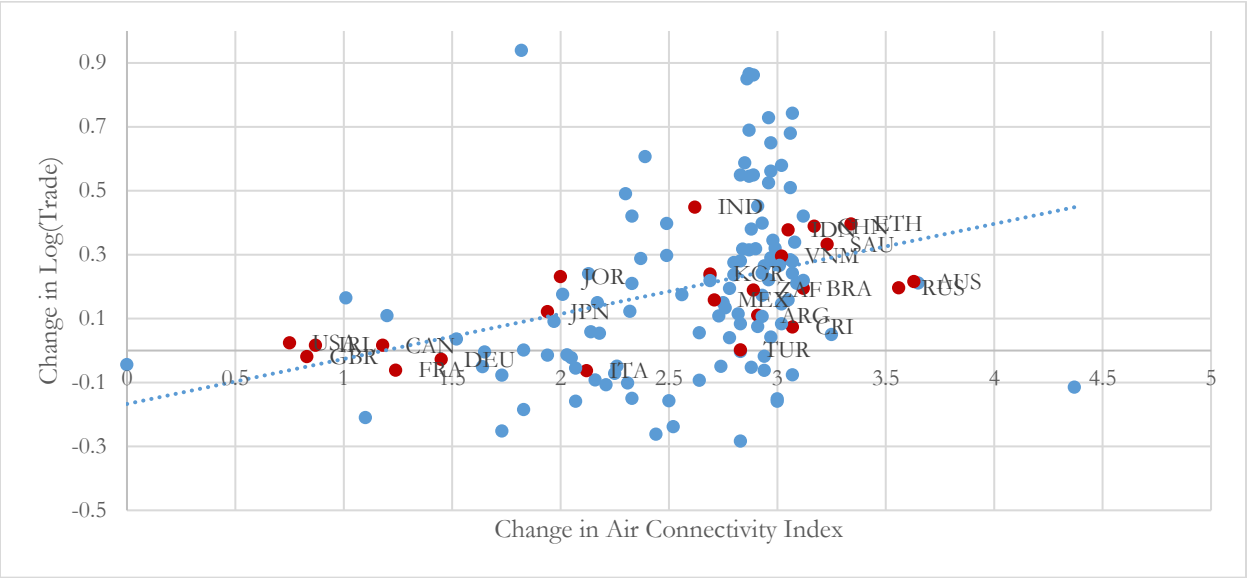
Source: Arvis et al. (Forthcoming); and UN Comtrade.

Note: One outlier removed. R2 = 0.50. Correlation is statistically significant at the 1% level. Countries in red are G20 members and case study countries. Saudi Arabia is in blue to improve readability.

Figure 1 provides a static, cross-sectional representation of the relationship between air connectivity and trade. That is mainly the approach of this report, which focuses on presenting the most up to date data, which could possibly be repeated in future to facilitate a dynamic analysis. For the ACI, however, a number of years of data are now available. Figure 2 therefore shows the dynamic association between the change in the ACI between 2008 and 2012, and the corresponding change in the total value of trade.[1] The association is again positive, which means that countries that have improved their air connectivity over time have tended to see corresponding increases in trade.

[1] The Global Financial Crisis and accompanying trade collapse intervene between these two points. However, the 2008 trade point is prior to the collapse, and the 2012 point follows a strong recovery in global trade. We prefer to use this period rather than, for example, 2010-2011 because it is plausible that there is a significant lag between improvements in air connectivity and changes in trade, and a single year delta may not be sufficient to capture the full nature of the dynamic effect.

Figure 2: Association between the change in the Air Connectivity Index and the change in trade, 2008-2012.



Source: Arvis et al. (Forthcoming); and UN Comtrade.

Note: The x-axis is rescaled so that the minimum observed value lies at zero. Countries in red are G20 members and case study countries. Outliers have been dropped to improve readability.

Having shown that there is a general relationship, both cross-sectional and dynamic, between air transport and trade, the remainder of the report looks more in detail at the particular role air cargo plays in GVCs. Section 2 provides a general overview of GVCs and development, focusing on the role of air cargo in promoting the linkage between the two. Section 3 then moves to the data component of the project, and presents the methodology for constructing indices for Air Trade Facilitation and eFreight Friendliness, as well as discussing results. Section 4 presents the country and sector case studies. Finally, Section 5 concludes and discusses policy recommendations based on the data analysis and case studies.

2 AIR CARGO, VALUE CHAINS, AND DEVELOPMENT

This section provides a policy-relevant introduction to the links between air cargo and GVCs. It starts by examining in more detail what exactly a GVC is and how it operates, focusing on some well-known examples. It then leverages recent economic analysis to show the ways in which GVC development can have positive implications for sustainable development, within the meaning of the recently adopted UN Sustainable Development Goals. Finally, it zooms in on the role of air cargo in linking firms to GVCs, particularly in developing countries. The analysis presented here is based on Shepherd (Forthcoming).

2.1 What is a Global Value Chain?

GVCs are complex, interlinked networks of cross-border and domestic flows of goods, services, and factors of production (capital, including knowledge capital, and labor). They rely on the ability to move goods quickly, cost effectively, and reliably across borders. Although GVCs are active in services, this report focuses on goods markets, where air cargo plays a particular role; for services GVCs, air passenger flows, which facilitate services trade through the temporary movement of natural persons, are of greater importance.

The GVC business model simply cannot work in the presence of long transport times, or other supply chain disruptions. Lead firms are crucially concerned with risk management, and aim to ensure continuous production even when unforeseen problems occur somewhere in the structure. Suppliers and assemblers keep inventories low, so as to avoid carrying costs, which means that stock outs can potentially be very costly to a wide variety of actors. The net result is that the relationship specific investments that drive GVCs are only made if lead firms can be confident that they will be able to coordinate suppliers of all sorts consistently and with a defined cost profile.

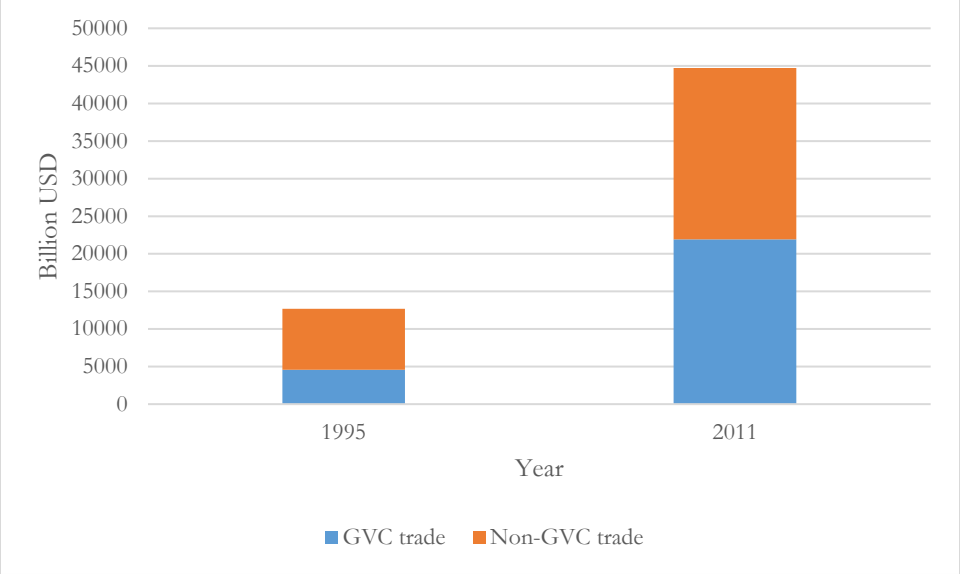
The most fundamental concept behind GVCs is trade in tasks. The GVC paradigm is consistent with narrower patterns of specialization, in which countries become proficient in one or a number of tasks—production of goods or services—needed as inputs for a particular good, but do not necessarily develop full domestic supply chains for entire industries. For example, when Korea was developing its transport equipment industry through middle-income status, it developed all parts of the supply chain, from research and development through component production, to assembly, and distribution and marketing. Now, a country like Vietnam takes a radically different approach: it assembles imported knockdown kits, and has more recently moved into production of some component parts for Asian automobile value chains.

GVCs are now active all around the world, in a range of sectors. East and Southeast Asia is a particular locus of activity, with sectors like electrical goods and transport equipment standing out. Early GVC development relied on investments by Japanese lead firms with global reputations and scope. They developed supplier networks throughout developing East and Southeast Asia, and brought together complex ranges of parts and components at designated assembly points, to be shipped to world markets. Transport is clearly an important input into GVC activity, and the important role of speed and reliability, noted above, means that air transport is frequently an attractive option for parts and components with a high value to weight ratio.

GVC trade has increased markedly in recent years, as the business model has spread into new regions and sectors, and intensified in existing ones. WTO data (Figure 3) show that trade in goods and services within GVCs grew at an average annualized rate of 10.30% between 1995 and 2011 (the latest year for which data are available); by comparison, trade outside GVCs—"traditional" trade transactions—grew at 6.67% annually. GVC trade now accounts for over $20 trillion worth of trade,

or 49% of the global total. Clearly, GVCs have become one of the most important issues on the trade agenda.

Figure 3: GVC and non-GVC trade in goods and services, 1995 and 2011, billion USD.



Source: World Trade Organization.

Trade in parts and components is a key component in GVC activity, and is tracked in the two most commonly used quantitative indicators of GVC activity. Databases like the OECD-WTO TiVA database, the World Bank's EVA Database, and the Eora Database develop a new approach to measuring trade flows that focuses on value added, i.e. trade value less intermediate inputs, whereas traditional trade statistics use gross values that do not account for input use. One of the main attractions of the value added approach to trade is that it provides a coherent methodology for identifying traded intermediate inputs, goods and services alike. This process has led to the development of "linkages" metrics that summarize a country's degree of integration into GVCs by looking at its exports and imports of intermediate goods. Specifically, backward linkages are measured as the percentage of a country's gross exports that is accounted for by foreign value added embodied in imported intermediate inputs. Forward linkages are the mirror image: the percentage of a country's gross exports that is accounted for by intermediates used in a foreign country's exports. These two processes—importing intermediates that are later embodied in a countries export goods, and exporting intermediates that another country then uses for export of its own goods—are characteristic of GVC participation at a macro-level. They emphasize trade in intermediate goods, rather than final products, and are indicative of countries that are pursuing specialization in particular tasks according to their comparative advantage, which has the effect of reducing prices and increasing variety. The two indicators can be summed to give an overall measure of GVC participation, and are frequently used both in the technical literature and in policy material, to provide a summary indicator of the degree to which a country participates in the types of trade that are characteristic of GVC participation. TiVA, EVA, and Eora make it possible to undertake these calculations for a wide range of countries and sectors. They play an important role below, where measures of air cargo performance are shown to be associated with these indicators of GVC integration—a quantitative indication of the links between air cargo and GVC integration.

Box: What do Backward and Forward Linkages Mean in Practice?

Economists use the concepts of backward and forward linkages to capture two types of trade that are of particular relevance to GVCs. But what do they mean in concrete terms?

To answer this question, we take a simple example. Many companies assemble desktop computers in China. A crucial input into many desktops is the hard drive. Thailand is the main global source of hard drives, with numerous large brands like Seagate and Western Digital having production facilities there. Chinese computer assemblers import hard drives from Thailand, as well as many other parts and components from other sources, then assemble them into a desktop computer in China. The computer is then exported around the world, to markets including Europe and the United States.

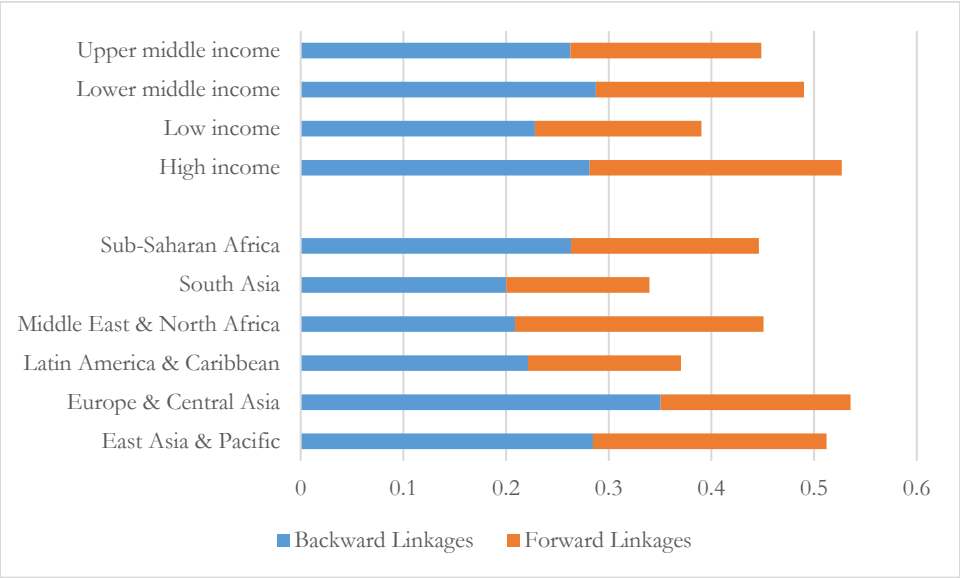
From the perspective of a Chinese computer assembler, importing hard drives from Thailand counts as a backward linkage. In terms of the concepts discussed in the main text, it is an import from another country that is incorporated in a Chinese export (computers). The value of the hard drive is therefore included in data summarizing the extent of China's backward linkages in the electrical goods sector.

From the perspective of a Thai hard drive manufacturer, exporting hard drives to China counts as a forward linkage: it is an export that is then incorporated in China's own exports (computers). The value of the hard drive is therefore included in data summarizing the extent of Thailand's forward linkages in the electrical goods sector.

In reality, economists and statisticians use complex techniques to construct datasets that measure backward and forward linkages. Data quality is improving all the time, and provides an important insight into the operation of GVCs around the world.

Kowalski et al. (2015) use data from Eora to calculate participation indices for a wide range of countries (Figure 4). Results show that levels of integration in Sub-Saharan Africa and South Asia are typically lower than in East Asia and the Pacific, where GVC activity is better developed. Nonetheless, even in South Asia—the least connected region—backward and forward linkages together account for about one third of gross exports. Comparing performance across income groups shows that high and middle-income countries tend to be significantly integrated into GVCs, but low income countries considerably less so. Of course, these results are based on aggregate trade (i.e., summing across all sectors), and differences would likely be observed at a more detailed sectoral level; this aspect is explored below, where sectoral data are presented, and through the country-sector specific case studies in Section 4. Despite this initial limitation, the overall picture that emerges is one of substantial developing country integration into GVCs all across the world.

Figure 4: GVC participation indices, 2011, by developing region and World Bank income group.



Source: Shepherd (Forthcoming), based on Kowalski et al. (2015).

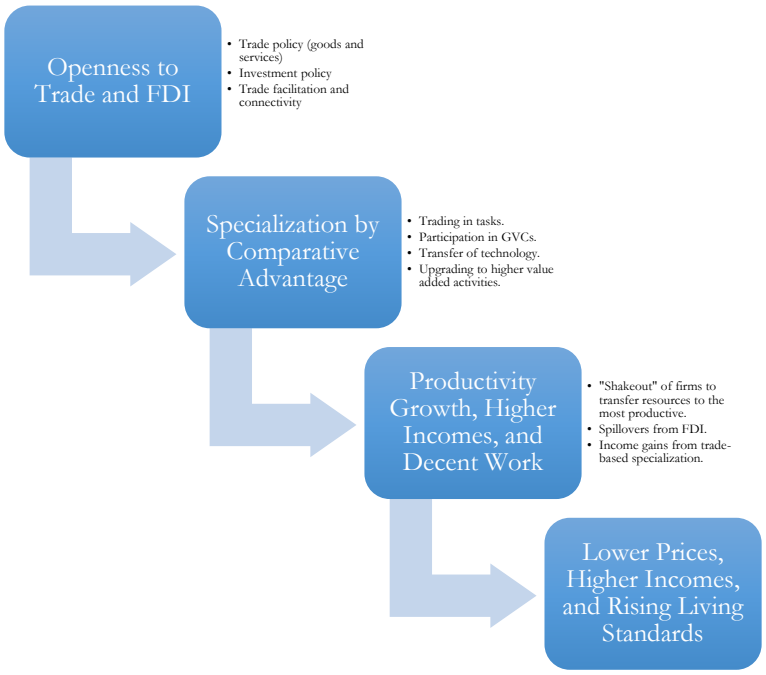
Notes: Geographical regions exclude high-income countries. All figures that present data by developing region or income group use simple averages across the countries in the relevant group, in accordance with standard practice.

2.2 GVCs and Sustainable Development

One approach to the term "sustainable development" is embodied in the United Nations Sustainable Development Goals. It combines economic, social, and environmental sustainability. It is indeed important that all three aspects be considered, as development cannot truly be sustainable if one of the three main pillars is unduly neglected. This section therefore examines the potential for GVCs to help promote development that is sustainable economically, socially, and environmentally.

The mechanisms underlying GVC-based development are in some cases complex, but it is possible to identify some key features that recur across countries. Figure 5 summarizes these links between GVC participation and economic outcomes, abstracting from the complex feedback loops between the different effects. First, GVCs generate employment and income, particularly for low-skilled labor. Then, from the perspective of the macro economy, there are national income gains through specialization by comparative advantage, pushed further than in the past due to the trading in tasks dynamic discussed above. Both of these forces are accentuated by investment and trade: engaging in GVC activities often produces industrial clustering, where spillovers across firms encourage additional internationalized activity. Finally, there is the possibility of moving up to higher value added activities, as labor markets tighten and per capita incomes increase—provided, of course, that there is a solid base in terms of human capital, which depends on policies in the area of education and training.

Figure 5: GVC participation and economic outcomes.



Source: Authors.

To elaborate on the mechanisms set out above, we consider the economic, social, and environmental aspects separately.

2.2.1 GVCs and Economic Development

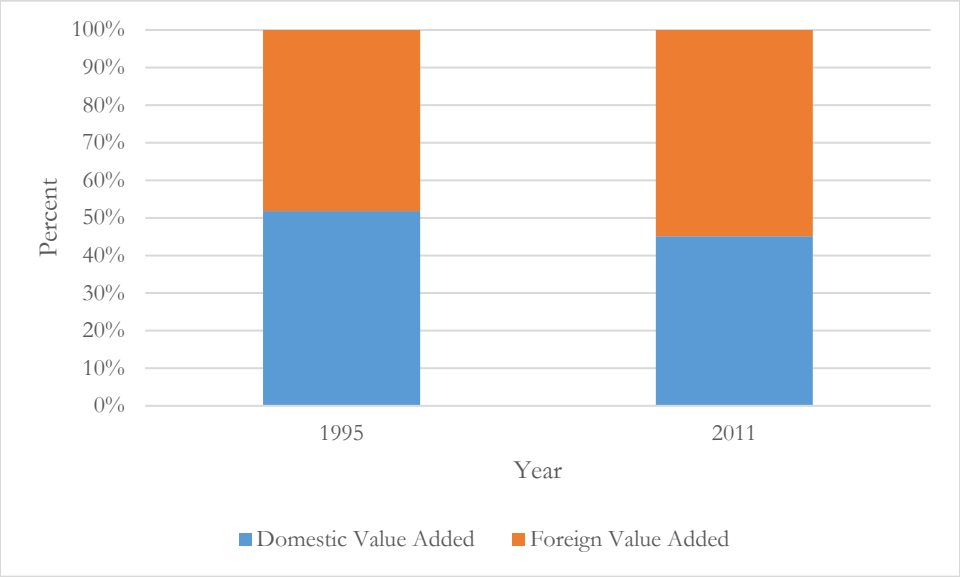
From an economic point of view, a typical point of entry into a GVC for a developing country is a low value added activity, such as assembly. Countries like China and Vietnam stand out for their success in this area in sectors like electrical products, such as cell phones. Although countries are concerned with "moving up" to higher value added activities, it is important to stress that even low value added activities can have economic benefits for developing countries compared to a situation of closed markets, i.e. no GVC linkages. Importantly, low value added activities are typically labor-intensive, which means that they can be a major source of formal sector employment, which helps support a shift from an agricultural to an industrial economy that is one of the hallmarks of economic development. In labor surplus economies, there is typically a large stock of unused human resources subsisting at very low income levels. Those people can be drawn into labor-intensive manufacturing, particularly towards the lower skilled end. Income gains can be substantial, and it can represent an entry point into the formal labor market for many people. China, for example, has seen a large-scale movement of human resources out of agriculture and into manufacturing, focused initially on low value added tasks like assembly. This process has been one of the cornerstones of the country's spectacular development gains, including higher per capita incomes and reductions in poverty.

In addition, there is also an industrial rationale for countries to be open to GVC-linked investments and activities. There is strong evidence that domestic and foreign value added are complements, so bringing them together through a GVC allows for faster sectoral growth on an overall basis than would otherwise be possible, even when the share of domestic value added in percentage terms falls as a consequence of increased GVC integration. Kowalski et al. (2015) characterize this feature of GVC-based trade as obtaining "a smaller slice of a larger pie". Figure 6 demonstrates it using data for

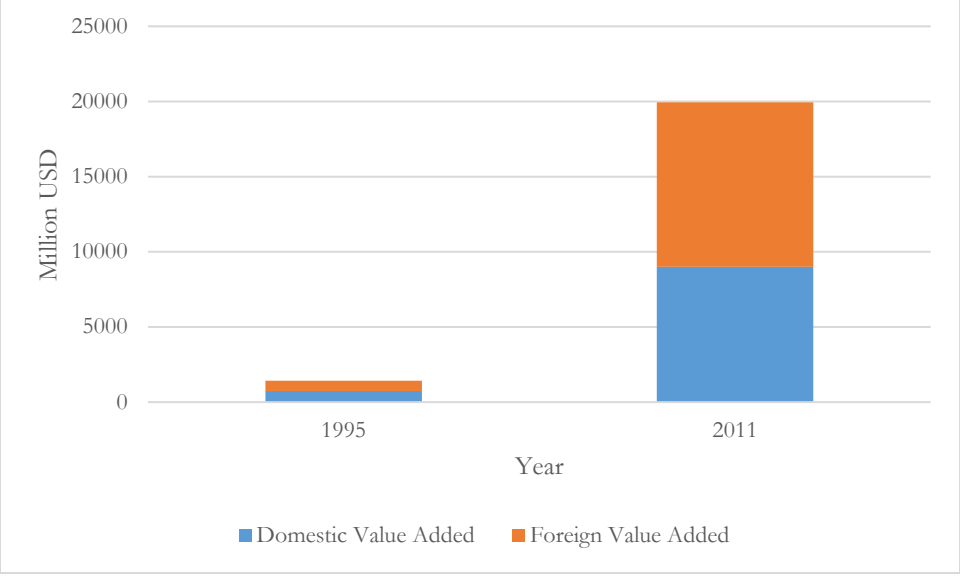
the transport equipment sector in Thailand, a well-established example of a successful GVC coordinated by Japanese lead firms. In essence, the point is that letting in foreign value added through imports of goods and services (as well as people and ideas) allows domestic value added to grow more quickly than it would under a restrictive trade and investment regime, even though the change in terms of proportions may be less marked, or even move in a different direction. This pattern is common throughout the developing world, and is reflected in the case studies in Section 4.

Figure 6: Complementarity between domestic and foreign value added in Thailand's transport equipment industry.

a) Domestic and foreign value added content of gross exports, shares, 1995 and 2011.



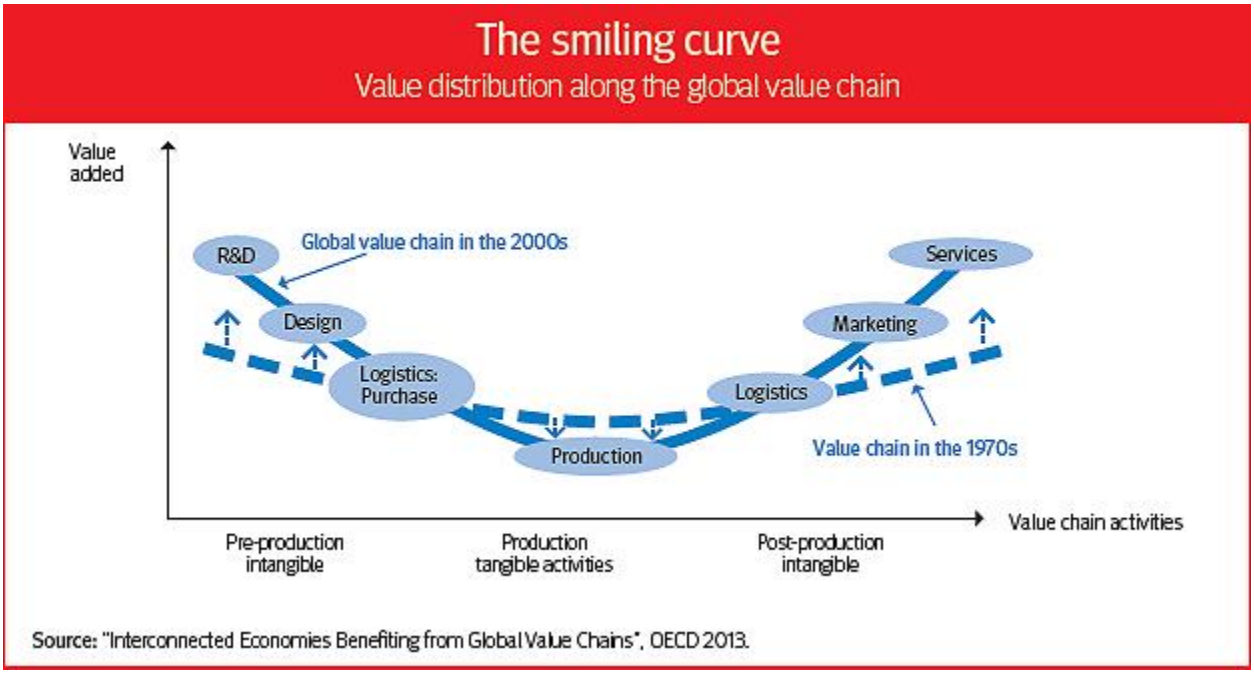
b) Domestic and foreign value added content of gross exports, million USD, 1995 and 2011.



Source: OECD-WTO TiVA.

GVCs involve a wide range of tasks, with different associated levels of value added or rent capture. Analysts typically see the distribution of value added by processing stage as following a "smile curve" (Figure 7). Upstream and downstream activities are typically relatively high value added, whereas mid-range activities—assembly is an example in manufacturing—are relatively low value added.

Figure 7: Value added distribution by task and processing stage in GVCs.



In policy discussions, there is sometimes a subtext in which GVC participation is only seen to be economically beneficial if it takes the form of high value added activities. But economists have long been at pains to point out that international trade can be beneficial for countries regardless of the level of value added associated with their product or task specialization. Paul Krugman's "pop internationalism" remains alive in discussions of GVCs in developing countries (Krugman, 1993). To be perfectly clear, a developing country can benefit economically relative to a closed economy from joining a GVC in a low value added activity, such as assembly in manufacturing or the supply of raw materials in commodity-based value chains. Concretely, these activities provide employment in countries where formal labor markets often suffer from structural deficiencies in demand in the face of growing, young populations. They provide formal sector income that can then flow back into the economy through the purchase of goods and services, and can serve as a tax base for the government, which can then provide at least some public goods that are underprovided by market forces alone. The prospect of engaging, at least initially, in low value added activities should not be a deterrent to developing countries from seeking to increase GVC activity within their borders. And of course, if other fundamental policies are right—like human capital development and institutions—there is the prospect of moving up to higher value added activities.

Of course, the above analysis does not mean that it makes no difference to a country whether it specializes in low or high value added activities. The comparison in the previous section was between a closed economy and an open one. But it is also important to recognize that once the economy is opened, the rate of productivity growth—which is the most reliable long-term driver of increases in per capita income—depends on the type of activities a country specializes in. For example, Hausmann et al. (2007) show that a country's growth rate is influenced by the level of sophistication of its export

bundle. Moving up in value chains to higher value added activities means that sectoral productivity is increasing, which in turn can provide the basis for higher per capita incomes—the core component of economic development. In addition, some high value added activities such as research and development or design have significant spillovers, which mean that their economic benefits go beyond the organizations that directly undertake them. Again, they can fuel growth in the manner of the class of endogenous growth models associated with Romer (1994), where one sector of the economy specializes in producing innovations that in turn affect production in other sectors.

From an economic development perspective, the dynamic process of "moving up" is therefore of real importance to developing countries. Over time, they want to shift into higher value added activities. However, that this aim does not support the widespread use of distortionary policies that artificially move economic resources into particular sectors. Although "industrial policy" has come back into vogue in some circles, it is important to stress that although correcting market failures through government intervention can be justified in principle, the practice is often problematic, as protection can be captured by uncompetitive firms or other rent-seekers; although there are instances of countries applying industrial policy successfully, there are also many cases of it leading to stagnating productivity, and even economic crisis. Robinson (2009) provides a helpful discussion of the political economy problems surrounding industrial policy in developing countries. By contrast with the patchy history of distortionary industrial policy, there is extensive firm-level empirical evidence showing that lowering trade costs—opening to the world economy—can support a process in which low productivity firms exit, high productivity firms grow, and overall sectoral productivity increases (see e.g., Pavcnik, 2002 for the case of Chile).

Experience on the ground suggests that GVC participation indeed offers significant potential for economic development. China's role as an assembly hub is typical of the early stages of GVC engagement, and was part of a broad-based engagement with the world economy that led to rapidly increasing incomes, and large scale poverty reduction. With labor markets tightening and a pool of well qualified technical workers, China is now engaging in substantial moving up in key value chains, like electrical products. Assembly activity is starting to move to lower cost countries, like Viet Nam—which is also leveraging GVC engagement to provide employment and higher incomes as the bedrock of economic development and poverty reduction.

2.2.2 Social Aspects of GVCs

Of course, incomes are not the only component of sustainable development. It is also important to consider social aspects, such as decent work—a key objective of labor organizations around the world. The core of that concept relates to employment creation, social protection, rights at work, and social dialogue. It is fair to say that there is at least some skepticism within the labor community as to the potential for GVCs to help promote decent work (e.g., ILO, 2016). Incidents such as factory fires and structural collapses in the garment industry are pointed to as examples of GVC-driven manufacturing activity being associated with unsafe and unfair working conditions. On the other hand, the economic mechanisms discussed in the previous section make clear that GVC expansion offers employment opportunities, including potentially to people not previously involved in the formal labor market, including women.

In addition to employment creation from GVCs, it is also important to consider wage levels. Economists have conducted extensive quantitative research on wage levels in exporting firms, including those involved in GVCs. The consensus is that firms that are engaged with the world economy through importing, exporting, or receiving FDI in fact pay higher wages than firms that serve the domestic market only. For example, Frias et al. (2009) conduct a detailed evaluation of the

Mexican case, and find that exporters pay higher wages than other firms, even after taking account of different skill compositions. Shepherd and Stone (2013) analyze data from a range of developing countries and similarly find that internationally engaged firms employ more workers, pay higher wages, and employ more skilled workers than firms that serve the domestic market only. Of course, these research results do not mean that wages paid in export industries in developing countries are at all comparable to those paid in developed countries. But that difference is due to macroeconomic factors like the price level, as well as large differences in productivity. In looking at the capacity of GVCs to create decent work, it is important to have the right counterfactual in mind: based on the available research, of which Shepherd and Stone (2013) is an example, the relevant counterfactual of relying on domestic investment to drive export oriented activities would in fact result in fewer jobs and lower wages than facilitating foreign investment, including by GVC lead firms, in export-oriented sectors. Moreover, developing countries are relatively capital scarce, so relying on domestic rather than foreign investment imposes a relatively low upper limit on the rate of industrial development—with attendant job growth and wage income—they can attain.

One sector in which social concerns are prominent is the apparel industry, which is explored in more detail in the case studies. Bangladesh has been very successful in developing GVC participation in the apparel industry, and has enjoyed considerable economic benefits as a result. However, there have also been notable cases of social difficulties in the sector, such as unsafe working conditions, and low wages. Consumer concerns with these problems led lead firms like H&M and Zara to develop traceability initiatives, which monitor the performance of subcontractors on social criteria. Both firms have increased transparency in their supply chains, and have contributed to the promulgation of standards that seek to improve their social footprint in countries like Bangladesh. As noted above, the evidence tends to suggest that working conditions tend to be better in the export sector than in firms that serve local markets only, and under consumer pressure, lead firms have been actively trying to improve conditions for workers.

2.2.3 GVCs and the Environment

Another potential challenge to the GVC paradigm from the sustainable development point of view relates to the environment. On the one hand, there is (as in the case of labor standards) a fear of a race to the bottom in terms of environmental protections as countries seek to lower costs and attract GVC activity. However, the empirical content of this argument seems to be limited, even though the mechanism could be important in theory. More fundamentally, though, GVC expansion into developing countries is part of a general expansion of the market economy that draws in natural resources as inputs, and affects the environment through externalities Clearly, if GVC expansion increases the strain on resources in developing countries, it has the potential to be associated with negative environmental impacts, and unsustainable practices.

In assessing these concerns, it is important to note that the types of environmental issues raised by GVC expansion are not, in fact, peculiar to GVCs as a form of business organization, but instead relate to most extensions of economic activity. Indeed, GVCs can, under appropriate circumstances, help promote environmentally sustainable development. For example, as in the case of social development, there is scope for developed country consumers to exert pressure on lead firms to ensure certain standards are met by their suppliers, through programs like supply chain transparency and traceability. Although such mechanisms are by no means perfect, they have led to important improvements in sectors like furniture, which make extensive use of natural resources. Lead companies like Ikea have developed sustainability initiatives covering their suppliers, with the objective of ensuring that they support a sustainable environmental footprint at all levels. In other sector, foreign

investment can come with technology transfer, which can allow developing country firms to adopt production methods that are at once more efficient and more respectful of the environment.

2.2.4 Bringing it All Together: Economic, Social, and Environmental Development

On balance, the evidence currently suggests that GVCs offer important development perspectives—covering economic, social, and environmental aspects—to developing countries, which leads to the question of policy steps that can be taken in those countries to help attract lead firm investments, and develop the supplier base. Experience over recent decades in regions heavily involved in GVCs, particularly East and Southeast Asia, shows that they can in the first instance bring significant economic benefits. GVC linkages with environmental and social issues are more complex, and depend crucially on domestic policies and regulations, as well as standards developed by lead firms in response to consumer pressures. Although monitoring is imperfect, the reality on the ground is that factories involved in prominent GVCs typically pay higher wages, and have stronger labor and environmental policies, than factories that produce for local markets only. Under the right circumstances, GVCs can be a powerful force promoting economic and social development, in a way that is respectful of the environment.

2.3 Linking Firms to GVCs: The Role of Air Cargo

As noted at the outset of this discussion, speedy transport of component parts is a key consideration for GVC lead firms in setting up their networks. Given that many components have a high value to weight ratio, air cargo is a logical choice for ensuring that goods move between production locations rapidly and reliably. Air cargo plays a particular role in many manufacturing GVCs, where express shipments of components are used to support the chain's just-in-time approach to combining and assembling inputs.

Tracking air cargo flows through trade data is not a simple task, as many countries do not publish such information, and global databases like Comtrade do not record it. Nonetheless, some major import markets do disaggregate by transport mode, including the US and the EU. For example, US import data identify a number of national product lines under code 847330, which covers parts and accessories for computers and similar equipment. In this case, approximately 70% of US imports by value come by air. The implication is clear: sectors where GVC activity is intense, and where small but high value component parts play an important role, rely heavily on air transport.

Looking more broadly at the data bears out this contention. Table 1 shows the sectors with the highest proportion of imports by air in the EU, and Table 2 repeats the analysis for the United States. Both tables break out the sectors considered in the case studies, and other sectors where air transport is particularly important. A number of the sectors explored in the case studies below come up in these tables, such as electrical equipment, and pharmaceuticals, as well as, in the case of the US, some textile products. In each of the case study sectors, air cargo is used extensively to transport high value to weight ratio goods, such as parts and components in the electronics and medical equipment sectors, and final products in pharmaceuticals, where controlled environments and rapid movement from producer to consumer are necessary to ensure a high quality final product. In the apparel sector, "fast fashion" retailers like H&M and Zara make extensive use of air cargo in their supply chains when time to market is critical for finished goods.

One point to highlight is that air cargo is not only important in manufacturing GVC sectors, but also in emerging agribusiness value chains: cut flowers are prominent in both data sets as a sector that relies heavily on air transport. Although not examined in this report, there is extensive evidence suggesting that the cut flowers sector has substantial GVC characteristics (e.g., Evers et al., 2014), which

reinforces the contention that air cargo performance can be a crucial determinant of GVC development. In the case of agribusiness GVCs, as well as for some pharmaceuticals, the crucial characteristic of air cargo that makes it well suited to the needs of business is its speed: when dealing with perishable goods, moving them rapidly from producer to consumer is vital. More generally, the two tables demonstrate that air cargo accounts for a substantial proportion of total trade in selected sectors in these two large markets, and that the amounts of trade coming by air are economically significant.

Table 2a: Proportion of EU imports by value coming by air, 2014, case study sectors.

Sector	Description	Value By Air (M EUR)	Total Value (M EUR)	Percentage of Value by Air
HS90	Precision (including medical) instruments	98000	160000	61.25
HS85	Electrical equipment	240000	520000	46.15
HS30	Pharmaceuticals	59000	160000	36.88
HS84	Machinery and parts	200000	550000	36.36
HS58	Fabrics and textiles	690	2200	30.78

Source: EU ComExt; and authors' calculations.

Table 1b: Proportion of EU imports by value coming by air, 2014, other key sectors (greater than 50% of value by air).

Sector	Description	Value By Air (M EUR)	Total Value (M EUR)	Percentage of Value by Air
HS01	Live animals.	590	660	89.39
HS06	Plants including cut flowers	3700	4800	77.08
HS71	Precious stones and metals	130000	170000	76.47
HS43	Fur products	1000	2000	50.00

Source: EU ComExt; and authors' calculations.

Table 3a: Proportion of US imports by value coming by air, 2015, case study sectors.

Sector	Description	Value by Air (M USD)	Total Value (M USD)	Percentage of Value by Air
HS50	Silk yarns and fabrics	91.29	116.64	78.27
HS30	Pharmaceuticals	56621.31	85507.99	66.22
HS90	Precision (including medical) instruments	45646.88	77441.37	58.94
HS85	Electrical machinery	152147.52	328286.27	46.35

Source: Census Bureau; and authors' calculations.

Note: Excludes special classification HS98.

Table 2b: Proportion of US imports by value coming by air, 2015, other key sectors (greater than 50% of value by air).

Sector	Description	Value by Air (M USD)	Total Value (M USD)	Percentage of Value by Air
HS28	Inorganic chemicals	12609.01	12609.01	100.00
HS97	Works of art	10823.45	11678.31	92.68
HS91	Clocks and watches	4775.47	5680.10	84.07
HS71	Precious stones and metals	47941.84	59309.04	80.83
HS06	Plants including cut flowers	1103.28	1735.02	63.59
HS29	Organic chemicals	26726.95	50922.10	52.49

Source: Census Bureau; and authors' calculations.

Note: Excludes special classification HS98.

Box: Tracking the Case Study Sectors in the Harmonized System

Tables 1 and 2 use the global standard for categorizing trade data: the Harmonized System (HS). The HS identifies over 5,000 individual products at the globally standardized level; countries like the US and the EU then use their own classifications to go into an even finer level of detail, typically over 10,000 items.

The summary tables use data aggregated to the Chapter ("2 digit") level. This is a very aggregate level, useful for uncovering broad trends in the data. The characteristics of the case study are developed in detail below, but it is useful to give some substance to the tables by briefly discussing the case study sectors, and how they relate to HS chapters. The sectors are: medical devices; textiles and apparel; pharmaceuticals; and electrical machinery.

Of the case study sectors, pharmaceuticals is the only one that receives its own, well-defined chapter. It covers products like tablets and capsules, as well as vaccines and other related products. Inputs (chemicals) are dealt with in other parts of the HS that deal with chemical products, classified by type (organic vs. inorganic, etc.).

The textiles and apparel sector is covered in considerable detail in HS chapters 50 to 65. Each chapter deals with a different type of product, for example cotton (including yarns and woven fabrics of cotton; Chapter 52), or knitted or crocheted articles of apparel and clothing accessories (Chapter 61). The set of textiles and apparel chapters covers major inputs as well as outputs.

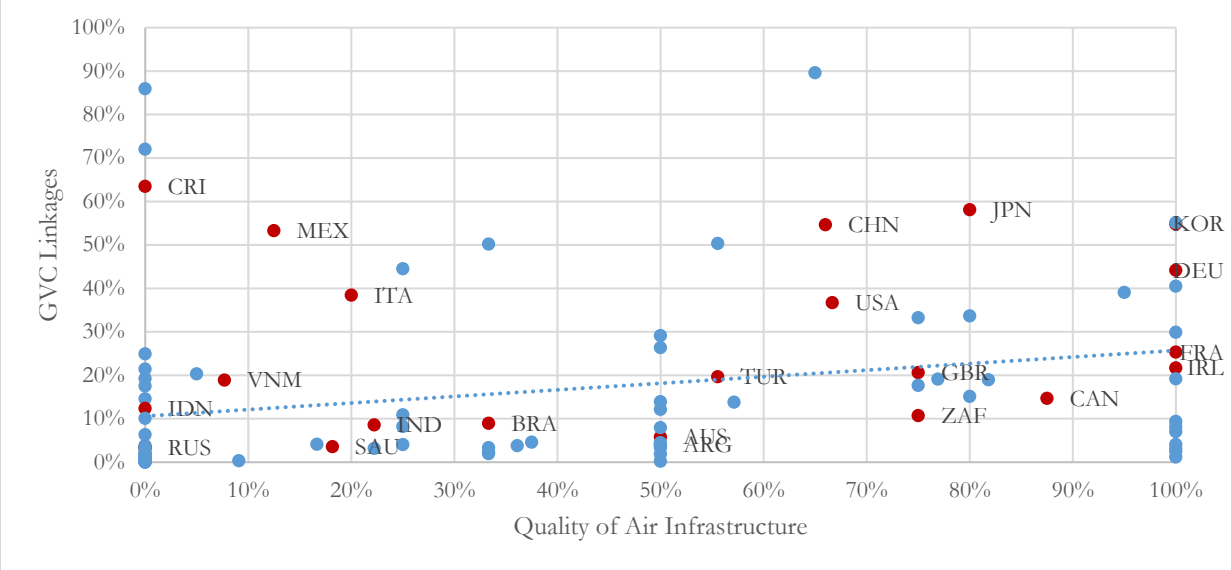
Machinery of various types is dealt with in a number of HS Chapters, each of which contains a large number of individual products. Chapter 84 is a broad classification covering many types of machinery, but includes computers. Other types of electrical equipment come under Chapter 85. Both chapters include parts and components for various types of machinery as separate product-level entries. Medical instruments are covered under Chapter 90 of the HS, which also includes various other optical and precision instruments. As this discussion suggests, the treatment of these kinds of products is complex in the harmonized system.

The case studies use aggregate data on broadly-defined sectors. Initiatives to measure GVC trade, for instance through backward and forward linkages, rely on national accounts data that are not available at the same level of detail as national trade data. However, the case studies supplement that broad-

based information with product-level detail from qualitative sources and country studies. It is important to have both perspectives in mind.

Section 3 below develops some novel metrics of air cargo performance that cover a range of these issues. They are strongly associated with higher levels of GVC integration, as measured by backward and forward linkages in relevant sectors. At this stage, it suffices to use pre-existing data to tell the basic story. The World Bank's Logistics Performance Index asks respondents—who are logistics professionals—to rate the quality of air transport infrastructure, and also the quality and competence of air transport service providers. Figures 8 and 9 show that the percentage of respondents indicating that quality is "good" or "very good" in a country is positively associated with GVC linkages, both backward and forward, in the machinery sector, which includes electrical equipment and medical devices. This sector has been chosen because it is an important GVC sector, and is examined in greater detail in the case study section of the report. These figures provide preliminary evidence to support the view that air transport can play an important role in promoting GVC development, in particular in developing countries: one way of increasing backward and forward linkages is to improve the quality of air transport infrastructure and services. Of course, there is considerable dispersion of points around the trend line, which means that air transport infrastructure and service sector quality are not the only factors that affect a country's degree of participation in GVCs; many other aspects of the policy environment and business climate are also important, as discussed above. Although the questions in the LPI survey are generally phrased, it is likely that respondents are answering based on their experience with cargo services, which they primarily use in their professional lives as freight forwarders and other types of logistics agents. The next section develops the links between air cargo performance and GVC integration in greater detail.

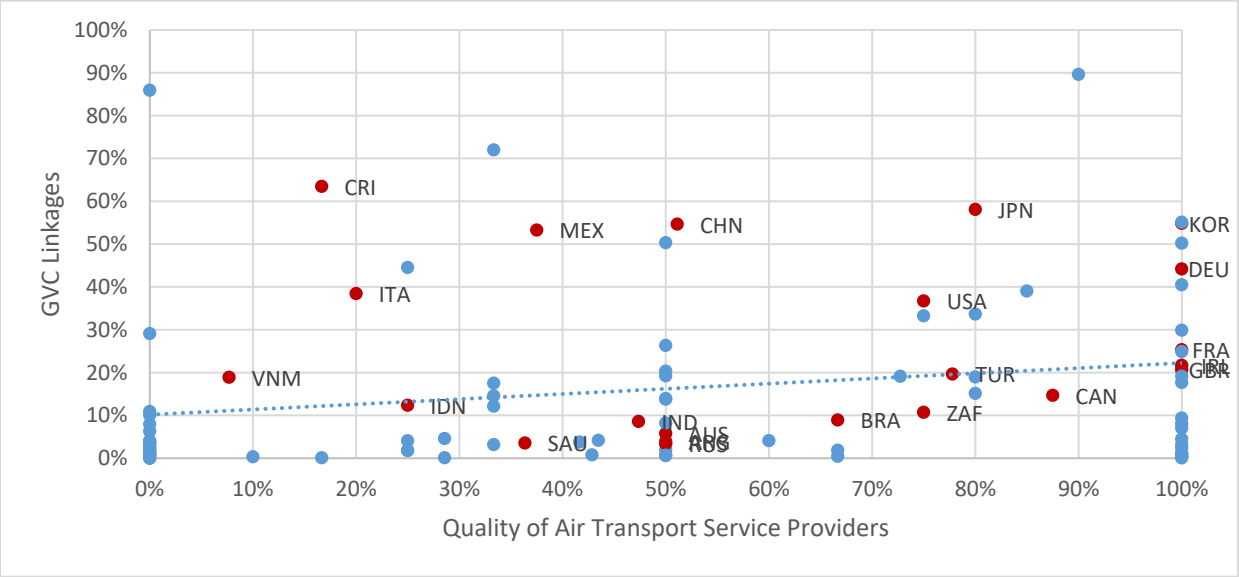
Figure 8: Percentage of Logistics Performance Index respondents indicating air transport infrastructure of "good" or "very good" quality vs. backward and forward GVC linkages, machinery sector.



Source: Logistics Performance Index; EVA Database; and authors' calculations.

Note: Countries in red are G20 members and case study countries.

Figure 9: Percentage of Logistics Performance Index respondents indicating air transport service providers of "good" or "very good" quality vs. backward and forward GVC linkages, machinery sector.



Source: Logistics Performance Index; EVA Database; and authors' calculations.

Note: Countries in red are G20 members and case study countries.

It is important to note that the discussion in this report focuses on goods GVCs, but this way of organizing economic activity is also becoming important in services sectors. In financial services, for example, investment banks use bases like India to support round-the-clock processing of back office transactions. More generally, high value services are often well-suited to the mix of trade and investment that GVCs bring to the fore. Whereas air cargo is crucial for goods GVCs, it is likely—although a question for future research—that air passenger transport plays a similar role for services GVCs. Services firms need to move experts and employees around the globe rapidly for meetings and client engagements. Air transport is, of course, the mode of choice. As developing countries move further into services, this aspect of the linkage between air transport and trade is likely to be of increasing importance, and solid data and research will be needed to support high quality policymaking.

3 Measuring Air Cargo Performance: Empirical Evidence on Air Cargo and GVCs

Although various indicators exist that are of relevance to air cargo performance, there is a clear need for additional metrics to inform discussions on policy changes and reforms that could help improve the air cargo environment, particularly in developing country. The World Bank's Logistics Performance Index (LPI) contains survey data on logistics professionals' perception of air transport infrastructure, and also air services. However, it does not deal specifically with cargo, even though the core expertise of survey respondents is typically in that area, so it could be assumed that their responses may relate more to cargo performance than to passenger traffic. The World Economic Forum surveys global executives in a wide range of areas, including infrastructure. This indicator can again provide some basic information on the state of air transport infrastructure in a country, but does not go into any detail about cargo performance.

Against this background, this section develops quantitative metrics of air cargo performance. The first, the Air Connectivity Index (ACI), is drawn from previous research (Arvis and Shepherd, 2016; and Arvis et al., Forthcoming). The other two are new to this report: the Air Trade Facilitation Index (ATFI), and the eFrieght Friendliness Index (EFFI). After developing the three indices and setting out their methodologies and data sources, there is a presentation of the association between these measures of air cargo performance and common metrics of GVC integration across countries. The net result is that there is clear quantitative evidence that better air transport is associated with improved integration into GVCs in a variety of sectors. This association is observed across a wide variety of countries, in all regions, and at all income levels, which suggests that the conclusion has general application.

3.1 The Air Connectivity Index

The first indicator considered is the ACI. Arvis and Shepherd (2016) developed this indicator as a summary measure of a country's position in the global air transport network. Countries with a higher ACI score have stronger air connections to a wider range of destinations than countries with a lower ACI score. Arvis and Shepherd (2016) show that a higher ACI score, which evidence stronger connectivity, is robustly associated with deeper integration into the world trading economy. GVCs rely on bringing together parts and components from a range of countries for assembly of final products. As such, connectivity is crucial to their operation: they need to move goods quickly, reliably, and safely. Air transport potentially has important advantages, and so we expect to observe an association between the ACI, as an outcome-based measure of air transport integration, and data on GVC participation.

The ACI is based on SRS Analyzer data on bilateral scheduled air services. It includes passenger, cargo, and mixed services. Belly cargo on passenger flights is typically thought to account for at least half of global air cargo, the rest being handled by dedicated freight services. The ACI therefore has some relevance to air cargo performance. Its main limitation is that it only uses data on scheduled services, and therefore does not include unscheduled services and cargo flights undertaken by express operators. It is presented here for its indicative value, at the same time as recognizing the ATFI and EFFI more directly capture the state of air cargo performance on a country level.

The ACI is an index ranging from zero to 100, with a higher score indicating greater connectivity. It is available for 2007-2012 in two papers, Arvis and Shepherd (2016) and Arvis et al. (Forthcoming). It has been calculated for 186 countries and territories. Table 3 presents the top ten countries for 2012. They are concentrated in Europe, but also include countries from North America, Asia, and the

Middle East. This pattern is consistent with the rise of important global hubs in the countries concerned. By contrast, the bottom ten countries (Table 4) are all isolated countries in the Pacific and Africa. Trade costs in these countries are known to be very high, and although air cargo plays an important role in enabling access to global markets, connections to other countries typically only include regional neighbors—reaching large, developed markets often takes considerable time and expense.

Table 4: Top ten Air Connectivity Index scores globally, 2012.

Country	ACI	Rank
United States	13.77	1
United Kingdom	7.45	2
Germany	6.95	3
Belgium	6.66	4
Spain	6.02	5
France	5.91	6
Netherlands	5.78	7
China, People's Republic of	5.66	8
Bahrain	5.59	9
Luxembourg	5.38	10

Source: Arvis et al. (Forthcoming).

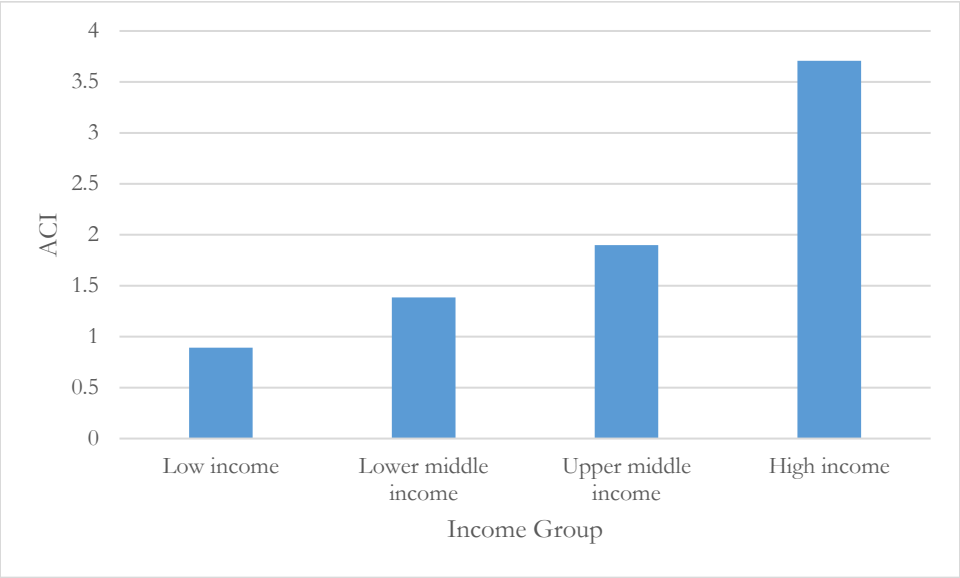
Table 5: Bottom ten Air Connectivity Index scores globally, 2012.

Country	ACI	Rank
Timor-Leste (East Timor)	0.57	177
Mozambique	0.56	178
Vanuatu	0.55	179
Nauru	0.55	180
Samoa	0.52	181
Kiribati	0.45	182
Solomon Islands	0.4	183
Marshall Islands	0.39	184
Tonga	0.38	185
Tuvalu	0.36	186

Source: Arvis et al. (Forthcoming).

It is useful to look at the distribution of average scores by World Bank income group. Figure 10 shows that performance is once again increasing in per capita income: higher income countries tend to have much higher scores than lower income ones, with consistent progress through the middle-income category. The ACI is notable for the dispersion of scores across countries, and this feature is reflected in the income group comparison: low income countries can be seen to be relatively marginal in terms of the global air transport network, likely due to a combination of geographical, policy, and private sector development challenges.

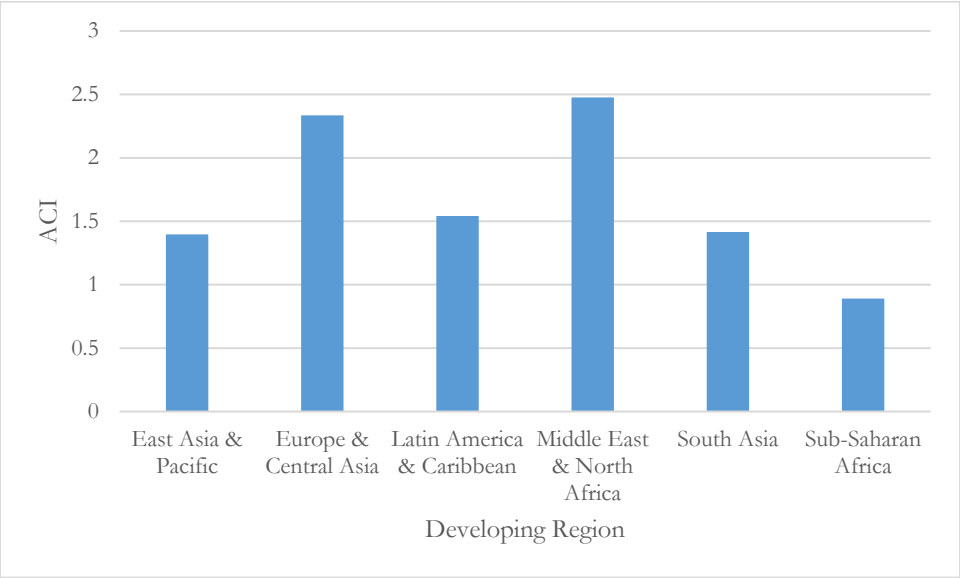
Figure 10: Air Connectivity Index scores by World Bank income group, 2012.



Source: Arvis et al. (Forthcoming); and authors' calculations.

Figure 11 breaks the data out by World Bank developing region, i.e. excluding high-income countries. Interestingly, the Middle East and North Africa leads the pack in terms of connectivity, surely due to the development of important global hubs in the region, which now serve as a connection point for many ongoing flights, in addition to those designed to service local demand. Performance across the other regions is variable: Europe and Central Asia performs well due to its proximity to the EU, where connections are very well developed. Sub-Saharan Africa has a noticeably lower average score than the other regions, which reflects its relatively marginal place in the air transport network. However, improvements in that region have been noted over recent years, with countries like South Africa developing significant capacity, and regional low cost operators coming into their own.

Figure 11: Air Connectivity Index scores by World Bank developing region, 2012.



Source: Arvis et al. (Forthcoming); and authors' calculations.

3.2 The Air Trade Facilitation Index

It is true in a general sense that trade facilitation is vital to moving goods across borders quickly, reliably, and at competitive cost. Trade facilitation performance is therefore linked to GVC participation: countries that do better on general indicators of the trade facilitation environment have been shown to engage in more trade in intermediate inputs (Saslavsky and Shepherd, 2014), which is a core part of GVC participation.

The considerations of speed and reliability are all the more vital in the context of air cargo, where time is very much of the essence: goods may be perishable, or they could be high value to weight ratio goods destined for a GVC operating on a just-in-time protocol. This report's ATFI has been developed with these insights in mind, and aims to inform policy discussions on air cargo including in the area of GVCs, but in no way limited to it. The objective of the ATFI is to capture the dimensions of trade facilitation that are most important to air cargo, and so supplement existing indicators that deal with trade facilitation more generally. Trade facilitation is an important determinant of GVC participation, including the ability to move up to higher value added products, so focusing on the air cargo dimension makes it possible to relate cargo performance to GVC participation in a policy-relevant way.

The ATFI is constructed using the following methodology. It draws on a number of data sources, and is a weighted average of underlying series. The aim is to capture a large amount of data from different sources, focusing on the aspects of trade facilitation that are most important from the perspective of air cargo, and particularly the use of information and communication technologies (ICTs) to facilitate air cargo transactions. The underlying data will be aggregated using a weighted average methodology, as follows:

1. Global Express Association's Customs Capability Database (25%).
2. OECD's Trade Facilitation Indicators (25%).
3. Signature of the 1999 Montreal Convention (30%), or equivalent domestic legislation.
4. Signature of the Revised Kyoto Convention (10%).

5. Notification of selected Category A Articles under the WTO Trade Facilitation Agreement (TFA) (10%).

Weights are based on expert judgment, formulated in consultation with IATA. Signature of the Montreal Convention is seen as a particularly important issue, as it represents a core modernization program for air cargo transactions. Next in importance are the two general indicators of trade facilitation performance. Signature of the Revised Kyoto Convention is significant from a customs performance point of view, but implementation on the ground—as measured by the first two indicators—is emphasized more than the agreement itself. Finally, notifications under the TFA are included in the data set, but as implementation of the Agreement still lies in the future for many developing countries, it is down-weighted.

To ensure the robustness of the weighting scheme, it was compared with one derived using objective statistical criteria. Principal Components Analysis (PCA) is a mathematical technique that makes it possible to derive a weighted average of a set of underlying indices that accounts for the maximum possible proportion of observed variance in the original indicators. Weights are not based on economic effects or policy interest, but instead reflect the ability to explain variance. The comparison with the expert judgment weights above is instructive: the correlation between our ATFI and an index derived by PCA is 0.96, which is a very strong correlation. Our ATFI weights therefore not only reflect expert judgment as to economic importance, but also have the desirable property of containing most of the information in the original underlying series.

Data in all categories are, if necessary, normalized to lie between zero and one prior to analysis. Data from categories 1, 2, and 5 need to be aggregated before being included in the weighted average. In the interests of simplicity and transparency, the approach adopted here is to sum underlying indicator values to produce an overall series result. Data for categories 3 and 4 are coded as 1/0 dummy variables (in a similar way to some of the underlying series in other categories).

Category 5 data present some problems because of the nature of TFA notification process. First, developed countries within the WTO definition cannot notify at all: the whole agreement is binding on them upon entry into force. They therefore record a one, which is the same score as notification by a developing country. To further complicate matters, a significant number of developing countries have not yet submitted their Category A notifications, but are likely to in the coming 12 months or so. There is no perfect solution to this problem. In the interests of avoiding reweighting for missing observations, and thereby preserving cross-country comparability, those developing countries that have not yet made notifications at all are coded as zero, in addition to those that have made notifications but have not included the relevant articles. Future updates of the index could include additional information to give a richer picture of implementation patterns, in particular Category B and C notifications, appropriately down weighted to take account of implementation timelines and conditions.

In terms of the amount of data to be captured in categories 1, 2, and 5, category 2 covers all measures. For category 1, the following questions are captured in the index:

1. New and changes to existing regulations for comment prior to implementation?
2. Does Customs accept and process electronically the data required for release of shipments in advance of their actual arrival so that they can be released either prior to or immediately after arrival?
3. Are there multiple inspections (inspections by agencies other than Customs)?
4. Is full-time (24/7) automated processing for the customs ports at which you operate available?

For category 5, data have been collected on Category A notifications of TFA Articles 2, 6, 7, and 10. These obligations represent the core trade facilitation measures of special interest from the air cargo perspective.

The output of this data capture, aggregation, and weighting approach is an ATFI with higher scores indicating better performance, ranging between 0 and 100 and expressed as a percentage. The ATFI covers 124 countries, in all regions and income groups. Tables 5 and 6 show the top and bottom ranked countries in terms of the index, which is reproduced in full in Appendix 2. The top ranked countries are all active trading nations with well-developed industrial sectors. They consistently figure well in related indices, like the World Bank's LPI. All are high-income countries according to the World Bank's classification, and most are located in Europe, although North America and East Asia also figure in the list. The ten lowest ranked countries, by contrast, are nearly all (except Honduras and Venezuela) on the UN's list of least developed countries—the poorest and most vulnerable economies on the planet. Trade is poorly developed, industrial structure is lacking, and these countries face serious deficiencies in terms of infrastructure and services when it comes to accessing global flows of air cargo.

Table 6: Top ten Air Trade Facilitation Index scores globally.

Rank	Country	Air Trade Facilitation Index Score
1	Austria	98.21%
2	Slovenia	97.09%
3	Korea, Republic of	97.07%
4	Italy	96.70%
5	Sweden	96.49%
6	Netherlands	95.38%
7	Finland	94.58%
8	Japan	94.15%
9	Canada	94.09%
10	Denmark	93.96%

Source: Authors' calculations.

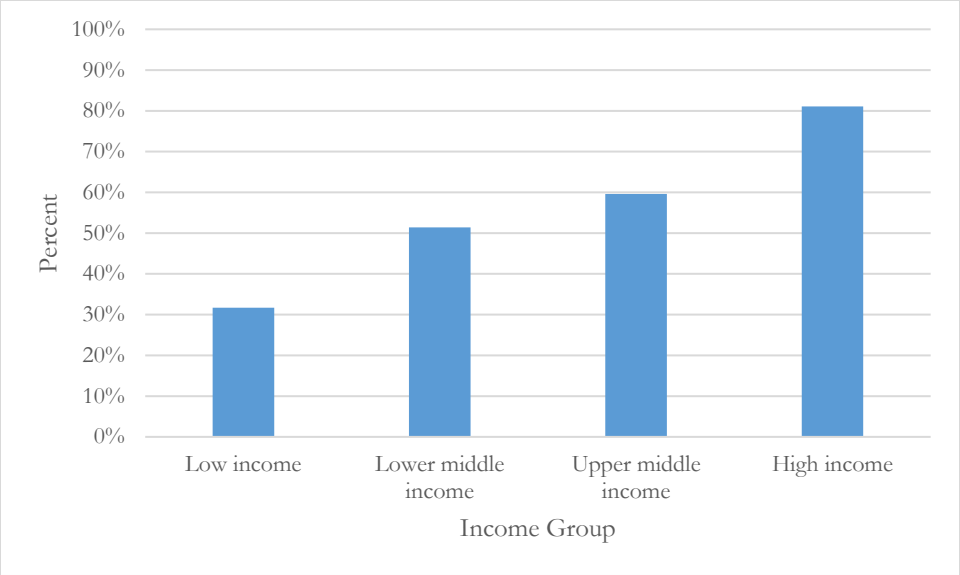
Table 7: Bottom ten Air Trade Facilitation Index scores globally.

Rank	Country	Air Trade Facilitation Index Score
115	Sierra Leone	22.93%
116	Cambodia	22.55%
117	Nepal	18.40%
118	Central African Republic	16.97%
119	Honduras	16.43%
120	Angola	15.28%
121	Venezuela	12.07%
122	Burundi	11.42%
123	Liberia	9.83%
124	Djibouti	6.71%

Source: Authors' calculations.

To provide an overview of the way the ATFI looks around the world, it is possible to break the results down by income group and region. This report uses the relevant World Bank conventions, so regions are limited to non-high-income countries (developing countries) only. Figure 12 first presents averages by World Bank income group. There is clearly a strong link between income level and performance: average ATFI scores increase with country income level, which means that higher income countries tend to have superior air trade facilitation performance. This result is a common one in cross-country economic indicators, including in the transport and logistics sector.

Figure 12: Air Trade Facilitation Index scores by World Bank income group.



Source: Authors' calculations.

Figure 13 provides additional information by breaking performance out according to developing region. Performance is actually quite comparable from one region to another, although Europe and Central Asia stands out as having a noticeably higher average score, and South Asia and Sub-Saharan Africa in particular have lower scores. It is difficult to compare scores across indices, as there is no underlying model relating the index to economic or sectoral performance.

Figure 13: Air Trade Facilitation Index scores by World Bank developing region.

Source: Authors' calculations.

3.3 The eFreight Friendliness Index

The ATFI provides a general indicator of the trade facilitation environment surrounding air cargo. Another aspect of air cargo performance that is increasingly salient relates to the ability to undertake transactions electronically. Electronic processing of cargo transactions has clear savings in time and cost for exporters and importers, and is spreading throughout the world as countries develop the necessary capacities. The purpose of the EFFI is to capture the state of those capacities at the present time. GVCs depend on moving goods quickly and reliably across borders, and the ability to leverage electronic processing to assist with that process can be a crucial determinant of performance. Electronic documentation and processing can result in shorter delays at borders, lower transaction costs, and enhanced security and reliability—all of which can be beneficial to firms involved in GVCs. The ATFI captures some aspects of the role information technology can play in trade facilitation, but the EFFI drills down to a much finer level of detail—specifically, it incorporates IATA data on the use of electronic processing in cargo transactions. It is therefore very much grounded in the "real world" experience of companies operating across borders, and reflects their ability to use electronic processing for cargo transactions.

The EFFI is based on a similar approach as for the ATFI, but with a narrower dataset. The core of the Index is new data supplied by IATA. One part of it covers e-Air Waybill (eAWB) use, disaggregated by bilateral country corridor. Those data are aggregated by origin and destination countries to provide an indicator of the extent to which eAWBs are used relative to total AWB transactions over a given period. The second part of the IATA dataset is information on eFreight transactions relative to the total number of AWBs. This second indicator captures a broader range of information than just eAWB use, including the ability to run the whole transaction electronically. Data are again provided bilaterally, and are aggregated by origin and destination country. In addition to the IATA data, the EFFI includes indicator 2 from the Customs Capability Database above. Weights for the EFFI are as follows:

1. IATA eAWB Penetration (35%).
2. IATA eFreight Usage (35%)

3. Does Customs accept and process electronically the data required for release of shipments in advance of their actual arrival so that they can be released either prior to or immediately after arrival? (Customs Capability Database; 30%).

As in the case of the ATFI, the weights are based on expert judgment, formulated in consultation with IATA. In this case, the three indicators are seen as having very similar levels of importance to overall performance. The small difference in weights between the first two categories and the third indicates a judgment that the index should have as its core electronic transaction processing capabilities in their broadest sense, beyond a Customs only perspective.

PCA can again be used to provide a point of comparison in terms of the weighting scheme. This alternative methodology produces a weighted average that accounts for the maximum possible proportion of the variance in the original indicators. As in the case of the ATFI, the correlation between our EFFI and a PCA-based alternative is very strong, 0.78. We are therefore confident that the index not only reflects expert judgment as to economic importance, but also has desirable statistical properties.

The output of this data capture, aggregation, and weighting approach is an EFFI with higher scores indicating better performance, ranging between 0 and 100 and expressed as a percentage. The Index covers 135 countries, and as for the ATFI, reweighting has not been applied if some data points are missing, so as to preserve cross-country comparability. Table 7 presents the top ten EFFI scores. Results are closely aligned with countries that are international hubs for air transport, including cargo, and which have developed sophisticated systems, including through mobilizing ICTs, to facilitate air cargo transactions. The top ten list includes countries from the Middle East, Europe, Asia, and North America. Unlike for the ATFI, the corresponding lowest scores are not reproduced, as the bottom fourteen entries in the table are all equal to zero. The reason for countries ending up at the extreme lower bound of the index is that they have not implemented eFreight or eAWBs at all—a clear disadvantage in the rapidly moving world of global air cargo. Those countries that have zero or very low scores on the index are primarily from Africa and the Pacific.

Table 8: Top ten eFreight Friendliness Index scores globally.

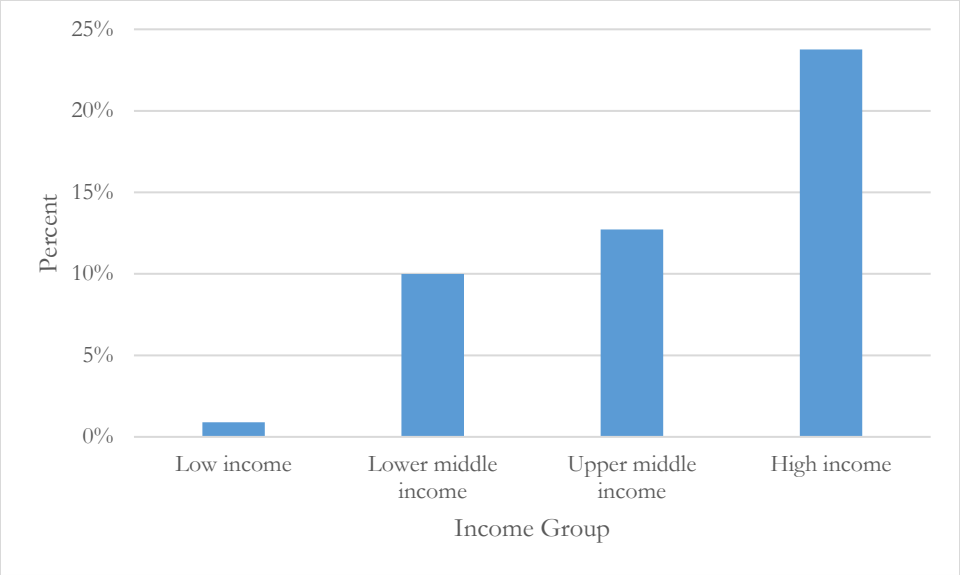
Country	EFFI Score	Rank
United Arab Emirates	47.37%	1
Denmark	41.60%	2
Hong Kong	41.59%	3
Singapore	40.18%	4
Sweden	39.77%	5
Korea, Republic of	39.31%	6
Canada	38.70%	7
Netherlands	38.61%	8
South Africa	37.71%	9
United States	37.70%	10

Source: Authors' calculations.

It is again possible to break results out by income group and developing region. Figure 14 shows the first split in the data. As with the ATFI, there is a clear association between income and performance: higher income countries perform more strongly on the EFFI. The scale of the difference between the high-income group and the other countries is very significant in this case. In particular, the low income

countries have a very low average score—as indicated by the reference to zeros for fourteen countries above—and even the upper middle-income group scores significantly lower than the high-income group. Clearly, eFreight is a major challenge for developing countries, and particularly the lowest income ones.

Figure 14: eFreight Friendliness Index scores by World Bank income group.



Source: Authors' calculations.

Figure 15 presents average scores by developing region. They are quite comparable for all regions except South Asia and Sub-Saharan Africa, which are much lower. But it suggests that if the EFFI is indeed found to be associated with value chain integration, then development of eFreight readiness in developing countries, particularly low income and least developed countries, will be critical if they are to boost value chain involvement and performance.

Figure 15: eFreight Friendliness Index scores by World Bank developing region.

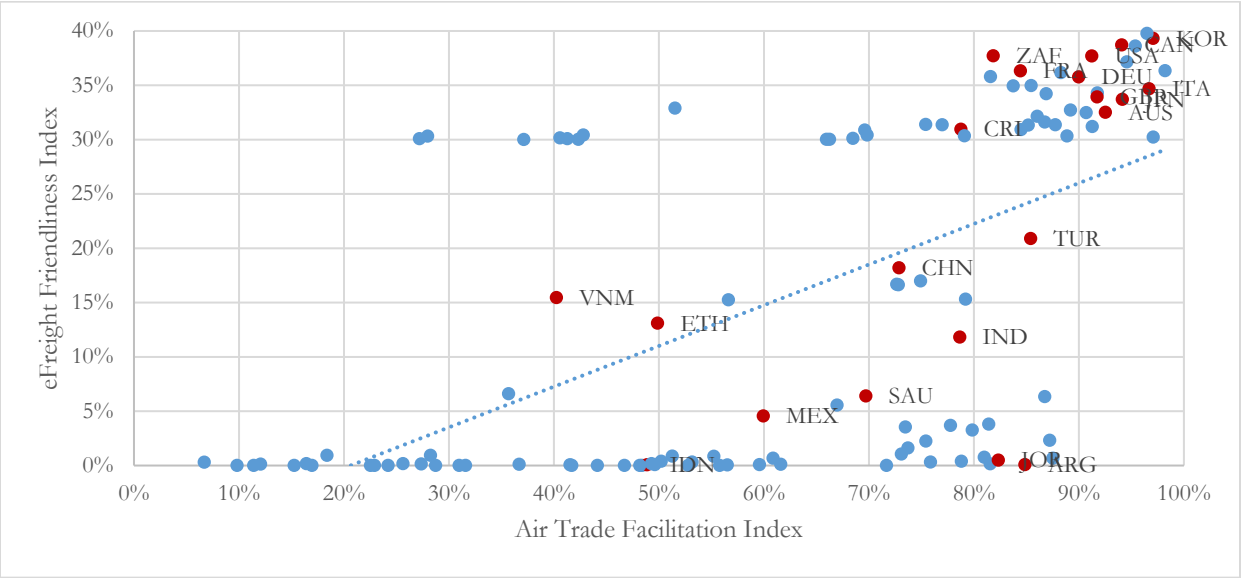
Source: Authors' calculations.

3.4 Comparing the ATFI and the EFFI

The two new indices created for this report measure different aspects of the air cargo environment. However, they should be positively correlated: higher performance on the ATFI should be associated with a higher EFFI score. The reason is that although the two indices are different, the underlying air transport environment represents a unified entity, and so they are complementary measures based on the same underlying structure.

To test whether or not this is in fact the case, Figure 16 plots the EFFI against the ATFI. There is, as expected, a clear positive association between the two indices, so there is good cause for confidence that they contain useful information on the underlying air cargo environment. Of course, there is also significant dispersion, for two main reasons. The first is substantive: the two indices are based on different information sets, and measure different aspects of the air cargo environment; if there were no dispersion in the figure, there would be no need for two separate indices, as they would effectively be measuring the same thing. The second reason is technical, and stems from the fact that the ATFI is based largely on binary variables that take values of zero or one, whereas the EFFI uses continuous data. This technical difference also necessarily results in some dispersion of scores around the trend line. The most important take away, however, is that the two indices are indeed strongly positively associated, in line with expectations.

Figure 16: Association between the Air Trade Facilitation Index and the eFreight Friendliness Index.



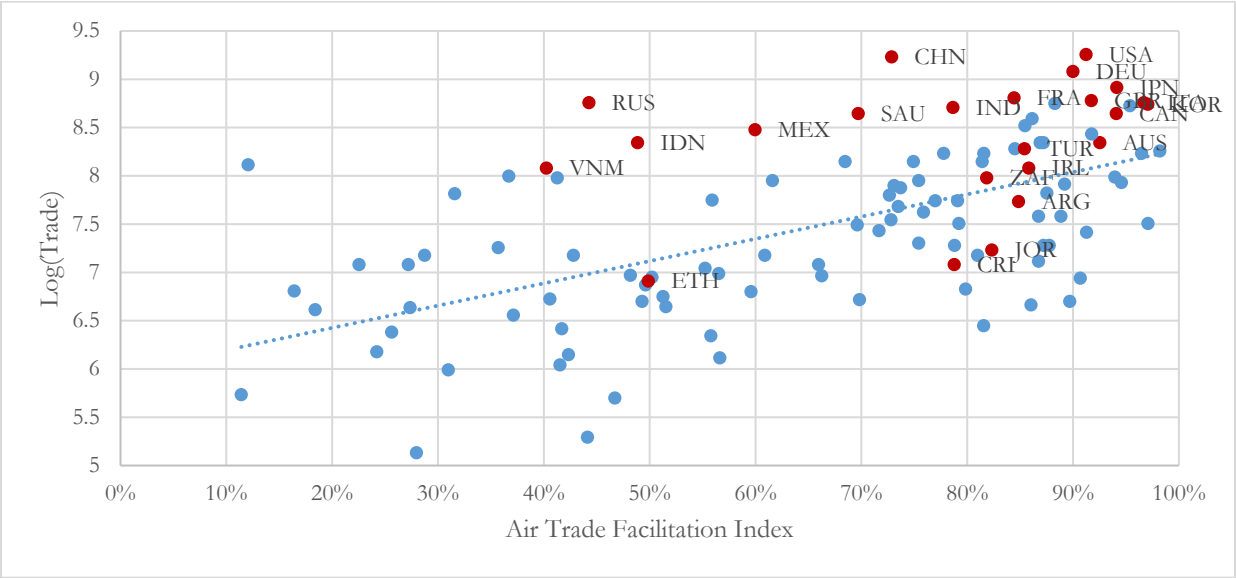
Source: Authors' calculations.

3.5 Air Cargo and GVC Integration: Quantitative Evidence

The previous subsections have introduced three metrics of air cargo performance: the ATFI, the EFFI, and the ACI. As part of their external validation, but also to show that air cargo performance is quantitatively linked to value chain integration, this subsection looks at the correlations between these indicators, on the one hand, and measures of value chain integration and development on the other.

As a preliminary to the analysis dealing specifically with GVCs, we first present correlations between the ATFI and EFFI, and countries' total trade flows, as was done for the ACI in Figure 1. Results are in Figures 17 and 18. As for the ACI, both figures clearly indicate a positive association between index scores and a country's total value of exports and imports. These findings represent preliminary evidence showing that the ATFI and the EFFI capture important dimensions of air cargo performance, which are linked to the ability of countries to engage with the global marketplace. Concretely, a one percentage point increase in the ATFI is associated with an increase in trade of 2.30%, while a one percentage point increase in the EFFI is associated with an increase in trade of 2.46%.

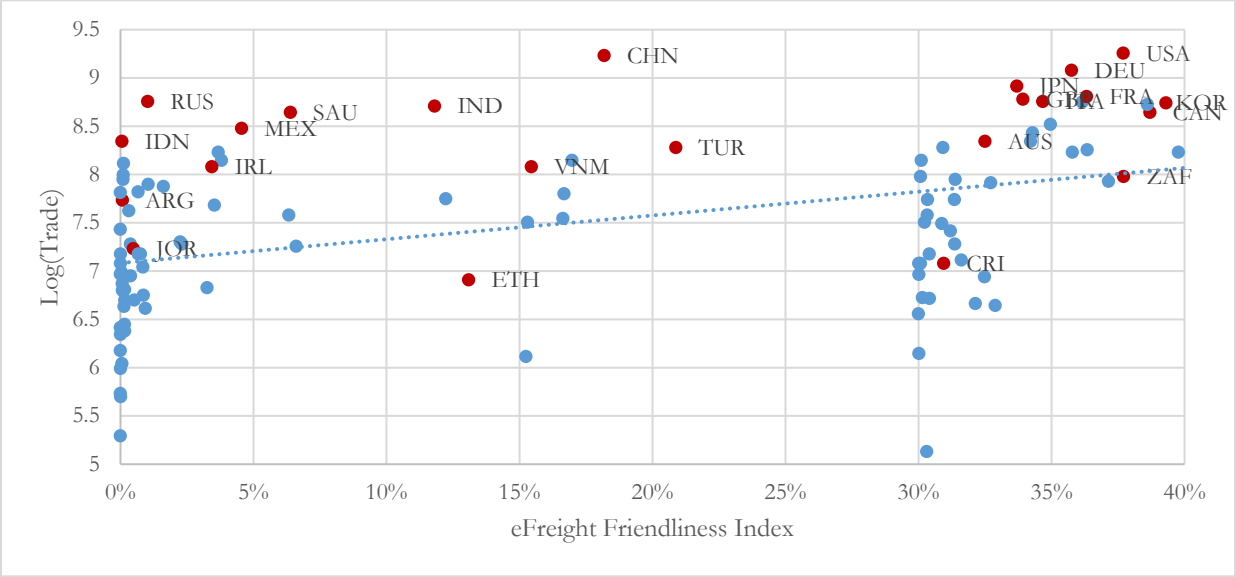
Figure 17: Association between the Air Trade Facilitation Index (horizontal) and total trade value (vertical), latest year.



Source: UN Comtrade; and authors' calculations.

Note: R2 = 0.36. Correlation is statistically significant at the 1% level. Countries in red are G20 members and case study countries. Outliers dropped to improve readability.

Figure 18: Association between the eFreight Friendliness Index (horizontal) and total trade value (vertical), latest year.



Source: UN Comtrade; and authors' calculations.

Note: R2 = 0.17. Correlation is statistically significant at the 1% level. Countries in red are G20 members and case study countries. Outliers dropped to improve readability.

As discussed in Section 2, GVCs rely heavily on moving parts and components between production points and assembly locations, which is a specific subset of the total trade values considered in the above two figures. Indicators of backward and forward linkages capture these processes. Backward

linkages are the percentage of gross exports accounted for by foreign value added, imported in the form of intermediate goods and services. Forward linkages are the percentage of gross exports of intermediate goods used in the importing country's exports. The two indicators can be summed to give an overall measure of GVC participation, which focuses on a country's role in using foreign parts and components, and sending its own parts and components overseas for incorporation into export goods.

The quantitative analysis presented here shows the association between our indicators of air cargo performance on the one hand, and total GVC integration (backward and forward linkages) on the other. It is important to stress that the relationships uncovered are correlations. Establishment of a causal link would require development of a fully specified econometric model. Nonetheless, the findings are indicative of important regularities observed across a wide range of countries. They are presented for their informative value, and as a spur to further research on the relationship between air cargo performance and GVC integration.

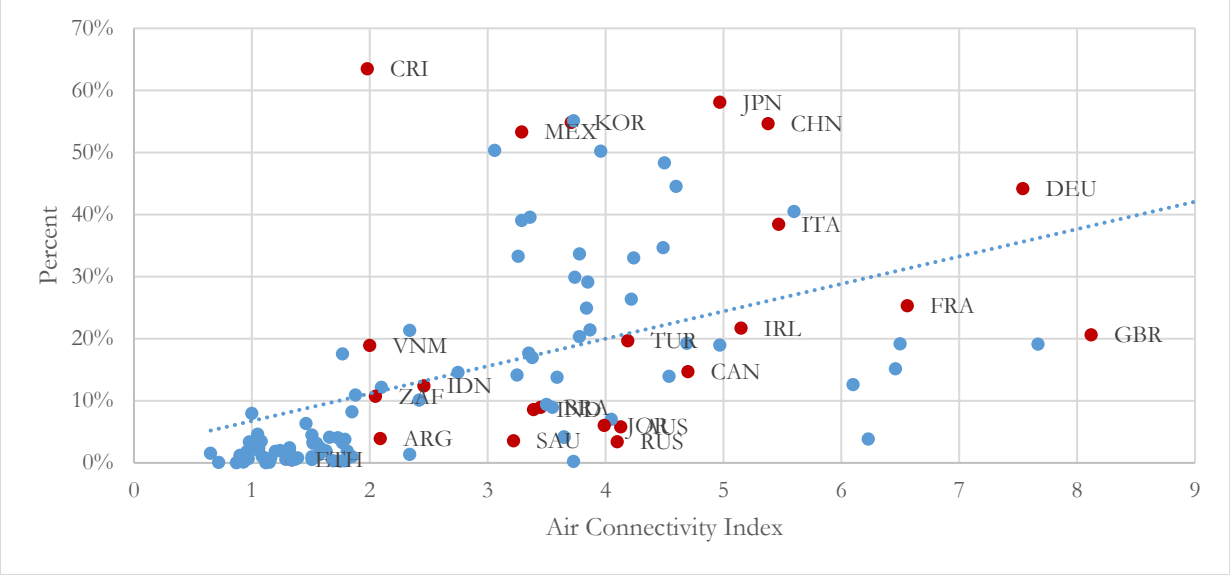
Three main data sources are available on GVC linkages in trade: the OECD-WTO TiVA Database, the World Bank's EVA Database, and the Eora Database. The EVA Database is used here, due to its extensive country coverage, particularly among lower income countries, and superior data quality relative to Eora.[2] The additional coverage comes at the price of sectoral specificity, however. Rather than use total trade—which includes bulk commodities that do not travel by air—the method adopted here is to focus on two example sectors that are well known as GVC hubs. The first is the machinery sector, which is defined in the EVA Database to include electrical equipment. Backward linkages in that sector therefore capture countries like Vietnam importing circuit boards or hard drives, for incorporation into cell phones or other consumer electronics. The second sector is transport equipment. Again, the focus is on parts and components: countries like Morocco have developed competence in the area of electrical components and wiring for European (most often, French) cars—exports of these goods to France count as forward linkages when French companies export the final product, namely motor vehicles.

The first association we examine is between the ACI and the two sectoral indicators of GVC integration. Figures 19 and 20 show that the lines of best fit are upward sloping. The association between a higher ACI score and increased GVC integration in machinery and chemicals as a proxy for pharmaceuticals is clearly strong. This finding confirms previous work using different data, which showed that air connectivity—one aspect of air cargo performance—is an important determinant of trade in parts and components, which is one of the core activities of GVCs (Arvis and Shepherd, 2016). Of course, the average relationship represented by the trend line does not hold equally for all countries. In Figure 19, for example, Germany lies noticeably above the trend line, which means that it is even more integrated into machinery GVCs than its strong connectivity performance would suggest, based on what is observed on average across countries. Indeed, Germany acts as a source of investment and technology within the context of value chains covering Central and Eastern Europe in this sector, and the role of its lead firms is very important in the regional context. Factors like these help explain its stronger than expected performance. Among developing countries, China is notable for lying similarly above the trend line. China has indeed made use of air connectivity in developing its value chains, but many other policies have also played a role. Economic liberalization starting in

[2] As a robustness check, we have repeated the analysis using Eora data on total GVC participation. Results are qualitatively identical: a one percentage point increase in the ATFI or the EFFI is associated with a 0.26 percentage point increase in GVC participation, while the comparable figure for the ACI is 2.90 percentage points.

the 1980s was a key factor without which GVC participation would have been impossible. Liberalization of domestic markets has gradually translated into a more liberal stance on trade and investment flows, which has made it feasible for the country to develop into an assembly hub in sectors like electrical equipment. Taking the full set of information presented by the figures together, it is clear that air connectivity can be one of a range of policies that can help promote greater GVC participation in developing and developed countries alike.

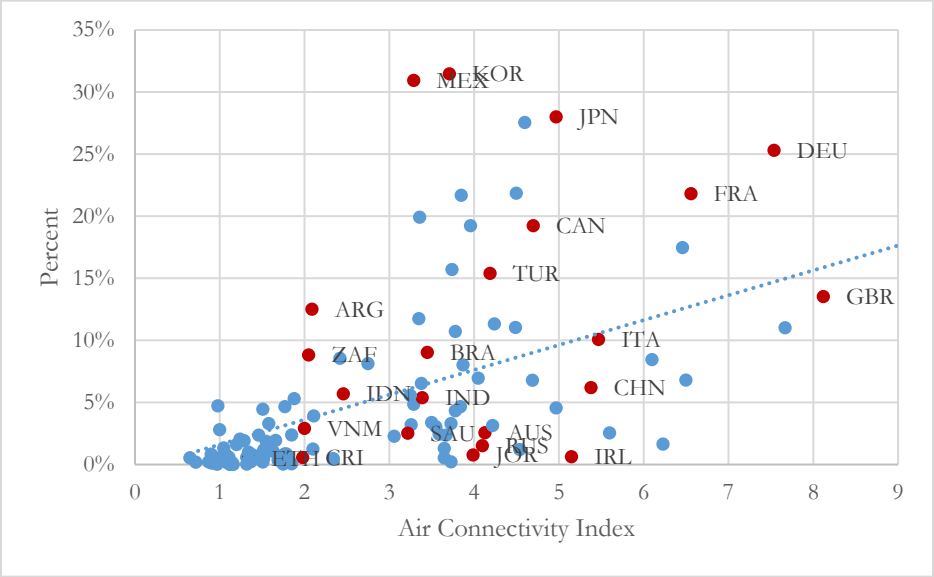
Figure 19: Association between the Air Connectivity Index (horizontal) and backward and forward linkages in the machinery sector (vertical), 2011.



Source: Arvis et al. (Forthcoming); World Bank EVA Database; and authors' calculations.

Note: R2 = 0.23. Correlation is statistically significant at the 1% level. Countries in red are G20 members, case study countries, and countries mentioned in the main text. Outliers dropped to improve readability.

Figure 20: Association between the Air Connectivity Index (horizontal) and backward and forward linkages in the chemicals sector (vertical), 2011.



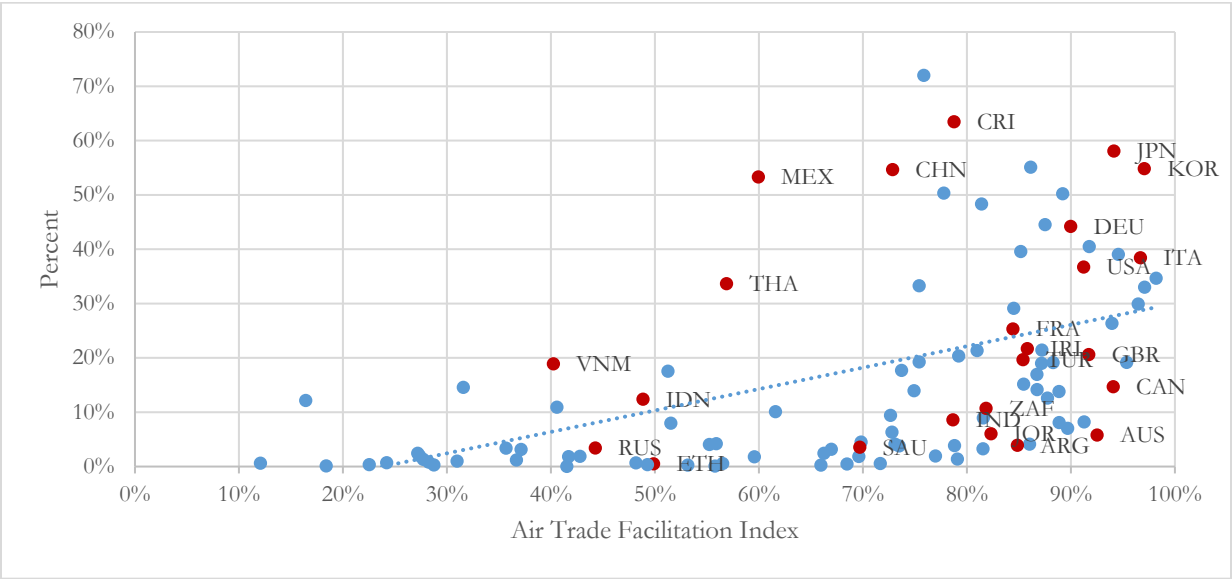
Source: Arvis et al. (Forthcoming); World Bank EVA Database; and authors' calculations.

Note: R2 = 0.30. Correlation is statistically significant at the 1% level. Countries in red are G20 members, case study countries, and countries mentioned in the main text. Outliers dropped to improve readability.

Next, we look at the association between the ATFI and the GVC integration indicator covering backward and forward linkages in the two sectors (considered separately). Figure 21 shows the association with machinery, and Figure 22 shows it with chemicals, as a proxy for pharmaceuticals; both sectors are considered in the case studies, below. In both cases, the line of best fit is upward sloping, which means that countries that score higher on the ATFI tend to be better integrated into GVCs in these two sectors. The result is in line with expectations, and reflects the analysis of the role of air transport in manufacturing GVCs developed above. Of course, there is also some dispersion of points around the trend line, which indicates that country performance in terms of GVC integration is not only a function of air cargo performance, but that other factors enter into the equation as well. For example, Mexico—a mid-range performer on the ATFI—lies well above the trend line. Thanks to the North American Free Trade Agreement (NAFTA), Mexican firms are well integrated into regional value chains, typically led by firms from the US or Canada. Production of machinery parts and components along the northern border with the US has taken off following NAFTA, thanks in part to trade facilitation performance, but also other factors like private sector development initiatives and business development programs, which contribute to Mexico's strong result. Nonetheless, A similar pattern is apparent with the observation for Thailand, which lies significantly above the trend line. Thailand is a major assembly hub for transport equipment in East and Southeast Asia, and is well-integrated into GVCs led by Japanese firms. In addition, it is an important exporter of electronics parts and components for computers and other devices. While air cargo performance is one factor that has helped it develop this position, relative openness to trade and investment flows have also played a crucial role. Thailand has made good use of regional integration, for example through ASEAN and APEC, to develop its trade profile, in cooperation with regional partners also involved in the same value chains. It is a good example of a developing country using trade facilitation, along with other

policies, to promote value chain growth and development. Moving away from these individual observations to take the figure as a whole, the point emerges strongly from these first two associations that across a wide range of countries, air cargo performance is positively correlated with integration into GVCs.

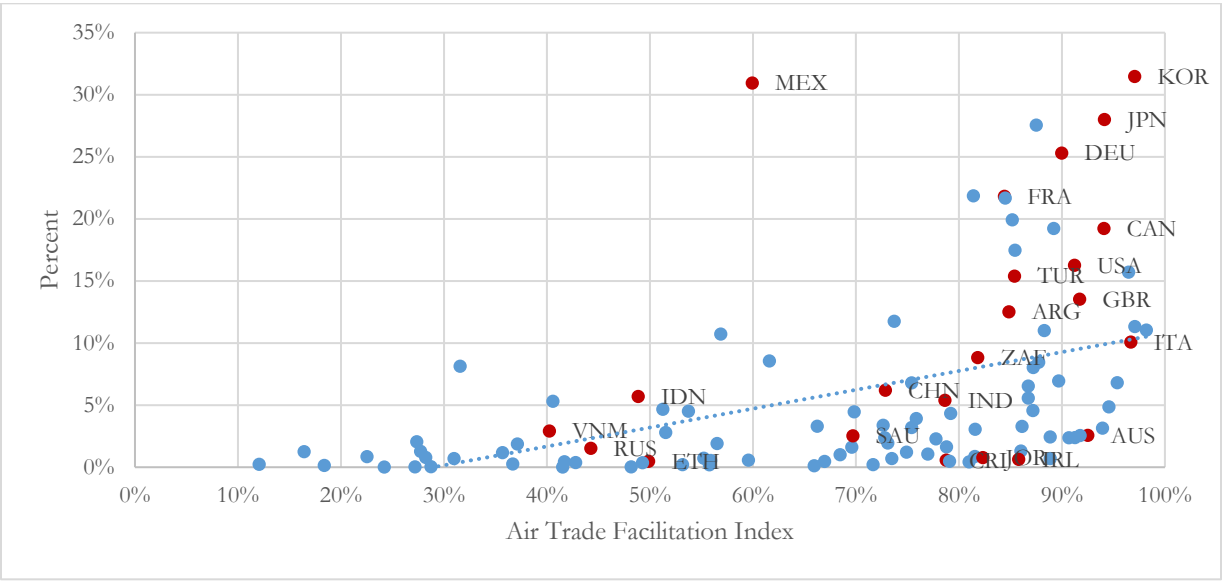
Figure 21: Association between the Air Trade Facilitation Index (horizontal) and backward and forward linkages in the machinery sector (vertical), 2011.



Source: World Bank EVA Database; and authors' calculations.

Note: R2 = 0.20. Correlation is statistically significant at the 1% level. Countries in red are G20 members, case study countries, and countries mentioned in the main text. Outliers dropped to improve readability.

Figure 22: Association between the Air Trade Facilitation Index (horizontal) and backward and forward linkages in the chemicals sector (vertical), 2011.

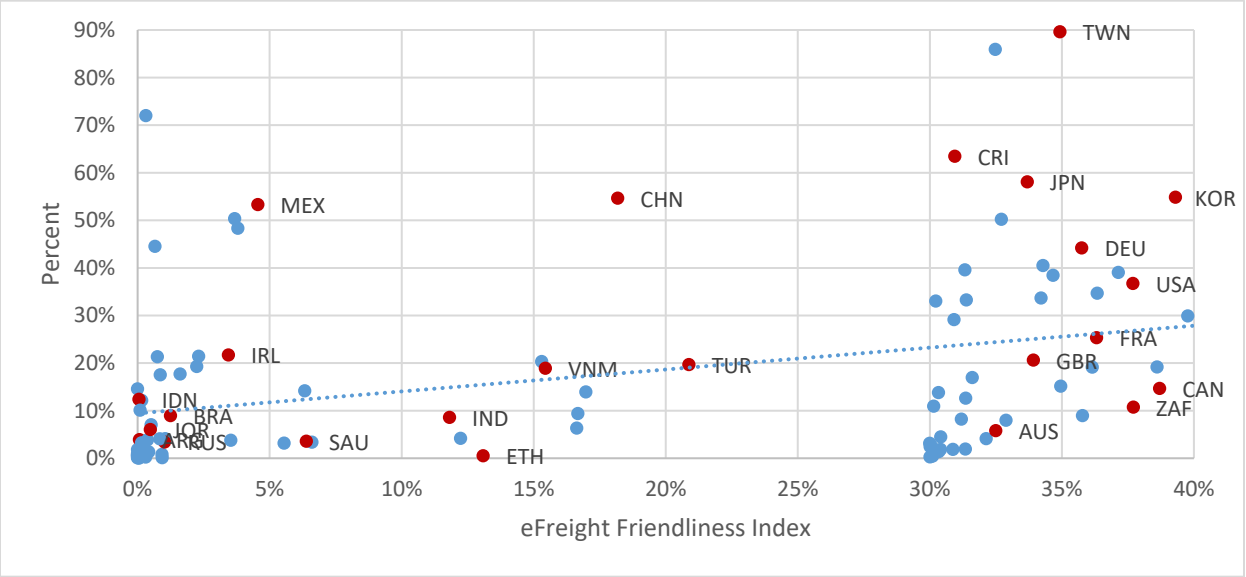


Source: World Bank EVA Database; and authors' calculations.

Note: R2 = 0.21. Correlation is statistically significant at the 1% level. Countries in red are G20 members, case study countries, and countries mentioned in the main text. Outliers dropped to improve readability.

The final aspect of air cargo performance analyzed in this report is captured by the EFFI. The exercise is repeated for that index in Figures 23 and 24. Once again, the line of best fit is upward sloping, although less strongly so than was the case for the ATFI. Moreover, the spread of points around the line is wider. Both indications suggest that the fit for this association is somewhat weaker than for the first index. But the evidence is nonetheless clear that countries that score higher on the EFFI tend to be more integrated into GVCs in the machinery and chemicals sectors. In terms of outliers with respect to the average relationship, Chinese Taipei has a strong score on the EFFI and a very high level of GVC participation in the machinery sector. As one of the "Asian Tigers" in the 1970s and 1980s, Chinese Taipei adopted a variety of measures that helped develop its industrial sector, focusing on areas like machinery. It is now an important hub for global trade in machinery subsectors like electrical goods. This example highlights the role that a supportive business environment can play in promoting GVC development, in tandem with strong air cargo performance. Japan also stands out in Figure 23 as lying above the trend line. The country has long been a leader in the development of value chains in machinery subsectors like electrical products and transport equipment. During the 1980s and 1990s, its lead firms shifted some production offshore, typically to East and Southeast Asia, in the first wave of GVC development. Japan's experience shows the important role played by the business environment in facilitating production sharing. Japan's post-war development model made it possible for large companies to develop in areas where scale activities are strong, but simultaneously fostered the emergence of a vibrant ecosystem of small and medium enterprises that were involved in supply chains as component suppliers. Experience with this model domestically helped firms internationalize it through GVCs. A strong legal system, which supports enforcement of contracts with suppliers, as well as measures to support private sector development, such as facilitating the flow of credit to worthy businesses, loom large as factors that can help these kinds of supplier relationships develop. Again, taking the information in the two figures in a global appreciation makes clear that facilitation of eFreight transactions can, in combination with other measures, support greater GVC participation.

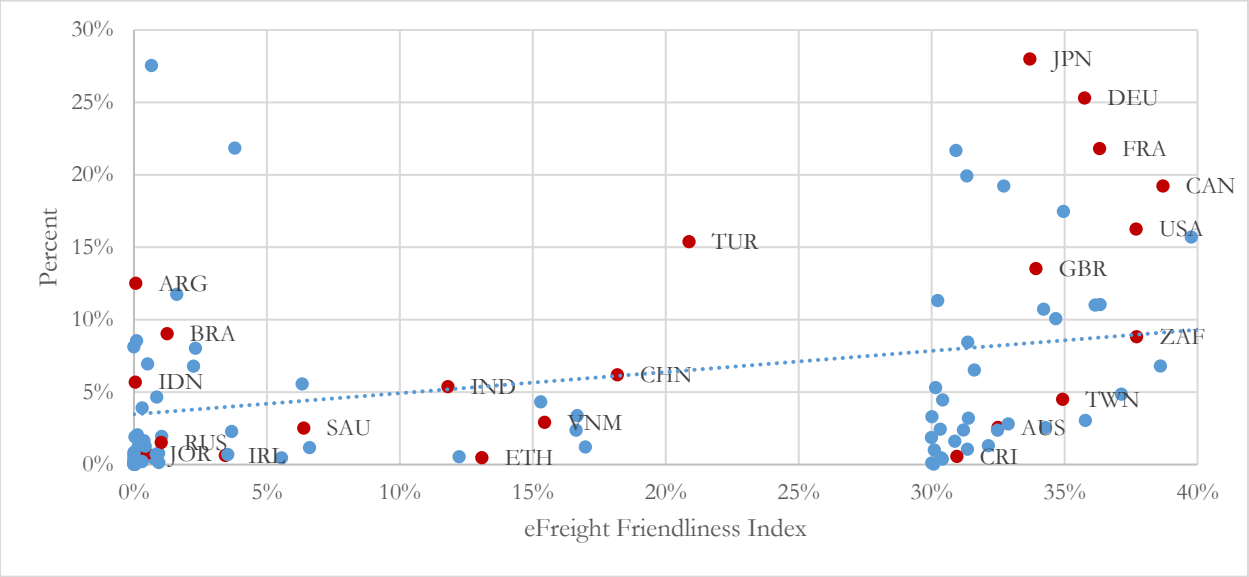
Figure 23: Association between the eFreight Friendliness Index (horizontal) and backward and forward linkages in the machinery sector (vertical), 2011.



Source: World Bank EVA Database; and authors' calculations.

Note: R2 = 0.14. Correlation is statistically significant at the 1% level. Countries in red are G20 members, case study countries, and countries mentioned in the main text. Outliers dropped to improve readability.

Figure 24: Association between the eFreight Friendliness Index (horizontal) and backward and forward linkages in the chemicals sector (vertical), 2011.

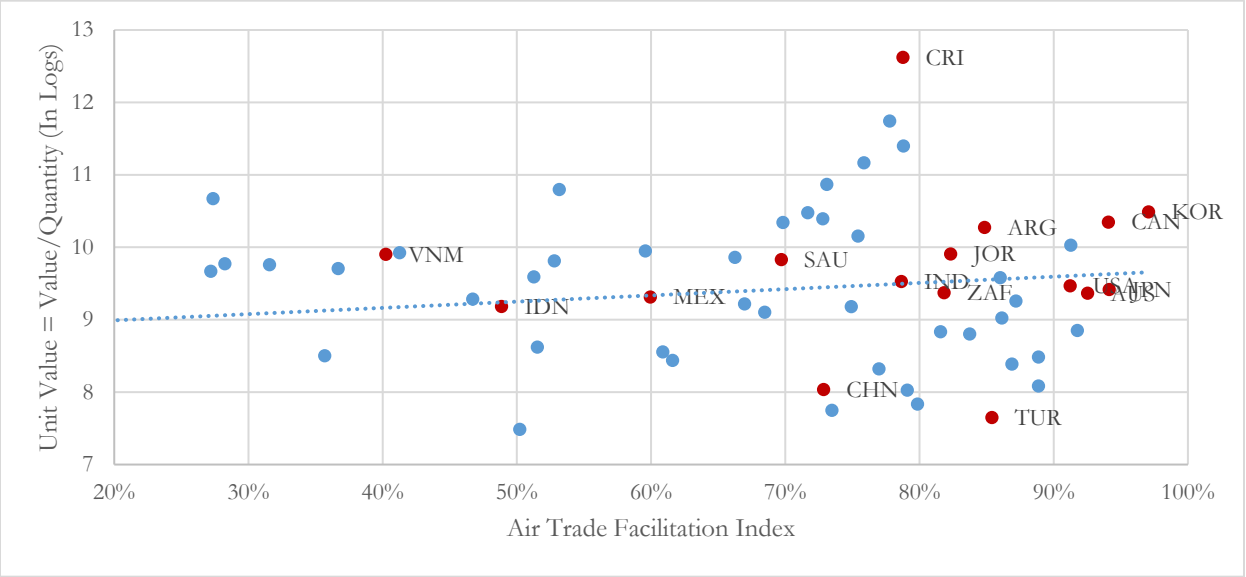


Source: World Bank EVA Database; and authors' calculations.

Note: R2 = 0.09. Correlation is statistically significant at the 1% level. Countries in red are G20 members, case study countries, and countries mentioned in the main text. Outliers dropped to improve readability.

The above analysis focuses on GVC participation, but it is also possible to use trade data to look at the issue of moving up to higher value added activities. Intuitively, it is reasonable to expect that better air linkages would support movement into higher value products, because air freight is most efficient when goods have a relatively high value to weight ratio. Higher unit values (total value divided by quantity) are understood by trade economists as indicating higher value products, and usually higher quality products. The EVA Database and similar information on trade in value added do not allow for decomposition of trade flows by value and quantity, so it is not possible to calculate unit values, which are proxies for prices. To examine the issue, we therefore use standard trade data, but focus on a fine sub-division, product 847330 in the HS classification: parts and components of computers and similar products. This product is highly relevant because GVC activity is known to be intense in the sector. Figure 25 shows the association between the ATFI and export unit values for this product, calculated using EU mirror data. The upward sloping trend line indicates that a better air trade facilitation environment is associated with higher unit prices of exports in this key GVC sub-sector. The data sit well with the contention that better air cargo performance can help countries and firms produce higher value, higher price, and higher quality goods, which is an important part of the process of moving up the value chain.

Figure 25: Association between the Air Trade Facilitation Index and export unit values (as a proxy for prices and quality) for computer parts and accessories, latest available year.



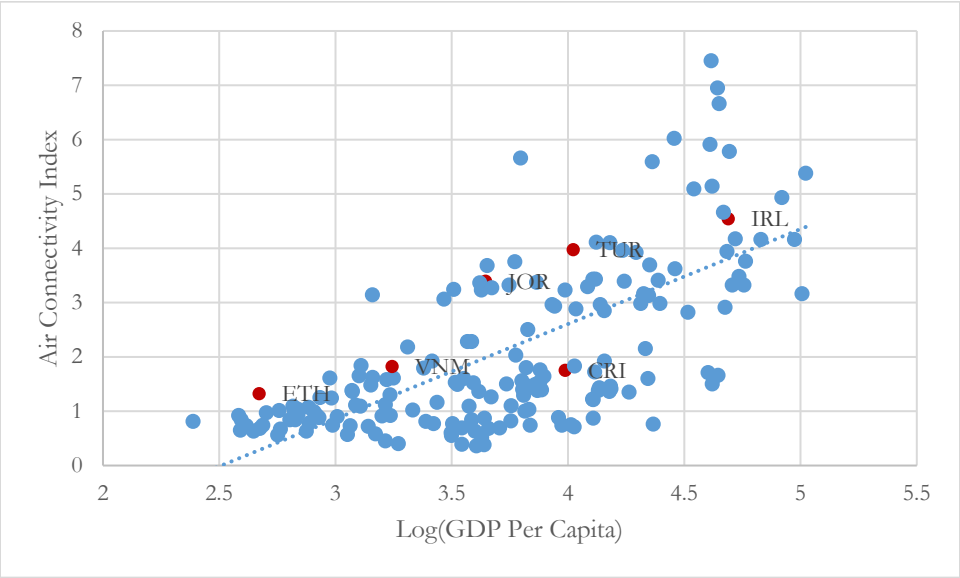
Source: EU ComExt; and authors' calculations. Countries in red are G20 members and case study countries. Outliers dropped to improve readability.

4 COUNTRY VALUE CHAIN CASE STUDIES

This section presents six case studies of country-sector GVCs, focusing on the role of air cargo in joining and moving up to higher value added activities. The purpose of the case studies is to provide more detailed analysis and narrative for the cross-sectional associations brought to light in the previous section. The case studies are largely qualitative in terms of methodology, but also make reference to quantitative data whenever relevant to show value chain development and the role of air cargo.

By way of introduction, it is important to put the selection of countries and sectors in context. As indicated in Section 2, sectors like pharmaceuticals and machinery—covering medical devices and electrical equipment—can be seen in US and EU trade data to be highly dependent on air transport, in value terms. This makes them good candidates for further exploration in this section, and each case study adds details on the evolution of the sector in each country, focusing on the particular role air cargo has played. To contextualize the choice of countries, it is useful to go back to the ACI data, but to account for the important role played by per capita income in determining air transport connectivity: it allows countries to develop better infrastructure, and is associated with stronger service sector development, for example, both of which contribute to superior performance. The ACI itself does not adjust for a country's income level in summarizing its performance. Figure 26 plots country ACI scores against per capita income, with a trend line summarizing the average relationship between income and connectivity. On average, a 1% increase in per capita income is associated with a 0.3% increase in the ACI. Countries above the line can be considered "over achievers" in terms of air connectivity: they have a level of performance in excess of what would be expected given their income. As can be seen from the figure, all case study countries except Costa Rica fall into that category. Indeed, a country like Ethiopia performs far more strongly than other countries at its income level, so this set of countries makes it possible to look at the ways in which forward thinking policies and effective private sector development can boost air cargo performance, which in turn, as has been seen above, can support increased GVC integration.

Figure 26: Association between per capita income and Air Connectivity Index, 2012.



Source: Arvis et al. (Forthcoming); World Development Indicators.

Note: Red points indicate case study countries, from left to right: Ethiopia, Vietnam, Jordan, Costa Rica, Turkey, and Ireland. Outliers have been dropped to improve readability.

4.1 Medical Devices in Costa Rica

4.1.1 Country Profile

Costa Rica is classified as a developing economy by the UN[3] and an upper middle-income country by the World Bank.[4] The country's recent growth performance has been robust, averaging 4.07% per annum. The Global Financial Crisis led to one year of negative growth, but the rate quickly rebounded. The relationship between air connectivity and per capita income (in current USD) plotted in Figure 25 reveals that Costa Rica lies marginally below the fitted trend line. This suggests that the air connectivity performance of the country is marginally lower than countries at a similar level of per capita income.

4.1.2 Sector Background

Manufacturing accounts for 16.35% of GDP, with the relevant employment share approximately the same. Traditionally, Costa Rica exported agricultural commodities, but more recently has moved into goods like medical devices and electronic components. The medical devices sector is relatively new and began in 1985 with the establishment of Baxter's operation in Costa Rica. The sector has since evolved with medical devices being one of the top exported products.

Costa Rica's strategy of export-led growth coupled with a sharp increase in FDI, especially in the manufacturing sector (amounting to 68% of total FDI flows), has led to tremendous growth of the medical devices sector over the past ten years. The number of people employed by this sector increased more than 100% from 6000 in 2006 (Cordero & Paus, 2008) to 12,500 in 2011 (Bamber & Gereffi, 2013).

[3] http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf
[4] http://www.worldbank.org/en/country/costarica

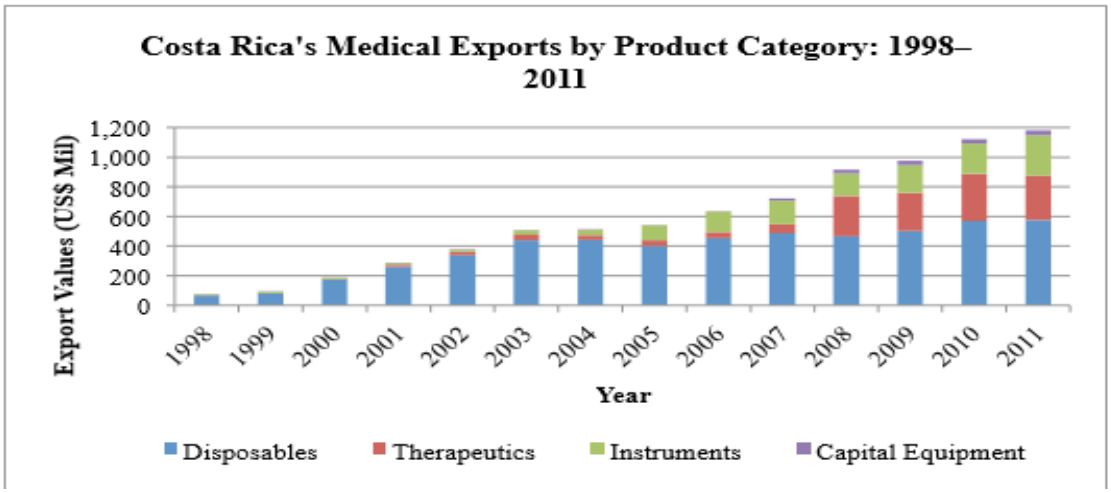
In 2015, the medical devices industry saw a 54% growth in exports over 2014, and medical devices were one of the top exported goods in Costa Rica. The value of medical devices exported increased from USD 97.3 million in 2014 to USD 149.9 million in January 2015.[5] According to the Costa Rican Investment Promotion Agency, the medical devices sector accounted for 4 percent of the country's GDP in 2015.

4.1.3 Evidence of the Sector's Integration into and Moving Up in GVCs

Costa Rica is now the second largest exporter of medical devices in Latin America and among the top seven suppliers to the US market. According to the Costa Rican Investment Promotion Agency, the country has evolved from producing Class I products like disposable and therapeutic products to Class III high tech medical devices including aesthetics, cardiovascular, dental, endoscopy, medication delivery systems, neuro-endovascular, neuro-modulation, optics, orthopedics/sport medicine/ENT, and surgical/diagnostics components. Most of the significant growth in the number and variety of firms has taken place from 2009 to 2012.

As Figure 27 below shows, Costa Rican firms have moved up the value chain by upgrading from Class I to Class III medical devices over 1998-2011. Until 2004, the medical devices sector only focused on basic manufacturing of medical devices. Since then, it has moved up the value chain into product and process upgrades like biopsy forceps, urethral stents, guide wires, as well as market diversification into other sectors like gastroenterology and urology (Gereffi, 2015). The diversification in medical devices products began in 2005 with the export of medical instruments, followed by therapeutic products in 2008 (Bamber & Gereffi, 2013).

Figure 27: Costa Rica's medical exports by product category, 1998-2011.



Source: Gereffi and Mayer (2015)

As noted above, backward and forward linkages can be used as a summary measure of a sector's integration into GVCs. Backward linkages capture foreign value added in a country's gross exports (essentially use of foreign inputs), and forward linkages capture domestic value added exported to another country which then uses it in its own exports (use of domestic output as an input into foreign exports). Quantitative evidence from the OECD-WTO TiVA database, reported in Table 8, suggests that the sector is well-integrated into GVCs. The shares of backward and forward integration into

[5] http://www.ticotimes.net/2015/02/23/medical-devices-top-costa-ricas-export-sales-in-early-2015

GVCs in 2011 were 41.5% and 34.9%, respectively. The sum of the shares of backward and foreign integration for this sector has declined slightly from 77.9% in 2000 to 76.4% in 2011, even as the reported data suggest that forward linkages may have become more important over time. This said, the high shares of backward integration also suggest that Costa Rican firms continue to source inputs from abroad to assemble the final product within the country.

Table 9: Measures of integration into GVCs.

	Share of forward integration		Share of backward integration	
Year	2000	2011	2000	2011
	31.7%	34.9%	46.2%	41.5%

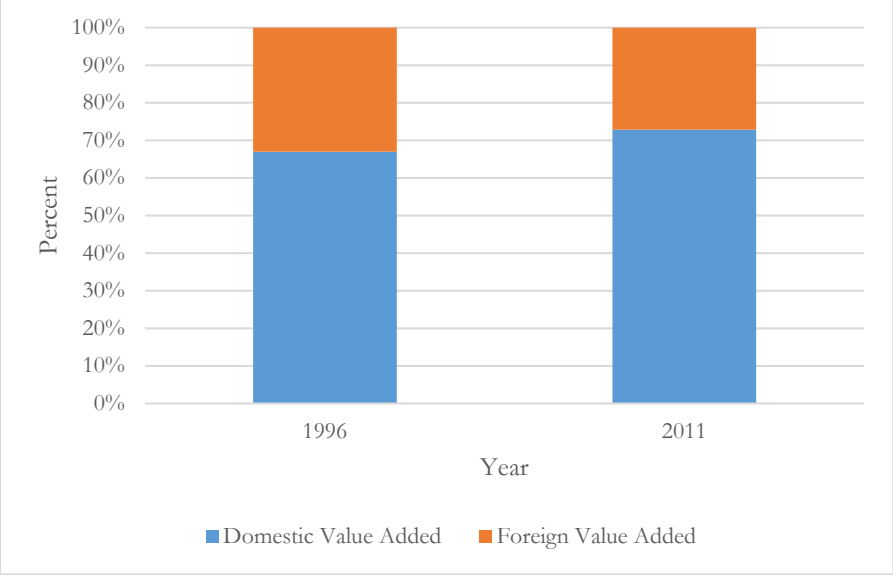
Source: OECD-WTO TiVA.

Note: Since medical devices is not directly available as a sector in OECD TiVA, the electrical machinery and apparatus, nec (not elsewhere classified) sector was selected in OECD TiVA for the descriptive statistics in this table.

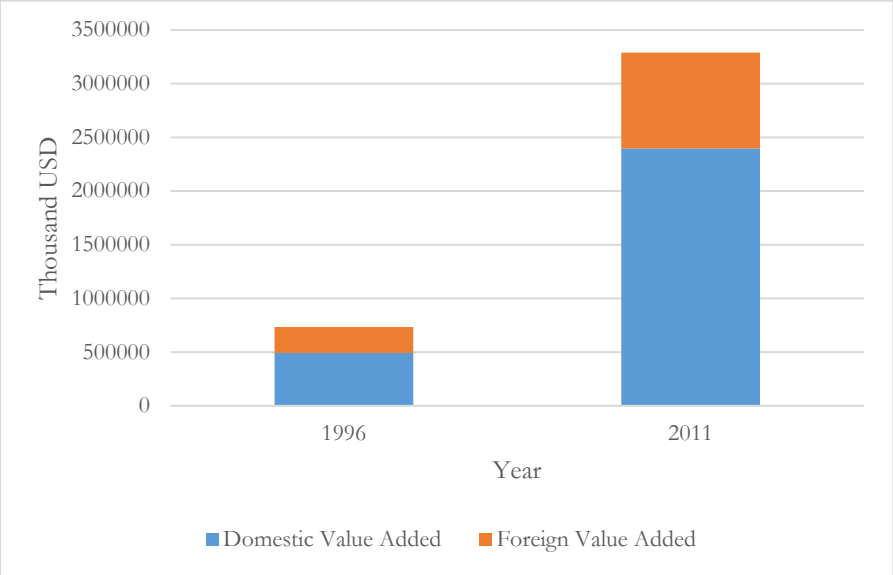
Figure 28 shows complementarities between domestic and foreign value added in the Costa Rican electrical and machinery sector (as the medical devices sector was not directly available), both in terms of percentage shares and USD thousands, over 1996-2011, based on the Eora MRIO database.

Figure 28: Complementarity between domestic and foreign value added in Costa Rica's electrical and machinery sector.

a) Domestic and foreign value added content of gross exports, shares, 1996 and 2011.



b) Domestic and foreign value added content of gross exports, thousand USD, 1996 and 2011.



Source: Eora MRIO database

The figure shows that (i) the total value of domestic and foreign value added has increased over time from USD 750 million to USD 3.3 billion over 1996-2011; and (ii) over the same time period, the share of domestic value in the total value added has increased from 67.5% to 72.5%. Thus, bringing domestic and foreign value added together through a GVC has allowed for faster sectoral growth on an overall basis and the domestic sector has also managed to obtain a bigger slice of a larger pie. Indeed, sectoral growth in value added, thanks in part to internationalization of production through GVC linkages, has been faster than overall GDP growth between 1996 and 2011, 10.51% annually versus 8.67%.

4.1.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain

In the year 2015, 25% of total EU imports and 36% of total US imports from Costa Rica were transported by air. In the case of some sectors (for instance EU imports of cereals, fertilizers and live animals and US imports of live animals, tobacco and knitted fabrics), the share of air cargo in the respective totals was 100%.

Air cargo has played a major role in facilitating the integration of the Costa Rican medical devices sector in GVCs. In fact, with the advent of the product and process upgrades of medical devices in the GVCs, the role of air cargo has become even more crucial.

Since Costa Rica is a part of the Central American Free Trade Zone, it has become a manufacturing hub for many companies in the medical devices sector. During 2001-2011, the Free Trade Zone exports of this sector have grown at an annual average rate of 8.6%. Foreign companies have started operations near free trade zones, such as Coyol Free Zone in Alajuela, which provides quick access to

the airport.[6] Factors such as these, in addition to a favorable political climate, have helped Costa Rica to attract foreign investments in the sector.

One of the major export destinations for Costa Rican medical devices is the United States. According to Caribbean Export Development Agency (2007), Costa Rica's proximity to the United States and the fact that 15 cargo airlines serve the capital city of San Jose is also a reason for the increased exports to the United States. Costa Rica has four international airports that connected with over 20,000 flights to 42 destinations in 2015 (IATA SRS Analyzer). This has in turn greatly increased the integration of this sector to GVCs through solid air cargo linkages.

Medical devices such as x-ray machines, computed tomography scanners, and magnetic resonance imaging (MRI) devices are very high value (OECD, 2014a), sensitive and large;[7] they require specific equipment, storage facilities and harmonized handling procedures.[8] All of this is being facilitated by steps taken towards air cargo trade facilitation and e-freight friendliness.

According to IATA's location status reports, while Costa Rica is not e-freight live yet, the e-freight capability target date was 2013. However, in terms of e-airway bill (AWB) capability, Costa Rica is conditionally capable for limited number of imports and exports, and transit and transshipment.

This said, qualitative evidence suggests that air cargo services have played a crucial role for international transfers of Costa Rican high-value products (OECD, 2013). For instance, in 2013, a small Costa Rican package company which dealt with high-tech and medical device manufacturers was acquired by United Parcel Service Inc., a US-based logistics company, to improve the air and ocean freight services between US and Latin America. Similarly, Boston Scientific, a US based multinational, has opened its second production plant in Costa Rica at Propark free-trade zone in Coyol, Alajuela, north of San Jose near the airport to export high tech medical devices to the US, which is a clear example of the sector's integration in GVCs and the role of air cargo services therein.[9]

To corroborate this qualitative evidence, we show the evolution of the air connectivity index (ACI) for Costa Rica and that of GVC-integration (sum of backward and forward linkages) for the country's electrical machinery and apparatus not elsewhere classified sector (as the medical devices sector is not directly included in WTO-OECD TiVA database) over 2008-2011 in Figure 29. The figure shows some co-movement in the ACI (plotted on the left axis) and GVC-integration (plotted on the right axis) for the country-sector, especially over 2009-2010, suggesting that improved air connectivity performance was associated with greater GVC-integration, everything else constant.

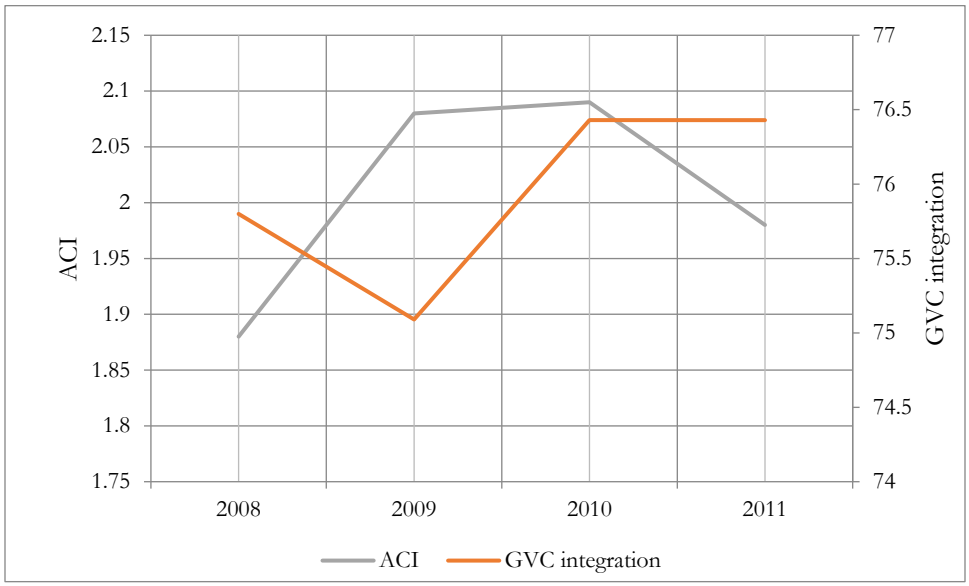
[6] ATEK Opens Medical Device Manufacturing Facility in Costa Rica, http://www.businesswire.com/news/home/20080402005360/en/ATEK-Opens-Medical-Device-Manufacturing-Facility-Costa

[7] Business Trends in Shipping Logistics for Medical Equipment, http://www.mddionline.com/article/trends-shipping-logistics

[8] Pharma and Healthcare Products, http://www.iata.org/whatwedo/cargo/pharma/Pages/index.aspx

[9] http://www.costaricaviews.com/boston-scientific-opens-new-plant-in-costa-rica/

Figure 29: Evolution of the ACI and GVC-integration for Costa Rica's electrical machinery and apparatus sector over time.



Source: OECD-WTO TiVA database; Arvis et al. (Forthcoming).

Our review of the relevant literature is also backed by quantitative evidence on the value of air transport in Costa Rica's medical devices exports and its relative position on different indices.

Air cargo was found to be a significant mode of transport in exporting medical devices from Costa Rica to the EU and US. The share of air cargo in the value of EU's imports of medical devices from Costa Rica in 2015, using data from ComExt, was 85%; the comparable figure for the US in 2015, using data from the Census Bureau, was 46%.

The ATFI value of Costa Rica is 78.78%, which is higher than the average (64.15%) of the countries for which this index has been calculated as well as the average (49%) for the eight Central American countries. The high ATFI value for Costa Rica points to the important role that air cargo services have played in the country's integration in GVCs, including at sectoral levels.

On the EFFI, the value of Costa Rica was 30.95% in 2016, which was much higher than the average (14.92%) for the countries for which this index has been calculated, and higher too than the average for the Central American countries (12.24%) for which the index has been calculated. The high EFFI value for Costa Rica suggests that the facilitation of e-freight has played an important role in the country's integration in GVCs, including at sectoral levels.

However, in terms of air connectivity, Costa Rica has not performed as well as its comparators. Costa Rica's average ACI value over 2008-12 of 1.96 is lower than the average value of 2.39 for the 186 countries for which this index has been calculated over the same time period. It is also lower than the period's average value of 2.06 for the eight Central American countries. Moreover, Figure 25 also suggests that the air connectivity performance of the country is lower than countries at a similar level of per capita income.

Together, these findings suggest that although Costa Rica has taken substantial steps forward on air cargo trade facilitation and eFreight friendliness—and has been rewarded through increased participation of medical device companies in GVCs—there remains much to be done, in particular in terms of increasing regularity and diversity of air services.

4.1.5 Policy Recommendations

According to IATA's location status reports, Costa Rica is not e-freight live yet, even though the e-freight capability target date was 2013. Also Costa Rica is only conditionally e-AWB capable for a very limited number of imports and exports, so there is ample scope for improving along both dimensions. One way forward would be for interest groups including industry, airlines, and customs authorities to make a concerted effort to work together to develop these capabilities. According to OECD (2013), improving the air infrastructure is also important to facilitate better integration of the Costa Rican economy in international production networks.

IATA's location status reports for Costa Rica also suggest that the country is not e-capable for documents such as the Electronic Export Goods Declaration, Electronic Export Cargo Declaration, Electronic Import Goods Declaration, Electronic Import Goods Declaration, Certificates of Origin, etc. Therefore, there is a need to promote and allow for electronic versions of these documents to ensure that the air cargo supply chain realizes maximum benefits from a more efficient e-freight process. Furthermore, the status reports recommend closer coordination between the border agencies, implementation of appropriate risk management systems, expansion of the Authorized Economic Operator program specifically focused on reducing long delays of clearing air cargo at import. This in turn would reduce the transport, inspection and warehousing costs of medical device components shipped to Costa Rica prior to making up finished products for export.

4.2 Textiles and Apparel in Ethiopia

4.2.1 Country Profile

Ethiopia is classified as an LDC and a Highly Indebted Poor Country and a Landlocked Developing Country by the UN[10] and a low-income country by the World Bank.[11] For the last ten years, Ethiopia has enjoyed very rapid economic growth, and has been making major strides forward in terms of development. Even the Global Financial Crisis did not lead the economy to contract. Average growth since 2004 has been 10.84%, one of the fastest sustained rates in the world. The relationship between air connectivity and per capita income plotted in Figure 25 reveals that Ethiopia lies near the fitted trend line. This suggests that the air connectivity performance of the country is about the same as other countries at a similar level of per capita income.

4.2.2 Sector Background

The economy is still dominated by agriculture, but manufacturing now accounts for 4.08% of GDP. The modern industrial sector has been the cornerstone of Ethiopia's rapid growth over recent years, with the textiles and apparel industry doing its part. The current 2016-2020 five-year plan, known as the Growth and Transformation Plan (GTP II), focuses on manufacturing and exports in textiles and garments, leather goods, and processed agricultural products.

The first garment factory in Ethiopia was established in 1939.[12] In terms of labor employment in this sector, as of 2015, 13,800 people were employed in textiles and 14,300 in garments (Nash International, 2015). The textile sector is part of the government's Growth and Transformation Plan (GTP) to transform the nation from an agriculture-dominated economy into a manufacturing economy (Nash International, 2015). The sector represented 6 percent of the country's total export value in 2015 with an ambition to grow to 22 percent by 2020 (Nash International, 2015). The Ethiopian textile and

[10] http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf
[11] http://www.worldbank.org/en/country/ethiopia
[12] Ethiopia: Textile Puzzle http://allafrica.com/stories/201504203377.html

apparel industry has grown an average of 51 percent over 2010-2015 and is now competing with Kenya as East Africa's leading textile manufacturer (Nash International, 2015).

As per UN COMTRADE data, Ethiopian exports of textile and apparel to the US in 2000 were nil and increased to USD 10 million by 2013. Similarly, for the EU, exports went from nil in 2000 to USD 43 million in 2013. This huge rise clearly shows an expansion of GVC-induced apparel exports from Ethiopia.

4.2.3 Evidence of the Sector's Integration into and Moving Up in GVCs

Geographically, Ethiopia has easy access to Asia, Africa, the Middle East, and Europe. Recently, Ethiopia has managed to attract a significant number of producers in the global apparel value chain linked to big brands such as H&M; several Turkish textile manufacturers have also invested in Ethiopia (Conceiçao et al. 2014).

In many Sub-Saharan African (SSA) countries including Ethiopia, the clothing industry is seen as a priority sector for export, employment generation, and industrial development. As part of policy, the Ethiopian government has restricted exports of Ethiopian raw cotton in order for it to be used in their own textile and apparel industry, to ensure that value addition takes place within the country. Similar bans have been put in place in the leather industry as well. The government of Ethiopia has also invested largely in knitting and weaving capacities, in order to avoid a situation where yarns are exported and value addition takes place outside the country (Nash International, 2015). Although such measures can develop domestic supply capacity, they are not without their problems: GVC activity requires access to good quality, reasonably priced inputs, which could be domestic or foreign in origin. Local content requirements such as these have historically proved problematic in developing countries, as they can negatively affect the competitiveness of downstream manufacturers. Concretely, they directly limit companies' ability to form international backward linkages of the type often seen within GVCs.

Nonetheless, Ethiopia's textile and apparel industry has seen marked development over time, moving from exporting raw cotton to exporting apparel and garments like polo shirts (Dinh et al. 2012). In producing polo shirts, a number of inputs like buttons, colors, collars, thread, and fabric are imported from China and Vietnam—an example of the type of international sourcing that can be limited by local content requirements. This is a good illustration of backward integration in the Ethiopian textiles and clothing industry. The manufactured shirts are then exported to the EU and the US.

Information on Ethiopia's GVC participation is taken from the Eora database. Table 9 suggests that backward and forward linkages are very significant in this sector, despite the local content requirements referred to above, which inhibit backward linkages. Nonetheless, there is some evidence of increasing linkages over time, and these numbers could undoubtedly be further developed with appropriate policy settings.

Table 10: Measures of integration into GVCs.

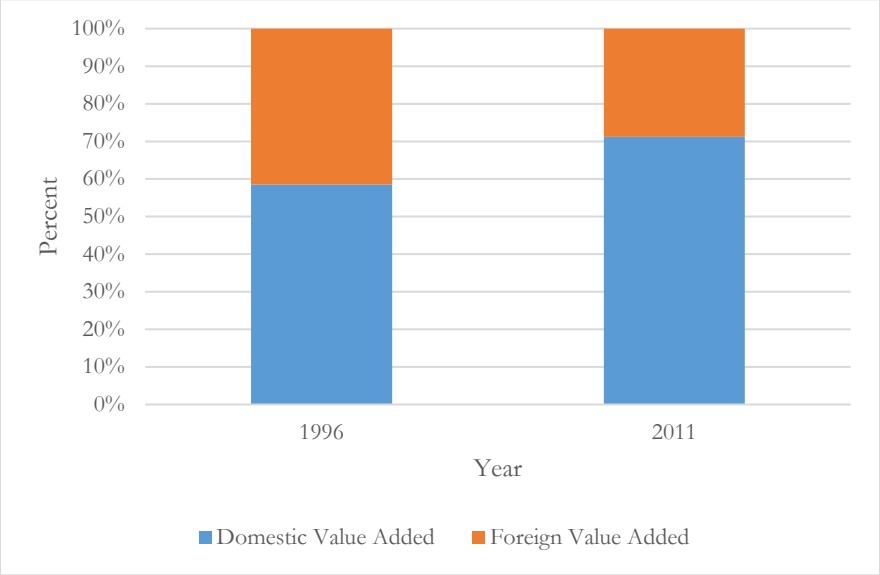
	Total share of backward and forward integration	
Year	1996	2011
Ethiopia – Textiles and Apparel	54%	55%

Source: Eora Database.

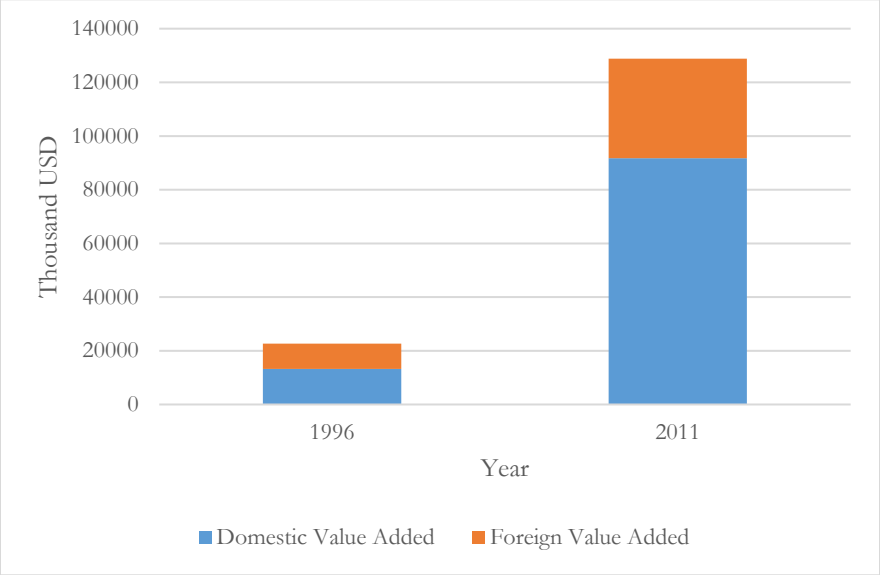
Figure 30 shows complementarities between domestic and foreign value added in the Ethiopian textiles and apparel sector, both in terms of percentage shares and USD thousands, over 1996-2011, based on the Eora MRIO database.

Figure 30: Complementarity between domestic and foreign value added in Ethiopia's textiles and apparel sector.

a) Domestic and foreign value added content of gross exports, shares, 1996 and 2011.



b) Domestic and foreign value added content of gross exports, thousand USD, 1996 and 2011.



Source: Eora MRIO database

The figure shows that (i) the total value of domestic and foreign value added has increased over time from USD 20 million to USD 130 million over 1996-2011; and (ii) over the same time period, the share of domestic value in the total added has increased from 59% to 71%. Thus, bringing domestic and foreign value added together through a GVC has allowed for faster sectoral growth on an overall basis and the domestic sector has also managed to obtain a bigger slice of a larger pie. Indeed, sectoral growth in value added has been very rapid, thanks in part to internationalization of production through

GVC linkages. The average annualized growth rate of total sectoral value added between 1996 and 2011 was 12.29%, compared with 9.19% for GDP.

4.2.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain

In the year 2015, 36% of total EU imports and 17% of total US imports from Ethiopia were transported by air. In the case of some sectors (for instance EU imports of clocks, cocoa and pharmaceuticals and US imports of inorganic chemicals, pharma and rubber products), the share of air cargo in the respective totals was 100%.

Air cargo services are an important facilitator of global sourcing, manufacturing, assembling and distributing goods in a textile GVC. Moreover, in the case of textiles, air cargo services play a crucial role, considering the delivery schedules involved and the textile value chain being one of the longest supply chains in GVCs.

As a real-world illustration of the use of air transport services in this sector, cited in Mahajan (2009), Garment Express PLC, a 100 percent export oriented unit owned by Dr. Worku Zewde, was using airfreight to export 1 million pieces of apparel to various sports chains in the US and employed 600 people in 2011. At a larger scale, Turkish firm Ayka made an initial $140 million investment in the Ethiopian garments sector, and now operates five plants around the capital, Addis Ababa. The company was responsible for just over half of total Ethiopian exports in the sector in 2012-13, and currently employs 7,500 people. Air cargo through Addis Ababa airport has been a significant factor in facilitating this expansion of exports, with corresponding impacts on value added and employment.

It is noteworthy that Ethiopia is a landlocked country, so air connectivity is all the more important for textile and apparel GVCs. In the case of Africa, Addis Ababa is already a main air hub and the home of Ethiopian Airlines, which carries two thirds of Africa's air freight and has significantly extended its cargo capacity and range.[13] Ethiopia has two international airports that connected with over 25,000 flights to 72 destinations in 2015 (IATA SRS Analyzer).

Ethiopian Airlines has also begun a four-fold expansion of its air cargo terminal in Addis Ababa as Africa's largest carrier improves the freight-handling ability of its hub to support a growing global reach. At a cost of $98 million, the new facility is expected to have an annual capacity of more than 600,000 tons.[14] In 2015, Ethiopian Cargo started a direct flight to Kempegowda International Airport - a very strategic decision because Bangalore is the closest international airport to Tirupur - the textile hub of India.[15] Once again, this development is suggestive of the important role played by air cargo services in the sector's integration in textile and apparel GVCs.

In fact, from being a major exporter of raw cotton to now being an exporter of high value apparels signifies that the sector has moved up the value chain. In part, this is due to the role of air cargo services in linking Ethiopian producers and international buyers rapidly and reliably, as the above narrative describes.

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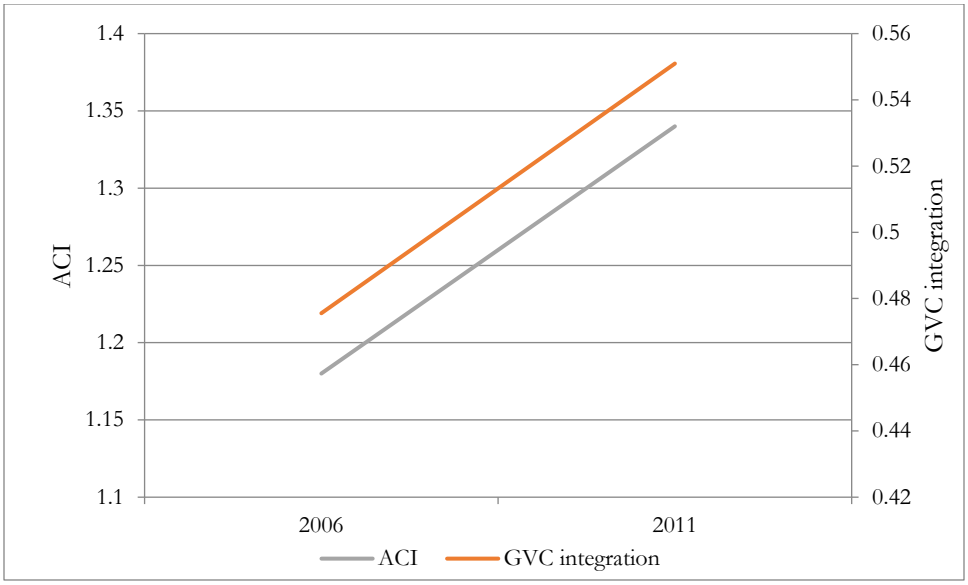
[13] Why Invest in Ethiopia, http://www.investethiopia.gov.et/why-ethiopia/why-invest-in-ethiopia

[14] Djibouti calls boost CMA CGM's growing Africa coverage, www.joc.com/maritime-news/container-lines/cma-cgm/djibouti-calls-boost-cma-cgm's-growing-africa-coverage_20160323.html

[15] Ethiopian Cargo's inaugural flight touches down in KIAB, www.stattimes.com/index.php/ethiopian-cargos-inaugural-flight-touches-down-in-kiab/

To corroborate this qualitative evidence, we show the evolution of the air connectivity index (ACI) for Ethiopia and that of GVC-integration (sum of backward and forward linkages) for the country's textiles and clothing sectors included in the Eora database for two points in time in Figure 31. While we can correlate only two recent years for which data are available, the figure shows strong co-movement in the ACI (plotted on the left axis) and GVC-integration (plotted on the right axis) for the country-sector, suggesting that greater GVC-integration was associated with improved air connectivity performance, everything else constant.

Figure 31: Evolution of the ACI and GVC-integration for Ethiopia's textiles and clothing sector over time.



Source: Eora MRIO database; Arvis et al. (Forthcoming).

At present, the cargo business of Ethiopian Airlines has achieved full paperless automation. They have launched E-freight/e-AWB. E-freight is very beneficial to the Ethiopian textile sector keeping in mind speed, security, supply chain visibility, and cost effectiveness. In order to facilitate timely delivery in textile GVCs, the airline has also fully automated its communications processes with Ethiopian Revenues and Customs Authority.

According to IATA, extensive customs modernization programs have been on-going in several African countries including Ethiopia. While the region's performance in terms of e-AWB penetration for the month of August 2016 stands at 54%, Ethiopia is amongst the top three performers. In fact, IATA[16] lists Ethiopian Airlines amongst the top 10 best performing airlines in the world.

Since 2015, IATA has also been engaging with stakeholders in Ethiopia on the e-AWB initiatives. These engagements have resulted in the endorsement of airport e-AWB standard operating procedures (SOPs) in Addis Ababa and Nairobi. It is believed that the e-AWB360 campaign will provide additional motivation for selected airports to reach 100% penetration. Currently, Addis Ababa airport is leading with 92.6% penetration rate followed by Mauritius at 67.5% and Nairobi at 61.5% (Smith & Moosberger, 2009).

[16] http://www.iata.org/about/worldwide/ame/industry-gazette-summer-2016/Pages/e-freight-in-africa.aspx

This review of the relevant literature is also backed by quantitative evidence on the value of air transport in Ethiopia's apparel exports and its relative position on different indices.

Air cargo was found to be a significant mode of transport in exporting textiles and apparel from Ethiopia to the EU and US. The share of air transport in the value of EU's imports of textiles and apparel from Ethiopia in 2015, using data from ComExt, was 29%; the comparable figure for the US in 2015, using data from the Census Bureau, was 16%.

The ATFI value of Ethiopia is 49.89%, which while lower than the average (64.15%) of the countries for which this index has been calculated, is much higher than the average (29.81%) for the African LDCs for which the ATFI has been calculated. The relatively high ATFI value for Ethiopia vis-à-vis African LDCs points to the important role that air cargo services have played in the country's integration in GVCs, including at sectoral levels.

On the EFFI, the value of Ethiopia was 13.09% in 2016, which was slightly lower than the average (14.92%) of the countries for which this index has been calculated. Ethiopia's EFFI value suggests that the facilitation of e-freight has played an important role in the country's integration in GVCs, including at sectoral levels, but that much more is necessary to develop practice closer to the global frontier.

Even in terms of air connectivity, Ethiopia has performed better than its comparators over 2008-2012. The country's average ACI value over 2008-12 of 1.28, while lower than the average value of 2.39 for the 186 countries for which this index has been calculated over the same time period, is still much higher than the period's average value of 0.98 for the African LDCs. Moreover, Figure 25 also suggests that the air connectivity performance of the country is better than that of other countries at a similar level of per capita income.

4.2.5 Policy recommendations

IATA has been working on several engagement programs on the implementation of the e-freight initiative across Africa including in Ethiopia. When it comes to Africa, efficient IT is still a challenge and there is lack of readiness from the regulatory environment which includes customs authorities that are entirely depending on paper documents in the handling of air cargo (Smith & Moosberger, 2009).

Other important constraints for Ethiopian textile value chains are poor trade logistics and access to trade finance. There should be a green channel for apparel at customs, and a free trade zone for apparel and textiles should be set up near Addis Ababa Airport.

According to IATA's location status reports, Ethiopia is not e-freight live yet, even though the e-freight capability target date was 2013. So there is ample scope for improvement along this dimension. In this regard, consideration should be given to an overarching air cargo trade facilitation assessment that will focus on the inhibiters to trade facilitation and make recommendations to maximize trade growth. eAWB penetration, whist healthy, only pertains to the national carrier, and the other carriers flying cargo to and from Ethiopia should consider following this example

4.3 Pharmaceuticals in Ireland

4.3.1 Country Profile

Ireland is classified as a developed economy by the UN[17] and a high-income country by the World Bank.[18] Ireland is again experiencing robust economic growth, following a difficult slump as a result of the Global Financial Crisis. The average growth rate over the last 15 years has been close to 3.64%, which is quite rapid for a developed economy. The relationship between air connectivity and per capita income plotted in Figure 25 reveals that Ireland lies above the fitted trend line. This suggests that the air connectivity performance of the country is higher than countries at a similar level of per capita income.

4.3.2 Sector Background

Ireland's manufacturing sector is significant, at 19.72% of GDP; most of the remainder is accounted for by services. Although seriously affected by the Global Financial Crisis, the Irish economy is now on a solid growth path again. Modern manufacturing and service industries are the cornerstone of the country's success.

Initially, the pharmaceutical sector in Ireland only focused on the export of bulk active ingredients, which were later processed into medicines in other countries. However, according to the Irish Pharmaceutical Healthcare Association,[19] Ireland is now the most attractive destination for pharma in Europe, with nine of the 10 largest pharmaceutical companies having manufacturing units there. Ireland is a favorite destination of multinational pharmaceutical companies because of its highly skilled workforce, favorable governmental policies, grants from the Industrial Development Agency, Ireland, and low corporation tax.[20]

In terms of employment, in 2005 there were 2500 people employed in the sector, whereas in 2016 there are 25,000 directly employed in these sectors, and another 25,000 are indirectly associated with the sector (McGee Pharma International, 2016). According to the Industrial Development Agency of Ireland,[21] Ireland is the 7th largest exporter of pharmaceutical products in the world and also the largest exporter to the EU. The pharmaceutical sector represents 30 percent of total Irish exports and supports activity equivalent to 27 percent of the country's GDP.

Ireland's pharmaceutical sector has an excellent track record with statutory safety and quality regulations like US Food and Drug Administration and Irish Medicines Board. Currently, Ireland is diversifying from an export-led manufacturing dominance to a more integrated sector, which includes research and development, sales and marketing, clinical trials, and regulatory affairs, all significant in a value chain. Increased investment in research and development has led to advancement in clinical trial requirements.

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[17] http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf

[18] http://econ.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20421402~menuPK:64133156~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html

[19] www.ipha.ie/alist/contribution-to-the-irish-economy.aspx

[20] An incredible success story - Irelands pharma sector - lifescienceworld.in/an-incredible-success-story-irelands-pharma-sector/

[21] http://www.idaireland.com/business-in-ireland/industry-sectors/bio-pharmaceuticals

4.3.3 Evidence of the Sector's Integration into and Moving Up in GVCs

In pharmaceuticals GVCs, innovation and clinical trials are considered to be high value-added activities. Manufacturing is seen as a relatively lower value-added activity, while sales and marketing are generally characterized as medium-level.

It is important to explore the qualitative changes in the value chain activity of pharmaceuticals in Ireland to ascertain which parts of the Irish pharmaceutical components of manufacturing (i.e. active ingredients and drug formulations) and research and development (i.e. discovery, clinical trials, and process development) are being done in the country, suggesting that Ireland has moved up the value chain. It has been seen over a period of time that Ireland has moved from manufacturing (low value) to R&D (high value) in pharmaceuticals. All these developments have also substantially increased the level of value creation along the supply chain (Egeraat and Barry, 2008), ensuring that Irish participation in pharma GVCs remains high. And the nature of that participation has also changed over time (Brennan and Rakhmatullin, 2015), suggesting that the sector has moved up the value chain by positioning itself more upstream.

The Irish pharmaceutical sector has evolved from producing active ingredients in bulk exports to finished products such as capsules and tablets. This has been the result of a number of companies setting up plants and research centers in Ireland.

Quantitative evidence from the OECD-WTO TiVA database suggests that the sector is well-integrated into GVCs, both in terms of backward and forward linkages (Table 10). The shares of backward and forward integration into GVCs in 2011 were 46.1% and 36.4%, respectively. The sum of the shares of backward and foreign integration for this sector has risen slightly from 81.4% in 2000 to 82.5% in 2011, even as the reported data suggest that backward linkages may have become more important over time. This said, the high shares of backward and forward integration suggest that Irish firms continue to source inputs from abroad to assemble the final product within the country as well as supply high-value inputs to GVCs.

Table 11: Measures of Integration into GVCs.

	Share of forward integration		Share of backward integration	
Year	2000	2011	2000	2011
	41.8%	36.4%	39.6%	46.1%

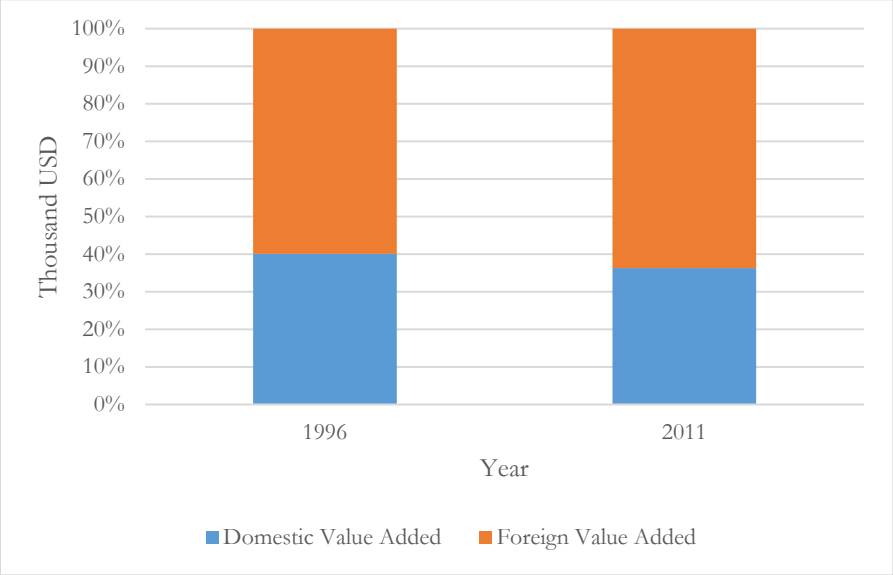
Source: OECD-WTO TIVA.

Note: Since pharma is not directly available as a sector in OECD TiVA, the chemicals and chemical products sector was selected in OECD TiVA for the descriptive statistics in this table.

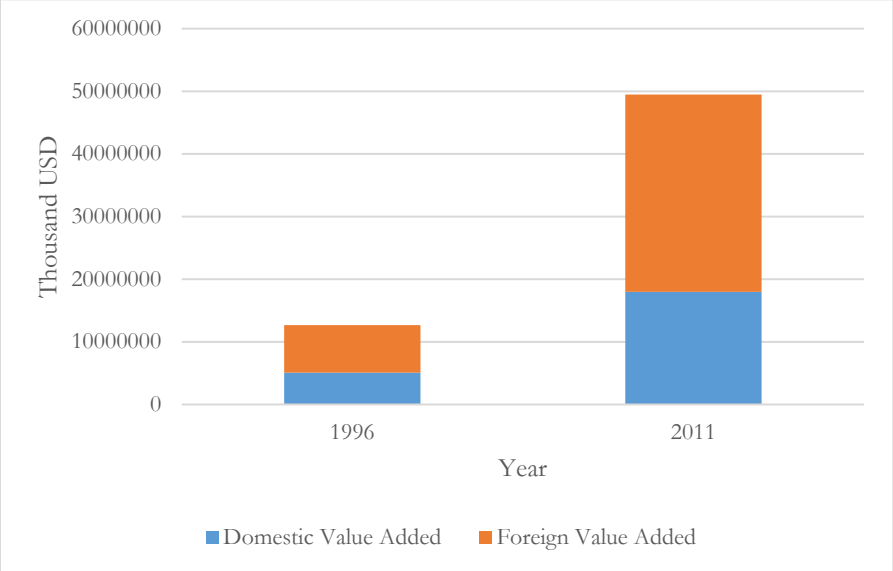
Figure 32 shows complementarities between domestic and foreign value added in the Irish petroleum, chemicals and non-metallic mineral products sector (as the pharma sector was not directly available), both in terms of percentage shares and USD thousands, over 1996-2011, based on the Eora MRIO database.

Figure 32: Complementarity between domestic and foreign value added in Ireland's petroleum, chemicals and non-metallic mineral products sector.

a) Domestic and foreign value added content of gross exports, shares, 1996 and 2011.



b) Domestic and foreign value added content of gross exports, thousand USD, 1996 and 2011.



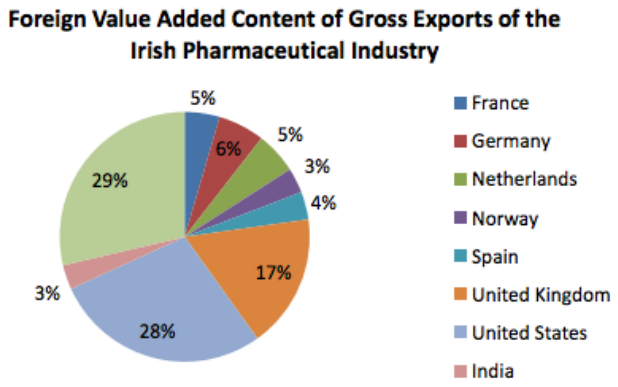
Source: Eora MRIO database

The figure shows that (i) the total value of domestic and foreign value added has increased over time from USD 13 billion to USD 50 billion over 1996-2011; and (ii) over the same time period, the share of domestic value in the total added has declined from 40% to 36%. Thus, bringing domestic and foreign value added together through a GVC has allowed for faster sectoral growth on an overall basis than it would under a restrictive trade and investment regime, even though the change for the domestic sector in terms of proportions has been in the opposite direction. Sectoral growth in value added has

indeed been very rapid, thanks in part to internationalization of production through GVC linkages. Total sectoral value added grew at an average annualized rate of 9.51% between 1996 and 2011, compared with 8.04% for GDP.

In Figure 33 below, we can see the breakdown by country of origin in foreign value added content of gross exports of the Irish pharmaceutical industry in the year 2009. The Netherlands contributes the most to the Irish pharmaceutical industry in terms of backward linkages, followed by the US and UK. While the geographical distribution of backward linkages is dominated by OECD countries, the Irish pharma industry also imports 3% of its gross exports as intermediate inputs from India. This sourcing pattern shows that Ireland is well-integrated into pharma GVCs with regional and global reach.

Figure 33: Foreign value added content of cross exports by country of origin



Source: Brennan and Rakhmatullin (2015)

4.3.4 Role of Air Cargo in GVC Integration and Moving up the Value Chain

In the year 2015, 19% of total Irish exports to the EU and 81% of total US imports from Ireland were transported by air. In the case of some sectors (for instance US imports of silk, cotton and tin products), the share of air cargo in the total was 100%.

According to IATA,[22] pharmaceutical products are extremely time and temperature sensitive and require specific equipment, storage facilities, and harmonized handling procedures that air services offer. Since Ireland is an island nation, accessibility to major overseas markets is central to the overall success of this industry. Since time, safety, and storage are vital to the export of pharma products, the massive increase in Irish pharma exports indicates that air transport has played a vital role in supporting the integration of this sector to GVCs.

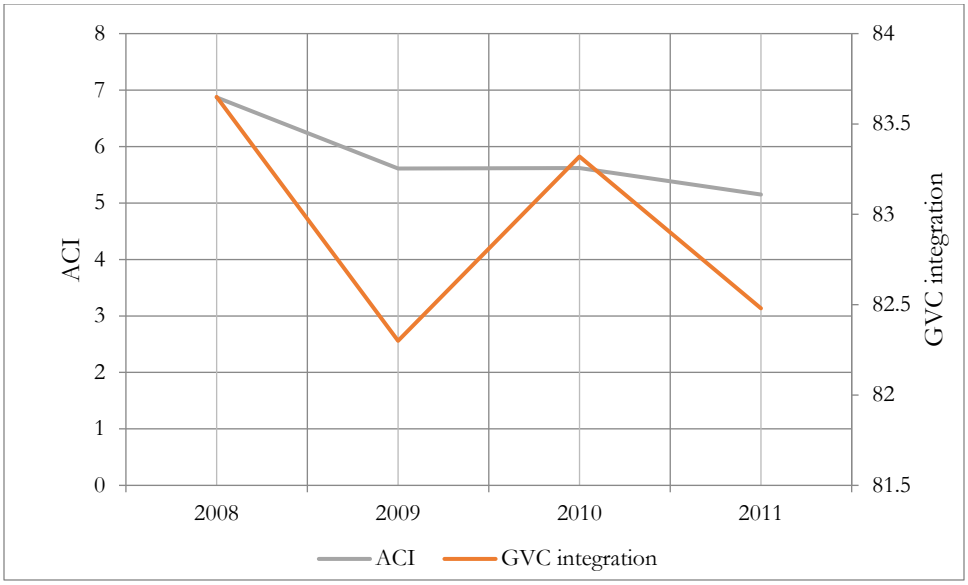
Consistent with this argument, air transport was found to be a significant mode of transport in exporting pharmaceuticals from Ireland to the EU and US. The share of air transport in the value of the US's imports of pharmaceuticals from Ireland using data from the Census Bureau, was 88%. The comparable figure for EU's imports of chemicals from Ireland in 2015, using data from ComExt, was 16%. Given that the chemicals sector includes bulk items that are not necessarily transported by air, the air transport share is comparatively lower relative to the true but unobserved level for pharma only.

Ireland has three international airports that connected with over 100,000 flights to 175 destinations in 2015 (IATA SRS Analyzer).

[22]Pharma and Healthcare products, http://www.iata.org/whatwedo/cargo/pharma/Pages/index.asp.

We also show the evolution of the air connectivity index (ACI) for Ireland and that of GVC-integration (sum of backward and forward linkages) for the country's chemicals sector (as the pharma sector is not directly included in OECD-WTO TiVA database) over 2008-2011 in Figure 34. The figure shows co-movement in the ACI (plotted on the left axis) and GVC-integration (plotted on the right axis) for the country-sector, suggesting that the decline in GVC-integration over this period was in part linked to reduced air connectivity performance, everything else constant.

Figure 34: Evolution of the ACI and GVC-integration for Ireland's chemicals sector over time.



Source: OECD-WTO TiVA database

According to IATA's location status reports, Ireland is both e-freight capable and eAWB-capable for imports, exports, transit and transshipment, which again highlights the significant role that air trade facilitation and eFreight friendliness have played in the pharma sector's integration and moving up in GVCs.

The ATFI value of Ireland is 85.82%, which places it amongst the top 30% in the list of countries for which this index has been calculated. Ireland's ATFI value is comparable to the average (87.71%) for the EU. The relatively high ATFI value for Ireland relative to global practice highlights the important role that air transport services have played in the country's integration in GVCs, including at sectoral levels.

On the EFFI, the value of Turkey was 3.44% in 2016, which was lower than the average (14.92%) of the countries for which this index has been calculated. This result suggests that relative to European partners, there is clear scope to boost performance in terms of facilitation and use of electronic processing to support air cargo transactions.

The country's average ACI value over 2008-12 of 5.56 is both much higher than the average value of 2.39 for the 186 countries for which this index has been calculated over the same time period, as well as the comparable figure (4.88) for the EU27. Ireland is clearly well served in terms of the strength and diversity of its connections, one factor that underlies its strong air cargo performance. Moreover, Figure 26 also suggests that the air connectivity performance of the country is higher than countries at a similar level of per capita income.

4.3.5 Policy recommendations

Ireland's e-freight and e-AWB capability suggests that the country fulfils the regulatory and technical requirements to work in an electronic environment. Indeed, this structure will be strengthened as the new European Union Customs Code (UCC) that entered into force in May 2016, takes effect. The UCC enables e-Borders including the provision of all declarations.

However, neither any Irish airline nor any of the country's three international airports are certified by the Centre of Excellence for Independent Validators in Pharmaceutical Logistics (CEIV) yet, which was launched by IATA to ensure common safety air cargo standards for pharmaceutical products and to help organizations get certified and address safety needs of pharmaceutical shipments. For further global integration of its pharma sector, Ireland needs to fast-track getting the CIEV Pharma certificate.

4.4 Pharmaceuticals in Jordan

4.4.1 Country Profile

Jordan is classified as a developing economy by the UN[23] and an upper middle-income country by the World Bank.[24] After enjoying rapid growth in the mid-2000s, Jordan has experienced a period of slower growth following the Global Financial Crisis. Nonetheless, the average growth rate over the last 15 years was 5.06%, which is a relatively strong performance. The relationship between air connectivity and per capita income plotted in Figure 25 reveals that Jordan lies well above the fitted trend line. This suggests that air connectivity performance of the country is much higher than countries at a similar level of per capita income.

4.4.2 Sector Background

Jordan is a small economy with a substantial manufacturing sector, accounting for nearly 18.47% of GDP. An important sector within the modern industrial sector is pharmaceuticals. Pharmaceutical manufacturing is classified into two categories: originators, which develop original molecules of the medicine, and generics, which manufacture similar drugs to the originators once they are off patent. Most of the Jordanian pharma manufacturers fall in the latter category.

The pharmaceutical sector in Jordan was first established in the early 1960s, with the first manufacturer, the Arab Pharmaceutical Manufacturer in 1962, followed by Dar Al Dawa in 1975 and Hikma Pharmaceuticals in 1977 (Rakan & Haya, 2007). However, real growth started with the country's accession to the WTO in 2000, being the first Arab country to implement the Trade-related Aspects of Intellectual Property Rights (the TRIPS Agreement) that proved to be very beneficial to the Jordanian pharmaceutical industry. Due to the agreement, the industry now has one of the highest standards of intellectual property laws for pharmaceutical products in the region, compared to the past when Jordan had been listed on United States Trade Representative (USTR)'s Special 301 watch list for failure to adequately protect US intellectual property rights. Moreover, the agreement has not only induced transfer and dissemination of technology but has also promoted technological innovation in Jordan.[25] Due to these developments, Jordan is now the medical hub for Gulf Cooperation Council (GCC) countries.

Over the last decade or so, a number of Jordanian companies have established licensing relationships with pharmaceutical companies from the United States, Japan, Korea, Italy, Switzerland, and the

[23]http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf
[24] http://www.worldbank.org/en/country/jordan
[25]Intellectual Property Watch, Inside Views: Access To Medicines and Intellectual Property In Jordan http://www.ip-watch.org/2012/07/23/access-to-medicines-and-intellectual-property-in-jordan/

United Kingdom, and have benefited from technology transfer and knowledge base. According to the Jordanian Association of Pharmaceutical Manufacturers,[26] the pharmaceutical industry is Jordan's second largest exporting industry with an export base of 60 countries but with 90 percent of exports to Arab countries. Sectoral specialties include antibiotics, anti-ulcer medication, hormones, and cancer treatments.[27]

Currently there are 16 local pharmaceutical plants having a market value exceeding USD 1.18 bn in production of medicines. Jordan's pharmaceutical exports were expected to reach USD 1 billion by 2015. Jordan's pharmaceutical industry employs more than 4,000 people directly, while another 3,000 are employed indirectly in supply and related industries (Global Investment House, 2007).

During 2004 to 2008, the pharmaceutical sector represented 8% of the total exports of the country. Between 70-80% of Jordan's pharma production is exported and the main destinations, Saudi Arabia, Algeria and Iraq, account for 90% of the country's total pharma exports (Rakan & Haya, 2007).

4.4.3 Evidence of the Sector's Integration into and Moving Up in GVCs

In pharmaceuticals GVCs, manufacturing is considered as a low value-added activity whereas innovation and clinical trials are considered to be high value-added activities. Therefore, it is pertinent to ascertain which parts of the value chain activity i.e. components of manufacturing (active ingredients and drug formulation) are carried out domestically.

The focus of the Jordanian pharma sector in the manufacture of generics and the profile of the main destinations for its exports suggest that the country is mainly positioned at the lower-end of the pharma value chain is still developing its capacity to move up.

Jordan's strong involvement in the pharma value chain is corroborated using data from the Eora MRIO database which suggests that that the GVC participation share (sum of backward and forward linkages) for the country's petroleum, chemicals, and non-metallic mineral products sector (due to the non-availability of the pharma sector) was a high 46% in 2011, though the share was lower than its value (54%) in 2001.

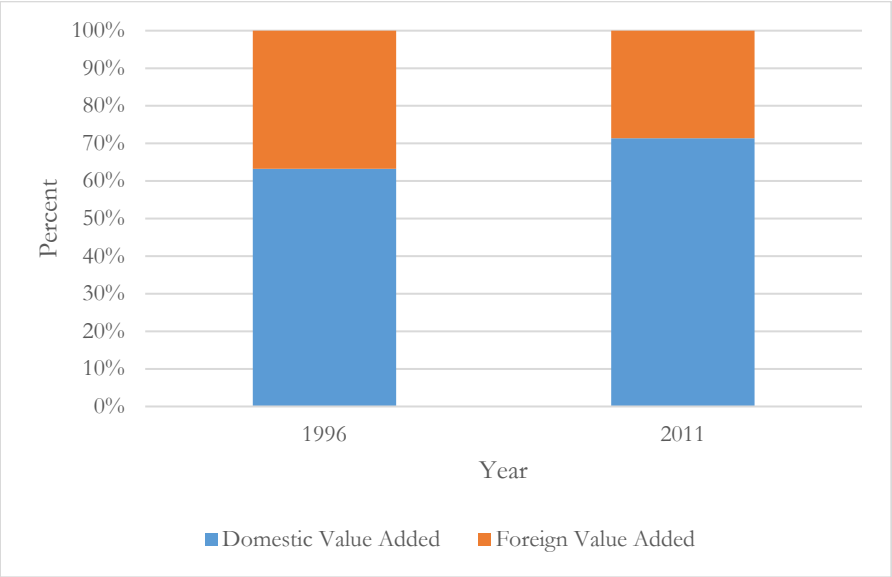
Figure 35 shows complementarities between domestic and foreign value added in the Jordanian petroleum, chemicals and non-metallic mineral products sector (as the pharma sector was not directly available), both in terms of percentage shares and USD thousands, over 1996-2011, based on the Eora MRIO database.

[26] Pharmaceutical Industry, www.japm.com/Public/English.aspx?Lang=2&Page_Id=194&Menu_ID=6&Menu_Parent_ID=-1&type=R

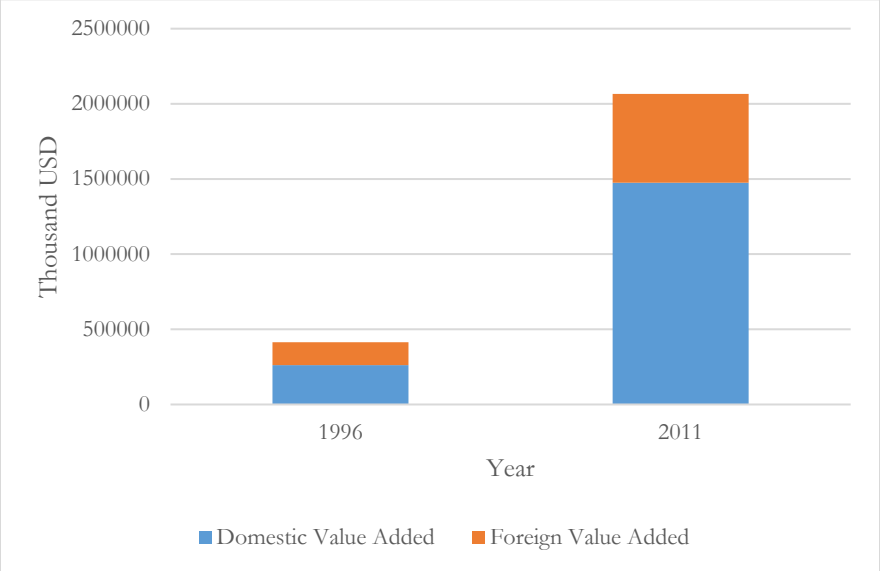
[27] http://www.jkb.com/sites/default/files/JKB_AnnualReport_En_2012.pdf.

Figure 35: Complementarity between domestic and foreign value added in Jordan's petroleum, chemicals and non-metallic mineral products sector.

a) Domestic and foreign value added content of gross exports, shares, 1996 and 2011.



b) Domestic and foreign value added content of gross exports, thousand USD, 1996 and 2011.



Source: Eora MRIO database

The figure shows that (i) the total value of domestic and foreign value added has increased over time from USD 480 million to USD 2 billion over 1996-2011; and (ii) over the same time period, the share of domestic value in the total added has increased from 63% to 71%. Thus, bringing domestic and foreign value added together through a GVC has allowed for faster sectoral growth on an overall basis and the domestic sector has also managed to obtain a bigger slice of a larger pie. Indeed, internationalization of production through GVC linkages has been one factor that contributed to a

rapid rate of sectoral growth in value added. Total sectoral value added increased at an average annualized rate of 11.30% between 1996 and 2011, compared with a rate of 9.97% for GDP.

4.4.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain

In the year 2015, 29% of total EU imports and 15% of total US imports from Jordan were transported by air. In the case of some sectors (for instance EU imports of furskins and live animals and US imports of leather, wood and paper articles), the share of air cargo in the respective totals was 100%.

Aviation Benefits Beyond Borders[28] suggest that 0.5 million tons of pharmaceutical products are transported by air every year against 3.5 million tons by sea. But the value of this air freight is around $213 billion against the $56 billion value of sea-freight – and it is increasing every year by around 6% a year. Air cargo is critical in flying temperature-sensitive pharmaceutical products in the best conditions, using cutting-edge technologies and procedures. For the same reason, air freight transport has seen larger growth rates for the pharmaceutical sector in comparison with other industries.[29]

According to pharmaceutical commerce, the global pharmaceutical industry is projected to rise by 41 percent by 2020. Within that, products that require refrigerated storage and transport are worth around $260 billion, and will rise by 65 percent by 2020, while non-refrigerated products are projected to rise by about 34%.[30]

From all this it can be inferred that air transport services have and will continue to play an important role in the integration and deepening of pharma GVCs internationally, including for Jordan.

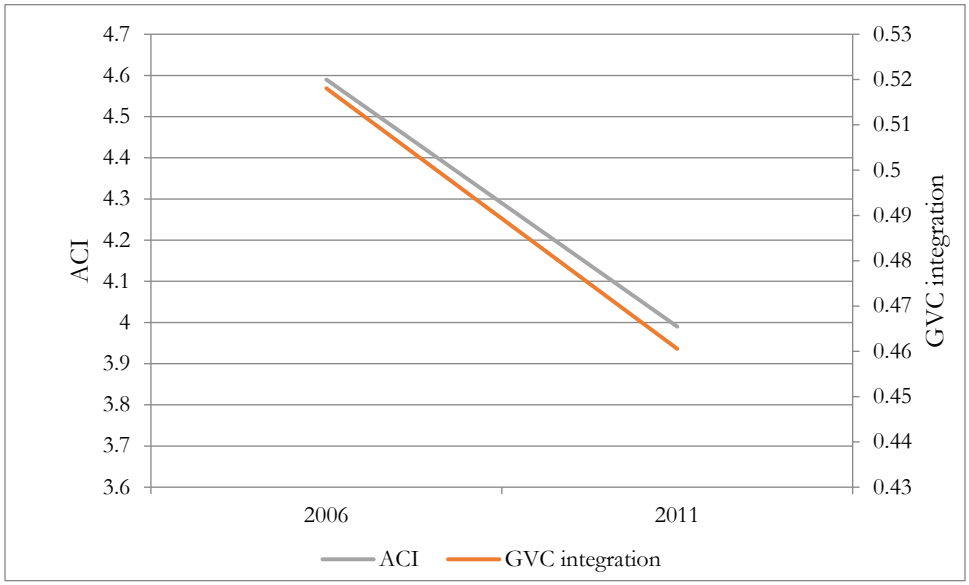
To corroborate this qualitative evidence, we also show the evolution of the ACI for Jordan and that of GVC participation (sum of backward and forward linkages) for the country's petroleum, chemicals and non-metallic mineral products sector (as the pharma sector is not directly included in the Eora MRIO database) over 2006-2011 in Figure 36. The figure shows strong co-movement in the ACI (plotted on the left axis) and GVC-integration (plotted on the right axis) for the country-sector, suggesting that the decline in air connectivity over this period was one potential cause of reduced GVC participation, everything else constant.

[28] A key link in the pharma supply chain, http://aviationbenefits.org/case-studies/airlines-key-links-in-the-pharmaceutical-supply-chain/.

[29] Air Freight Innovation , www.samedanltd.com/magazine/15/issue/224/article/3946.

[30] Pharmaceutical cold chain logistics is a $12.6-billion global industry, www.pharmaceuticalcommerce.com/supply-chain-logistics/pharmaceutical-cold-chain-logistics-is-a-12-6-billion-global-industry/.

Figure 36: Evolution of the ACI and GVC-integration for Jordan's petroleum, chemicals and non-metallic mineral products sector over time.



Source: Eora MRIO database; Arvis et al. (Forthcoming).

Jordan has two international airports that connected with over 30,000 flights to 67 destinations in 2015 (IATA SRS Analyzer). In 2014, Royal Jordanian inaugurated the e-freight system. The e-freight system connects directly with the electronic system that is applied at the Jordanian Customs Department and other concerned parties, thus easing and accelerating clearance of goods and delivery to the consignee.[31] It is seen as a very important step in integrating Jordanian pharmaceutical products with GVCs.

This review of the relevant literature is also backed by quantitative evidence on the value of air transport in Jordanian pharma exports and its relative position on different indices.

Air transport was found to be a significant mode of transport in exporting pharmaceuticals from Jordan. The share of air transport in the value of EU's imports of pharmaceuticals from Jordan in 2015, using data from ComExt, was 61%. However, the comparable figure for the US in 2015, using data from the Census Bureau, was only 4%, which possibly reflects the sensitivity of pharmaceutical products to distance.

The ATFI value of Jordan is 82.33%, which places it amongst the top one-third in the list of countries for which this index has been calculated. Jordan's ATFI value is also higher than the global average (64.15%) and the average for MENA countries (67.50%) for which the ATFI has been calculated. The significantly high ATFI value for Jordan highlights the important role that air transport services have played in the country's integration in GVCs, including at sectoral levels.

On the EFFI, the value of Jordan was 0.49% in 2016, which was much lower than the average (14.92%) of the countries for which this index has been calculated. This suggests that the role played by the facilitation of e-freight in the country's integration in GVCs, including at sectoral levels, has been limited so far and there is ample scope for further development.

[31] Royal Jordanian launches e-freight system, www.rj.com/en/news/title/2986.html

In terms of air connectivity, Jordan has performed much better than its comparator group as well as the world on average over 2008-2012. The country had an average ACI value of 4.03 over 2008-12, which is both much higher than the average value of 2.39 for the 186 countries for which this index has been calculated over the same time period, as well as the comparable figure (3.33) for MENA countries. Moreover, Figure 26 also suggests that the air connectivity performance of the country is much higher than countries at a similar level of per capita income.

4.4.5 Policy recommendations

IATA's location status report for Jordan suggests that while the country is not e-freight live yet, the e-freight capability target was set as 2014. Also while the country is e-AWB capable for transshipment only, it has passed IATA's High Level Assessment (HLA) but not the Detailed Level Assessment (DLA) yet. The HLA investigates a location's regulatory and customs environment for air freight, while the DLA reviews the readiness of a location and its stakeholders to participate in IATA e-freight from technical, process and regulatory perspectives. This suggests that more work needs to be done to make the country both e-freight friendly and e-AWB capable. A major priority is the digitization of core industry transportation documents. One way forward would be via organized lobbying by various interest groups including industry, airlines and customs authorities.

Major problems in pharmaceutical trading in general are lack of compliance, standardization, accountability, and transparency in the air cargo industry. According to Fernandes (2016), in the absence of safety standards or trade facilitation procedures for air cargo of pharmaceuticals, companies can suffer annual product losses between $2.5 and $12.5 billion due to negligent or delayed handling. To ensure common safety air cargo standards for pharmaceutical products, IATA has launched the Centre of Excellence for Independent Validators in Pharmaceutical Logistics (CEIV), to help organizations get certified and address safety needs of pharmaceutical shipments. However, according to Fernandes (2016), neither any Jordanian airlines nor the Queen Alia International Airport are CIEV certified, which needs to be addressed.

4.5 Textiles and Apparel in Turkey

4.5.1 Country Profile

Turkey is classified as a developing economy by the UN[32] and an upper middle-income country by the World Bank.[33] From a high level in the early 2000s, Turkey's GDP growth was already falling prior to the Global Financial Crisis. It has since recovered to a reasonable rate, and has averaged 4.31% over the last 15 years. The relationship between air connectivity and per capita income plotted in Figure 25 reveals that Turkey lies well above the fitted trend line. This suggests that the air connectivity performance of the country is much higher than countries at a similar level of per capita income.

4.5.2 Sector Background

Textiles and apparel are among the most important sectors of the Turkish economy. As per the Turkish Ministry of Economy (2014), Turkey is the second largest supplier of textiles and clothing to the EU. Turkey's long-standing association with the EU is a big reason for its inclusion in the global apparel value chain and also preferential access to one of the largest apparel markets in the world. According to Istanbul Textile and Apparel Exporters Association (ITKIB),[34] Turkey also exports

[32]http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf
[33] http://www.worldbank.org/en/country/turkey
[34] http://www.itkib.org.tr/english/about/sectors/textile/textile_info.pdf

textiles and clothing to former USSR countries like the Russian Federation, Ukraine, Azerbaijan, and Uzbekistan.

According to the Turkish Ministry of Economy (2014), there are more than 52,000 textile and clothing companies in Turkey with more than 918,000 employees. Furthermore, the sector employs 26.3 percent of the manufacturing labor force in the country (Kocaman, 2013). The textile and clothing sector also contributes 7 percent to Turkey's GDP (Turkish Ministry of Economy, 2014).

Turkish clothing exports have continued to increase after the expiration of the global textile quota system with exports of USD 15 billion alone in 2013. The sector exports about 65 percent of its production (Turkish Ministry of Economy, 2014). The sector in Turkey has grown by an average annual rate of 11.8 % over 1980-2011.

4.5.3 Evidence of the Sector's Integration Into and Moving Up the Value Chain

The textiles and apparel industry has a buyer-driven supply chain. It is pertinent to note that in a buyer driven supply chain, global buyers determine what is to be produced, where, by whom, and at what price. These buyers outsource manufacturing to a global network of contract manufacturers that offer the most competitive rates. As a result, margins for producers can be slim. Therefore, most profits come from innovation and most value is added from high-value research, design, sales, marketing, and financial services. The textiles sector has one of the longest value chains i.e. research and development, design, purchasing/sourcing (inbound), production/ assembly/cut, make, trim, distribution (outbound), marketing, sales and service (World Bank, 2014).

Table 11 taken from World Bank (2014) shows that most of the value is generated by Turkish exports of final goods, i.e. 70 percent of the export value, and over 50 percent of value addition is generated by final goods exports in 2010; the shares are relatively stable over time.

Table 12: Textiles, share of exports and value added in different segments of the GVC.

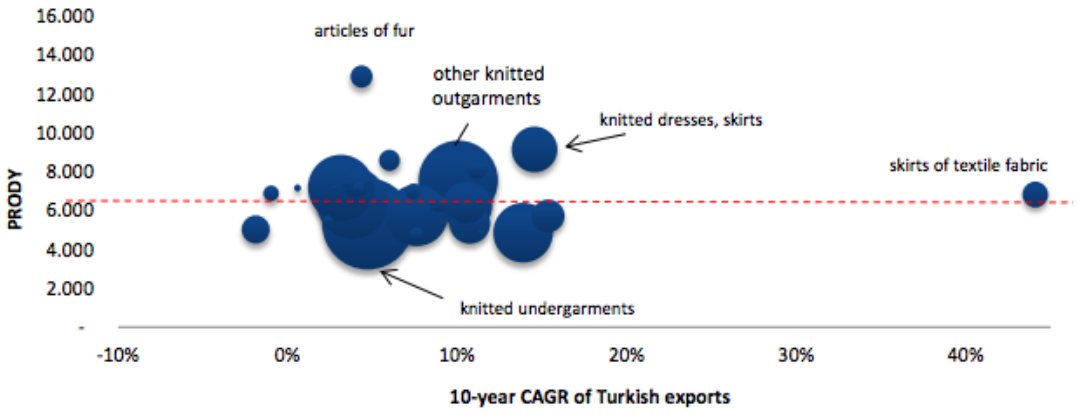
2003	Final	Main	Standard	Raw	Machinery	Total
Export share	78.8	11.9	7.3	1.7	0.3	100.0
Value added	55.5	19.1	13.5	9.2	2.7	100.0
2010	**Final**	**Main**	**Standard**	**Raw**	**Machinery**	**Total**
Export share	70.0	15.0	8.6	5.7	0.7	100.0
Value added	56.0	17.0	13.2	11.8	2.0	100.0

Source: World Bank staff calculations based on data from TurkStat.

Source: World Bank (2014).

Figure 37, also taken from World Bank (2014), shows the growth rate of Turkish exports on the horizontal axis, and a measure of export sophistication on the vertical axis. It is clear that Turkish apparel exports have a cluster of strengths in middle and higher sophisticated product areas, which suggests that from traditional early 1980s, the strength of full package suppliers to global brands have more recently succeeded in moving the value chain towards product design and product brand activities.

Figure 37: Export Performance and Sophistication.



Source: World Bank staff calculations based on data from TurkStat.

Source: World Bank (2014).

There are several examples of Turkish textile and apparel exports moving up the value chain. For instance, Sarar, Mirtha, Bilsar, and Erak clothing, all of which were originally full package suppliers to international brands, are now are successfully selling their own brands in various countries (World Bank, 2014). Bilsar has opened retail stores in Milan and Paris, and similarly Sarar has withdrawn from their 13-year partnership with Hugo Boss and has established their own brands. Additionally, Erak clothing, which was once a full package supplier to international brands such as Calvin Klein, Guess, and others has also moved up the value chain and established its own brand called Mavi Jeans, which is exported worldwide (Fernandez-Stark et al., 2011).

Quantitative evidence from the OECD-WTO TiVA database points to the sector's integration into GVCs, both in terms of backward and forward linkages (Table 12). The sectoral shares of backward and forward integration into GVCs in 2011 were 22.7% and 20.7%, respectively. The sum of the shares of backward and foreign integration for the textiles and apparel sector has risen from 37.8% in 2000 to 43.4% in 2011, even as the reported data suggest that backward linkages may have become more important over time. Thus Turkish textiles and apparel sector firms continue to source inputs from abroad to assemble the final product within the country as well as supply inputs to GVCs.

Table 13: Measures of integration into GVCs

Country-sector	Share of forward integration		Share of backward integration	
Year	2000	2011	2000	2011
Turkey- Textiles and Apparel	23.2%	20.7 %	14.6%	22.7%

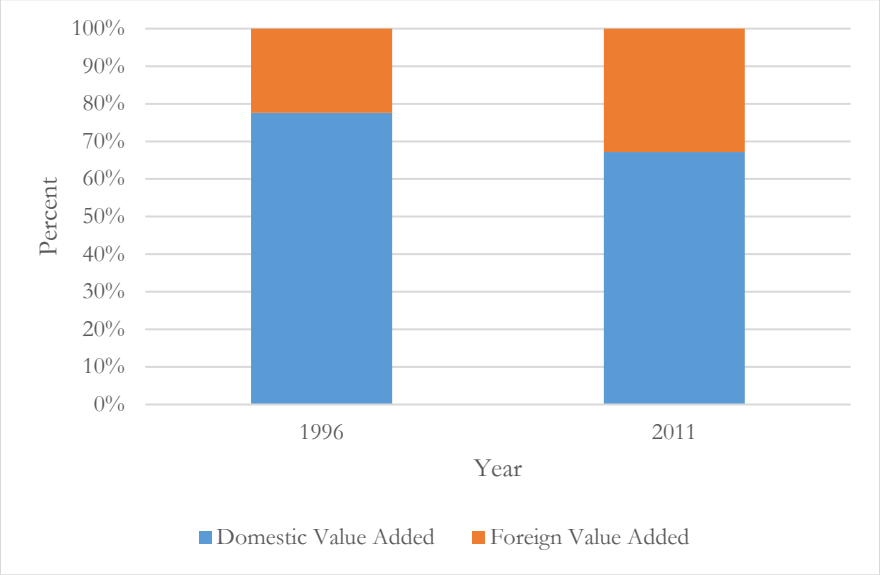
Source: OECD-WTO TIVA.

Note: Since textiles and apparel is not directly available as a sector in OECD TiVA, the textile, textile products, leather and footwear sector was selected in OECD TiVA for the descriptive statistics in this table.

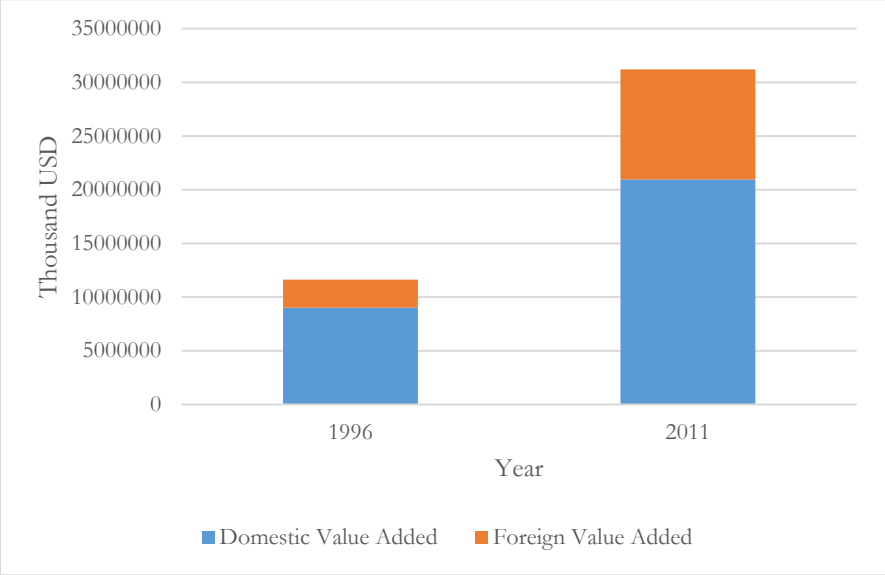
Figure 38 shows complementarities between domestic and foreign value added in the Turkish textiles and apparel sector, both in terms of percentage shares and USD thousands, over 1996-2011, based on the Eora MRIO database.

Figure 38: Complementarity between domestic and foreign value added in Turkey's textiles and apparel sector.

a) Domestic and foreign value added content of gross exports, shares, 1996 and 2011.



b) Domestic and foreign value added content of gross exports, thousand USD, 1996 and 2011.



Source: Eora MRIO database

The figure shows that (i) the total value of domestic and foreign value added has increased over time from USD 15 billion to USD 31 billion over 1996-2011; and (ii) over the same time period, the share of domestic value in the total added has declined from 78% to 67%. Thus, bringing domestic and foreign value added together through a GVC has allowed for faster sectoral growth on an overall basis than it would under a restrictive trade and investment regime, even though the change for the domestic sector in terms of proportions has been in the opposite direction. Sectoral value added has grown strongly over the 1996-2011 period, although in contrast to the previous case studies, it has been

slower than the rate of GDP growth (6.80% versus 10.16%). The difference in rates is likely due in part to sectoral characteristics: productive spillovers are relatively weaker from the textiles and apparel sector in a diverse economy like Turkey's, compared with more advanced manufacturing sectors.

4.5.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain

In the year 2015, 5% of total EU imports and 17% of total US imports from Turkey were transported by air. In the case of some sectors (for instance EU imports of natural or cultured pearls and works of art, and US imports of live animals, silk and clocks and watches), the share of air cargo in the respective totals was above 90%. Turkey has thirteen international airports that connected with over 200,000 flights to 303 destinations in 2015 (IATA SRS Analyzer).

With its strategic location between Asia, Africa, and Europe and with its robust infrastructure, Turkey is well-suited to exporting textiles and apparel to all these markets. Of these, Turkey's relationship with the EU—where air cargo has been shown to be crucial—is particularly important. Most Turkish textile exports to the EU are of high-end fashion products. To enable that, Turkish Airlines has increased its frequency between Istanbul and Budapest, and is primarily exporting apparel from Turkey to Eastern Europe.[35]

Turkish exports of textiles to Africa namely Uganda, Namibia, and South Africa are for further processing and are re-exported as finished products to other countries. Moreover, according to the Organic Trade Association (2015), Turkey is one of the largest organic cotton growers in the world after China and India, for which there is significant demand worldwide; thus Turkey is also a part of the organic cotton value chain. Air connectivity to Uganda has been very useful for Turkish textile enterprises as a lot of the companies have spinning and weaving plants there.[36] Turkish textiles are in high demand in Uganda due to quality and timely delivery.[37] The recent move by Turkish Airlines to launch flights from Istanbul to Entebbe targets business by 19 companies from Turkey with interests in textiles; these include Milan Uganda and Turkish Textile Company.[38] Additionally, according to the Turkish Ministry of Foreign Affairs,[39] Turkey is well known in Kenya for its high quality textile products. In fact, in December 2012, Turkish Airlines started flying to Mombasa, which is the textile hub of Kenya.

Similarly, air cargo services have proved to be very beneficial for the expansion of Turkish apparel and textiles in the Middle East especially in Qatar. Turkish cargo is also eyeing Vietnam for shipments of textiles, besides building up a presence or increasing it in places such as Dakar, Lahore, Addis

[35] Turkish Cargo increase frequency, www.bud.hu/english/business-and-partners/cargo/turkish-cargo-increase-frequency-9748.html

[36] http://www.observer.ug/business/38-business/9249-we-are-here-to-stay-turkish-airlines - We are here to stay - Turkish Airlines

[37] Most Uganda traders are interested in Textiles and furniture. http://www.busiweek.com/index1.php?Ctp=2&pI=420&pLv=3&srI=58&spI=24&cI=19

[38] Uganda: New Flights to Entebbe Target 19 Turkish Firms http://allafrica.com/stories/201009131162.html

[39] Relations between Turkey and Kenya, www.mfa.gov.tr/relations-between-turkey-and-kenya.en.mfa

Ababa, and the Congo Republic,[40] all of which are a part of apparel GVCs. Turkish apparel products have enjoyed considerable success in Russia, with air cargo again playing a pivotal role.[41]

The Turkish textile value chain also goes to Asia, in countries like Vietnam and Cambodia. Almost 90 percent of Cambodia's exports to Turkey comprises textiles, and factories producing them are Turkish-owned. Taking advantage of this, there are talks of a direct Turkish Airlines flight to Cambodia.[42] Similarly, 24 percent of Turkish exports to Sri Lanka consist of textile products. Sri Lanka is also a hub for manufacturing apparel for which Turkish textiles are in high demand. Turkish Airlines is soon going to start two direct flights to Sri Lanka in addition to indirect ones via Maldives.[43]

As the above evidence shows, air cargo services have played an important role in integrating textile and apparel products of Turkey into GVCs and moving up the value chain be it by export of high end fashion products of domestic brands or international brands, or connecting the Turkish apparel industry to manufacturing hubs in Africa and Asia.

At present, with closed land borders due to regional instability and political tensions, air cargo services can play a pivotal role in ramping up exports and moving up the value chain. Infrastructure development is an important element in enabling developing countries to participate in GVCs. The ability of developing country firms and industries to engage in trade is determined much more by the quality of their airport facilities in not just major cities like Istanbul but also smaller manufacturing towns like Izmir.

To corroborate this qualitative evidence, we also show the evolution of the air connectivity index (ACI) for Turkey and that of GVC-integration (sum of backward and forward linkages) for the country's textile, leather and footwear sector (as the textiles and clothing sector is not directly included in OECD-WTO TiVA database) over 2008-2011 in Figure 39. The figure shows some co-movement in the ACI (plotted on the left axis) and GVC-integration (plotted on the right axis) for the country-sector, especially over 2009-2010, suggesting that the rise in GVC-integration over this period was linked to somewhat improved air connectivity performance, everything else constant.

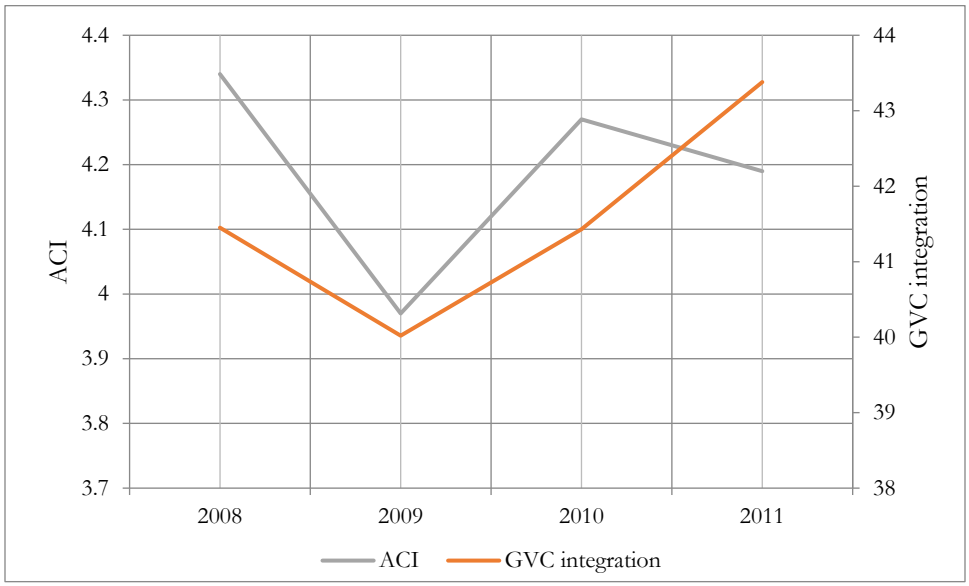
[40] Turkish Cargo sharpens focus on large North American market, www.dailysabah.com/money/2015/07/27/turkish-cargo-sharpens-focus-on-large-north-american-market

[41] Turkish textiles are in hot demand in Russia. www.worldbulletin.net/turkey-economy/152885/turkish-textiles-are-in-hot-demand-in-russia

[42] Cambodia, Turkey seeking to boost trade, www.phnompenhpost.com/cambodia-turkey-seeking-boost-trade

[43] Turkey to boost trade with Sri Lanka, www.news.lk/news/world/item/7198-turkey-to-boost-trade-with-sri-lanka

Figure 39: Evolution of the ACI and GVC-integration for Turkey's textiles, leather, and footwear sector over time.



Source: OECD-WTO TiVA database; Arvis et al. (Forthcoming).

This review of the relevant literature is also backed by quantitative evidence on the value of air transport in Turkish apparel exports and its relative position on different indices.

Air transport was found to be a significant mode of transport in exporting textile and apparel products from Turkey to the EU and US. The share of air transport in the value of EU's imports of textile & apparel from Turkey in 2015, using data from ComExt, was 5%, comparatively lower than the other case studies possibly due to Turkey's ability to move goods to Europe by road. The comparable figure for the US in 2015, using data from the Census Bureau, was 60%.

The ATFI value of Turkey is 85.41%, which places it amongst the top 30% in the list of countries for which this index has been calculated. Turkey's ATFI value is also higher than the comparable average (67.5%) for MENA countries but slightly lower than the average (87.71%) for the EU. Nonetheless, the relatively high ATFI value for Turkey highlights the important role that air transport services have played in the country's integration in GVCs, including at sectoral levels.

On the EFFI, the value of Turkey was 20.88% in 2016, which was higher than the average (14.92%) of the countries for which this index has been calculated. This suggests that the role played by the facilitation of e-freight in the country's integration in GVCs, including at sectoral levels, has been important, but that relative to regional partners like Europe, there is clear scope to boost performance.

In terms of air connectivity, while Turkey has performed much better than the MENA countries and the world on average over 2008-2012, it has not yet matched the EU. The country had an average ACI value of 4.15 over 2008-12, which is both much higher than the average value of 2.39 for the 186 countries for which this index has been calculated over the same time period, as well as the comparable figure (3.33) for 20 MENA countries. However, Turkey's ACI value is lower than the average value of 4.88 for the EU27 over 2008-2012. This said, Figure 26 suggests that the air connectivity performance of the country is much higher than countries at a similar level of per capita income.

4.5.5 Policy Recommendations

IATA's location status report for Turkey suggests that while the country is not e-freight live yet, the e-freight capability target was set as 2013. Also the country is e-AWB capable conditionally for imports and exports, but fully for transit and transshipment. More work needs to be done to make the country e-freight friendly. One way forward would be to galvanize more support for an e-freight environment amongst the different agents of the air cargo supply chain. Once again an air cargo trade facilitation assessment would be helpful in identifying barriers to e-freight and e-AWB, and could provide a roadmap towards implementation if the political will exists in Turkey in the current environment.

4.6 Electrical Machinery in Vietnam

4.6.1 Country Profile

Vietnam is classified as a developing economy by the UN[44] and a lower middle-income country by the World Bank.[45] As is well known, Vietnam has enjoyed remarkable growth success over recent years. Although its growth rate dipped slightly during the Global Financial Crisis, it has grown quite steadily at an average rate of 6.40% for the last 15 years. The relationship between air connectivity and per capita income plotted in Figure 26 reveals that Vietnam lies above the fitted trend line. This suggests that air connectivity performance of the country is higher than countries at a similar level of per capita income.

4.6.2 Sector Background

The electrical machinery sector has played a pivotal role in the Vietnamese economy, attracting foreign direct investment, access to technology, participation of multinational firms, and increasingly generating domestic demand for these products, although their major outlet remains the world market. One major example of multinational firms is GE,[46] which was one of the first American companies established in Vietnam in 1993. According to BDG Asia,[47] in 2013 Vietnam exported USD 138 billion worth of goods, out of which electrical and electronic equipment was valued at USD 38.4 billion, exhibiting a three-year growth rate of 198.9 percent. However, traditionally, Vietnam's share of export of electrical parts and components has remained comparatively low whereas its imports of these parts have increased over time in recent years. Hence, we can conclude that Vietnam's export of electrical machinery is supported by imports of parts and components and inexpensive labor costs, a pattern which is very similar to that of China in previous decades (Findley, 2015). It has also been seen that the share of state owned enterprises in electrical and electronic equipment is on a downward trend.

4.6.3 Integration Into and Moving Up in GVCs

According to UNESCAP (2015), traditionally, technology-intensive parts and electronic components were produced in relatively advanced industrial countries of the region, such as Japan and South Korea, while the assembling of different intermediates into finished products took place in emerging economies like Vietnam. Consistent with this observation, Vietnam is ranked higher in backward integration than in forward integration of the electrical machinery sector according to the OECD-WTO TiVA database.

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[44] http://www.un.org/en/development/desa/policy/wesp/wesp_current/2012country_class.pdf

[45] http://www.worldbank.org/en/country/vietnam

[46] GE in Vietnam, http://www.ge.com/news/company-information/vietnam

[47] Vietnam's Top Five Export Sectors (2013), www.bdg-asia.com/vietnams-top-five-export-sectors-2013/

However, more recently, in terms of electric machinery exports, Vietnam has moved up the value chain somewhat by exporting specialized high technology products (OECD, 2014b).

In Vietnam, the electrical machinery industry's value chain basically has two kinds of firms, the original machinery manufacturers and component manufacturers. In the case of component manufacturers, Vietnamese companies manufacture components and parts for other electrical machinery manufacturers in other countries. Vietnamese companies have also gained expertise in manufacturing value added parts of electrical machinery. For instance, Vietnam has gained a strong reputation in mold making. Molds are an important value added part for injection molding machines. Customers contract with Vietnamese molding companies from the very early stages and association continues through designing, manufacturing, assembling, testing, and sales and after sales service.

More recently, the electrical machinery industry in Vietnam has moved up the value chain. Increasingly, some manufacturers are focusing on product development, marketing, and distribution; they carry brands and sell branded products and systems in final markets to end-users. These firms initiate value chain activities in electrical machinery by placing orders with suppliers. For instance, Vietnamese manufacturers are now manufacturing highly sophisticated all electric injection-molding machines themselves, and some import their molds from Taiwan or even China.

Quantitative evidence from the OECD-WTO TiVA database suggests that the sector is deeply integrated into GVCs, especially in terms of backward linkages (Table 13). The sectoral shares of backward and forward integration into GVCs in 2011 were 66.4% and 20.96%, respectively. The sum of the shares of backward and foreign integration for Vietnam's electrical machinery sector has risen from 80.15% in 2000 to 87.36% in 2011, suggesting deeper involvement in GVCs over time. Moreover, reported data suggest that backward linkages may have become even more important over time. Thus, Vietnamese firms in the electrical machinery sector now source more inputs from abroad to assemble the final product within the country than before even as their supply of inputs to GVCs seems to have declined.

Table 14: Measures of Integration into GVCs.

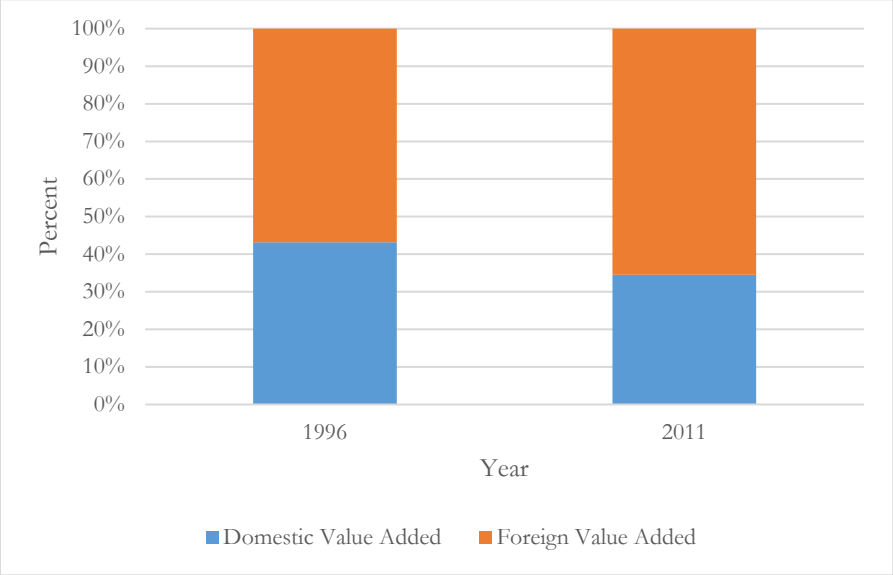
	Share of forward integration		Share of backward integration	
Year	2000	2011	2000	2011
	31.25%	20.96%	48.9%	66.4%

Source: OECD-WTO TiVA.

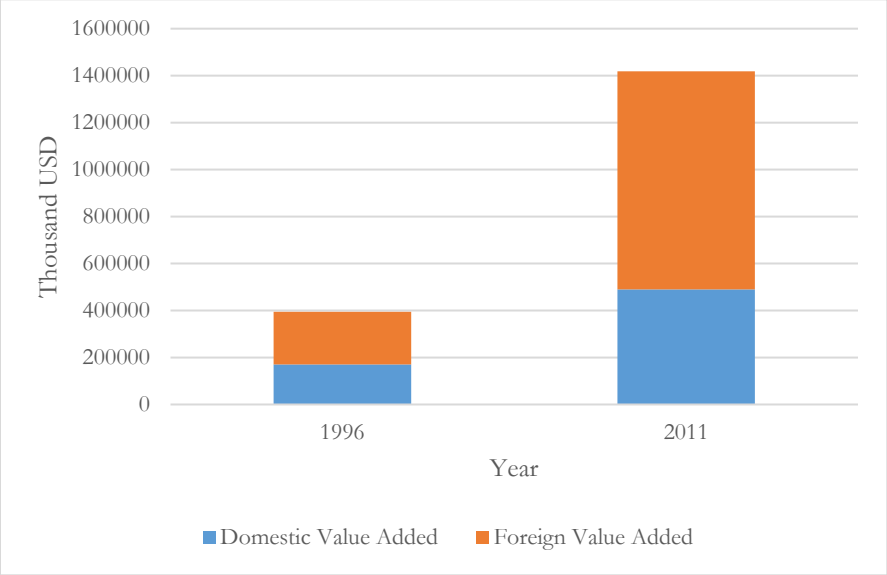
Figure 40 shows complementarities between domestic and foreign value added in the Vietnamese electrical and machinery sector, both in terms of percentage shares and USD thousands, over 1996-2011, based on the Eora MRIO database.

Figure 40: Complementarity between domestic and foreign value added in Vietnam's electrical and machinery sector.

a) Domestic and foreign value added content of gross exports, shares, 1996 and 2011.



b) Domestic and foreign value added content of gross exports, thousand USD, 1996 and 2011.



Source: Eora MRIO database

The figure shows that (i) the total value of domestic and foreign value added has increased over time from USD 400 million to USD 1.4 billion over 1996-2011; and (ii) over the same time period, the share of domestic value in the total added has declined from 42% to 34%. Thus, bringing domestic and foreign value added together through a GVC has allowed for faster sectoral growth on an overall basis than it would under a restrictive trade and investment regime, even though the change for the domestic sector in terms of proportions has been in the opposite direction. Growth of total sectoral value added was very strong between 1996 and 2011, recording an average annualized rate of 8.90%.

However, GDP grew more quickly, at 12.03%. The comparison suggests that although Vietnam has enjoyed considerable success in the electronics industry, due in part to its ability to leverage international connections through air cargo, there may be constraints to growth that are becoming apparent, for instance in relation to the availability of a pool of more skilled workers.

4.6.4 Role of Air Cargo in GVC Integration and Moving Up the Value Chain

In the year 2015, 41% of total EU imports and 29% of total US imports from Vietnam were transported by air. In the case of some sectors (for instance EU imports of live animals and US imports of live animals, meat and silk), the share of air cargo in the respective totals was 100%. Vietnam has ten international airports that connected with over 60,000 flights to 65 destinations in 2015 (IATA SRS Analyzer).

Increasing globalization has subjected the electronics industry to time and cost pressures. Many companies have relocated their manufacturing facilities to Vietnam. At the same time, product life cycles in the electronics sector are getting shorter and shorter, and global supply chains of electrical machinery are very fragmented. According to Airports Council International, air cargo traffic through Hanoi grew more than 23% last year to 348,000 tons. Traffic through Ho Chi Minh City increased by 10% to 375,000 tons.[48] On the international front, global foreign carriers are also lining up to partake in the projected air cargo growth on Vietnam's horizon, with Qatar Airways Cargo, Lufthansa Cargo, and Volga-Dnepr in the mix.

In Southeast Asia, Vietnam dominates the air cargo market, with limited direct connectivity to Europe and Australia, and no non-stop North America connections, although that situation seems likely to change in the near future. The fastest-growing air trade lanes linking emerging markets with the US/EU are: US-Vietnam up 42.7 per cent, EU-Vietnam up 17.0 per cent.[49] Air transport was found to be a significant mode of transport in exporting electrical machinery products to the EU and US. The share of air transport in the value of EU's imports of electrical machinery from Vietnam in 2015, using data from ComExt, was 77%; the comparable figure for the US in 2015, using data from the Census Bureau, was 79%.

In recent years, Vietnam has been a significant benefactor of a manufacturing shift out of China, and several companies manufacturing electrical machinery have established production facilities in the country. The major reason for this is increasingly affordable high-quality labor options and air connectivity.

In 2002, Saigon High-tech Park (SHTP) was established in Vietnam with the support of the Ho Chi Minh (HCM) City government and the Vietnamese government. The country was successful in connecting to high-technology GVCs by attracting a number of foreign companies, including Intel Sanofi (France), Datalogic (Italia), Nidec (a Japan-based computer motor fans producer), and Sonian (a leading producer of micro acoustic and micromechanical components). With the establishment of SHTP, the infrastructure that boasts of an airport within half an hour has contributed to greater economic participation with GVCs (OECD, 2013). This indicates that air transport has played a major role in the integration of the electrical machinery sector with GVCs. Illustratively, in order to facilitate

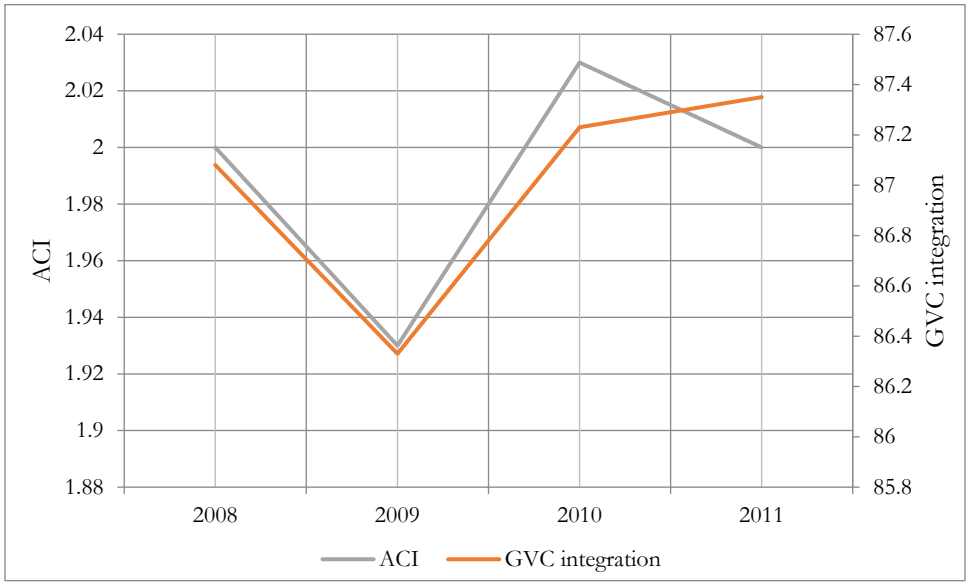
[48] Vietjet eyes freighters to help break into the high-flying Vietnam air cargo market http://theloadstar.co.uk/vietnam-air-cargo/

[49] Vietnam and Cambodia lead air cargo surge for emerging markets, www.aircargonews.net/news/single-view/news/vietnam-and-cambodia-lead-air-cargo-surge-for-emerging-markets.html

GVCs from their manufacturing hub in Vietnam, Samsung is soon planning to operate its own air cargo-handling terminal at Hanoi's Noi Bai International.[50]

To corroborate this qualitative evidence, we show the evolution of the air connectivity index (ACI) for Vietnam and that of GVC-integration (sum of backward and forward linkages) for the country's electrical machinery and apparatus nec sector (as the electrical machinery sector is not directly included in WTO-OECD TiVA database) over 2008-2011 in Figure 46. The figure shows stark co-movement in the ACI (plotted on the left axis) and GVC-integration (plotted on the right axis) for the country-sector, suggesting that improved air connectivity performance was associated with greater GVC-integration, everything else constant.

Figure 41: Evolution of the ACI and GVC-integration for Vietnam's electrical machinery and apparatus sector over time.



Source: OECD-WTO TiVA database; Arvis et al. (Forthcoming).

Vietnam has yet to realize the benefits of e-freight, which will improve the efficiency of air cargo by replacing paper processes with electronic documentation. IATA has been trying to improve the value proposition of the air cargo industry to stem the modal shift of its customers to cheaper ocean freight, and paperless documentation will drive quality and time improvements. This said, Vietnam Airlines is benefitting from the efficiencies of e-air waybill but only for domestic freight. It is not able to do so for international freight as Vietnam has yet to ratify the Montreal Convention.

This review of the relevant literature is also backed by quantitative evidence on the relative position on Vietnam on different indices.

The ATFI value of Vietnam is 40.25%, which places it amongst the bottom 20% in the list of countries for which this index has been calculated. Vietnam's ATFI value is also considerably lower than the comparable average (58.39%) for eight of the ten ASEAN countries for which this index has been calculated. This suggests that, relative to the other countries in this study, the role that air transport services have played in the country's integration in GVCs, including at sectoral levels may be

[50] Shipper to operate own air cargo terminal in Hanoi, www.lloydsloadinglist.com/freight-directory/air/Shipper-to-operate-own-air-cargo-terminal-in-Hanoi/20578.htm#.V9PYuSN94y4.

somewhat limited. But it is important to keep Vietnam's income level in mind: it is considerably lower than some of the countries considered in this section, and is one factor contributing to lower performance.

On the EFFI, Vietnam has a value of 15.45%, which is comparatively higher than the average (14.92%) of the countries for which this index has been calculated. Moreover, the EFFI for Vietnam is also higher than the comparable average (10.50%) for 9 of the 10 ASEAN member states for which this index has been calculated. This points to the important role that the facilitation of e-freight has played in the country's integration in GVCs, including at sectoral levels.

However, in terms of air connectivity, Vietnam has not performed as well as its comparators. The country's average ACI value over 2008-12 of 1.96 is lower than the average value of 2.39 for the 186 countries for which this index has been calculated over the same time period. It is also lower than the period's average value of 2.42 for the ten ASEAN member states. Again, however, it is important to keep income effects in mind in interpreting these results. In fact, Figure 26 suggests that the air connectivity performance of the country is higher than countries at a similar level of per capita income.

4.6.5 Policy recommendations

According to IATA's location status reports, Vietnam is not e-freight live yet and the e-freight capability target date was set at 2015. There is no information on Vietnam's e-AWB capability for imports, exports, transit and transshipment in these reports, which suggests that there is ample scope for improving along all dimensions.

One way forward would be to galvanize support for a paperless environment amongst different stakeholders of the air cargo supply chain. Policymakers also need to promote and allow for electronic versions of key documents that are currently not available electronically for Vietnam. Furthermore, in order to overcome existing airport congestion brought about by rapid trade growth of exports, consideration should be given to the full implementation of trusted trader programs such as Customs Authorized Economic Operator and security Known Consignor and Regulated Agent programs. All three of these programs support the Customs clearance of goods and the application of appropriate security controls away from the airport thus allowing rapid processing at the borders.

5 CONCLUSIONS AND POLICY IMPLICATIONS

This report has examined the links between air cargo and GVCs, as one way of highlighting the benefits improved air cargo performance can bring, in particular to developing countries. GVCs are now active in a range of countries and sectors, and experience suggests that air cargo is important not only for joining them, but for moving up to higher value added activities within them. Although countries can benefit even from low value added activities—witness the massive economic benefits from early development of the electronics industry in China and Vietnam—higher productivity activities such as research and development can have significant economic spillovers that can lift and sustain growth rates in the medium to long term.

There is a burgeoning literature on GVCs that deals with their development, extension, and the possible gains and losses from a sustainable development point of view. Much of this literature, including detailed sectoral studies, highlights two key facts from the point of view of this report: speed and reliability are everything in structuring a GVC; and trade in high value to weight intermediates is a core GVC activity. These two insights combine to suggest naturally that air cargo can play a transformative role in terms of a country's ability to successfully integrate its firms into GVCs.

This analysis provides the motivation for this report, which focuses exclusively on the role air cargo can play in promoting GVC integration, which in turn can support important economic and sustainable development gains for a range of countries, including developing ones. The first part of the report develops two new indicators of air cargo performance, the ATFI and the EFFI. The first one captures country level performance on the particular dimensions of trade facilitation most important for air cargo. The second one focuses in on the issue of eFreight, and captures country capabilities in that area. Quantitative analysis shows that both indices are strongly associated with increased GVC integration, as measured by backward and forward linkages—essentially the importance of trade in intermediates on the import and export sides. These indices will undoubtedly prove useful for country benchmarking as well as analytics. They use data that is either publicly available or collated by IATA, and so can easily be updated at regular intervals so that performance can be tracked over time.

The second part of the report presents a series of six case studies on the role of air cargo in promoting GVC activity. The case studies are drawn from a variety of sectors in developed and developing countries alike. They show that air cargo can play an important role in helping local companies link to GVCs, and can be one factor influencing the decision by lead firms to make relationship specific investments. Many factors go into the choice to use air rather than maritime cargo, but in the GVC context, and more particularly for products that need special handling (like pharmaceuticals) or high value to weight components (like computer parts), air cargo can be the method of choice. In most cases, the case study countries exhibit relatively strong performance on the ATFI and EFFI, which suggests that policymakers there have been alive to the need to develop air cargo as one way of becoming more involved in the global trading economy.

Clearly, however, there is much still to be done in terms of developing the potential of air cargo. In particular, as developing countries become further integrated into GVCs, they will need to invest in infrastructure, and also regulatory and procedural "software" that makes modern air cargo transactions possible. Use of ICTs remains a particular issue, given the efficiency gains that can be reaped using instruments like eAWBs and eFreight.

Indeed, the case studies examined here uniformly highlight the important of ICTs in their recommendations. This agenda is a broad one, cutting across many aspects of trade facilitation. On

the one hand, it is important that customs and other border agencies are able to process import and export transactions electronically, preferably through a Single Window system, to prevent repetitious interactions with government agencies. For air cargo, however, special considerations also apply. It is important that officials, in concert with the private sector, develop both the regulatory infrastructure and the private sector capacity needed to support electronic freight transactions, going beyond eAWBs to encompass the full set of dealings involved in an air freight transaction.

As policymakers grapple with the many new policy issues presented by GVCs, one area they will need to give particular attention to is the interplay between air cargo and GVCs. As this report has shown, there is strong evidence to suggest that countries that do more to facilitate air cargo flows, especially through the use of ICTs, tend to be more closely integrated into GVCs. Air cargo is particularly important for transporting high value to weight goods, like some machinery and electrical components. In addition, it is a vital transport link when intermediate or final goods are perishable and require special handling, as in sectors like agribusiness, including horticulture and cut flowers. Developing connectivity, air trade facilitation, and eFreight friendliness should be key policy priorities for governments all around the world, but especially in developing countries, where GVCs hold out the promise of higher incomes and faster growth, as well as, potentially, social and environmental benefits relative to other types of economic activity.

Researchers also have a number of open questions in relation to the broader relationship between air transport and GVCs. On the one hand, it is important to identify time sensitive products with greater precision, and better understand their relationship to GVC trade. New data on intermediate input flows will be useful in this regard. Finally, an interesting extension to this work would be to move beyond manufacturing to look at services GVCs. Sectors like finance and business services use air passenger transport intensively to facilitate temporary movement of service providers and intra-corporate transferees. Future research could build on the relationships examined here to look at the ways in which air transport more broadly—beyond cargo—can be leveraged to support the development of new GVCs particularly in services, and their extension to new parts of the world.

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APPENDIX 1: AIR CONNECTIVITY INDEX

Source: Arvis et al. (Forthcoming).

Country	ACI Score (2012)	ACI Rank (2012)
United States	13.77	1
United Kingdom	7.45	2
Germany	6.95	3
Belgium	6.66	4
Spain	6.02	5
France	5.91	6
Netherlands	5.78	7
China	5.66	8
Bahrain	5.59	9
Luxembourg	5.38	10
United Arab Emirates	5.14	11
Italy	5.09	12
Switzerland	4.93	13
Japan	4.66	14
Ireland	4.54	15
Canada	4.17	16
Australia	4.16	17
Qatar	4.16	18
Croatia	4.11	19
Russian Federation	4.1	20
Turkey	3.97	21
Slovak Republic	3.96	22
Austria	3.94	23
Czech Republic	3.92	24
Denmark	3.76	25
Thailand	3.75	26
Slovenia	3.69	27
Bosnia and Herzegovina	3.68	28
Cyprus	3.62	29
Singapore	3.48	30
Hungary	3.43	31
Poland	3.43	32
Korea, Rep.	3.41	33
Estonia	3.39	34
Jordan	3.39	35
Bulgaria	3.37	36
Tunisia	3.36	37
Algeria	3.32	38
Kuwait	3.32	39

Country	ACI Score (2012)	ACI Rank (2012)
Sweden	3.32	40
Brazil	3.29	41
Macedonia, FYR	3.27	42
Egypt, Arab Rep.	3.24	43
Albania	3.23	44
Mexico	3.23	45
Malta	3.16	46
Norway	3.16	47
India	3.14	48
Greece	3.13	49
Morocco	3.06	50
Portugal	2.98	51
Saudi Arabia	2.98	52
Latvia	2.96	53
Romania	2.96	54
Lebanon	2.93	55
Finland	2.91	56
Malaysia	2.88	57
Lithuania	2.85	58
Israel	2.82	59
Belarus	2.5	60
Indonesia	2.28	61
Ukraine	2.28	62
Moldova	2.18	63
Oman	2.15	64
Dominican Republic	2.03	65
Argentina	1.92	66
Philippines	1.92	67
Yemen	1.84	68
Panama	1.83	69
Vietnam	1.82	70
Iraq	1.8	71
Honduras	1.79	72
South Africa	1.76	73
Costa Rica	1.75	74
New Zealand	1.71	75
Iceland	1.66	76
Pakistan	1.65	77
Colombia	1.64	78
Cambodia	1.61	79
Nicaragua	1.61	80
Armenia	1.6	81

Country	ACI Score (2012)	ACI Rank (2012)
Bahamas, The	1.6	82
St. Vincent and the Grenadines	1.56	83
Guatemala	1.53	84
El Salvador	1.52	85
Brunei	1.5	86
Jamaica	1.5	87
St. Lucia	1.49	88
Sri Lanka	1.49	89
Chile	1.46	90
Dominica	1.46	91
Barbados	1.41	92
Peru	1.4	93
Antigua and Barbuda	1.38	94
Azerbaijan	1.38	95
Kyrgyz Republic	1.38	96
Georgia	1.36	97
Kenya	1.36	98
Uruguay	1.36	99
Ethiopia(excludes Eritrea)	1.32	100
Belize	1.26	101
Venezuela	1.22	102
Kazakhstan	1.21	103
Nigeria	1.16	104
Ghana	1.12	105
Cameroon	1.11	106
Ecuador	1.1	107
Cote d'Ivoire	1.09	108
Guyana	1.09	109
Uganda	1.09	110
Nepal	1.04	111
Papua New Guinea	1.02	112
Togo	1.01	113
Maldives	1	114
Benin	0.99	115
Rwanda	0.98	116
Gambia, The	0.97	117
Afghanistan	0.94	118
Tanzania	0.93	119
Malawi	0.92	120
Zambia	0.92	121
Senegal	0.9	122
Mauritius	0.88	123

Country	ACI Score (2012)	ACI Rank (2012)
Zimbabwe	0.88	124
Mongolia	0.87	125
Seychelles	0.87	126
Burkina Faso	0.84	127
Niger	0.84	128
Paraguay	0.84	129
Sierra Leone	0.84	130
Namibia	0.82	131
Burundi	0.81	132
Bhutan	0.81	133
Mali	0.78	134
Bolivia	0.77	135
Congo, Rep.	0.77	136
Palau	0.75	137
Botswana	0.74	138
Guinea	0.74	139
Suriname	0.74	140
Lesotho	0.73	141
Mauritania	0.72	142
Cape Verde	0.69	143
Central African Republic	0.68	144
Fiji	0.68	145
Comoros	0.63	146
Madagascar	0.63	147
Sao Tome and Principe	0.58	148
East Timor	0.57	149
Mozambique	0.56	150
Samoa	0.52	151
Kiribati	0.45	152
Solomon Islands	0.4	153
Tonga	0.38	154

APPENDIX 2: AIR TRADE FACILITATION INDEX

Country	ATFI Score	ATFI Rank
Austria	98.21%	1
Slovenia	97.09%	2
Korea, Republic of	97.07%	3
Italy	96.70%	4
Sweden	96.49%	5
Netherlands	95.38%	6
Finland	94.58%	7
Japan	94.15%	8
Canada	94.09%	9
Denmark	93.96%	10
Australia	92.53%	11
Switzerland	91.78%	12
United Kingdom	91.73%	13
New Zealand	91.29%	14
United States	91.24%	15
Malta	90.70%	16
Germany	89.99%	17
Cyprus	89.70%	18
Hungary	89.22%	19
Hong Kong	88.88%	20
Morocco	88.87%	21
Belgium	88.30%	22
Luxembourg	87.77%	23
Slovakia	87.53%	24
Estonia	87.22%	25
United Arab Emirates	87.20%	26
Thailand	86.90%	27
Lithuania	86.76%	28
Latvia	86.75%	29
Singapore	86.15%	30
Albania	86.03%	31
Ireland	85.82%	32
Spain	85.46%	33
Turkey	85.41%	34
Romania	85.19%	35
Argentina	84.86%	36
Poland	84.51%	37
France	84.44%	38
Chinese Taipei	83.75%	39
Jordan	82.33%	40

Country	ATFI Score	ATFI Rank
South Africa	81.85%	41
Norway	81.59%	42
Armenia	81.57%	43
Czech Republic	81.43%	44
Dominican Republic	81.00%	45
Macedonia, the former Yugoslav Republic of	79.86%	46
Bulgaria	79.22%	47
Oman	79.10%	48
Bahrain	78.82%	49
Costa Rica	78.78%	50
India	78.66%	51
Malaysia	77.79%	52
Chile	76.99%	53
Philippines	75.87%	54
Croatia	75.43%	55
Israel	75.42%	56
Qatar	74.93%	57
Portugal	73.73%	58
Pakistan	73.49%	59
Colombia	73.11%	60
China	72.87%	61
Peru	72.81%	62
Greece	72.66%	63
Azerbaijan	71.68%	64
Georgia	69.84%	65
Saudi Arabia	69.72%	66
Ecuador	69.62%	67
Nigeria	68.48%	68
Kenya	66.98%	69
Uruguay	66.26%	70
Bolivia	65.97%	71
Ukraine	61.61%	72
Lebanon	60.89%	73
Mexico	59.96%	74
Cameroon	59.58%	75
Barbados	56.64%	76
Côte d'Ivoire	56.53%	77
Egypt	55.91%	78
Madagascar	55.79%	79
El Salvador	55.25%	80
Kuwait	53.17%	81
Gabon	52.81%	82

Country	ATFI Score	ATFI Rank
Mauritius	51.54%	83
Panama	51.27%	84
Bosnia and Herzegovina	50.23%	85
Ethiopia	49.89%	86
Congo	49.63%	87
Jamaica	49.30%	88
Indonesia	48.87%	89
Congo, the Democratic Republic of the	48.41%	90
Paraguay	48.18%	91
Belize	46.72%	92
Russian Federation	44.28%	93
Gambia	44.14%	94
Guatemala	42.80%	95
Fiji	42.34%	96
Burkina Faso	41.71%	97
Benin	41.54%	98
Algeria	41.28%	99
Nicaragua	40.59%	100
Viet Nam	40.25%	101
Kyrgyzstan	37.14%	102
Kazakhstan	36.70%	103
Sri Lanka	35.70%	104
Belarus	31.59%	105
Rwanda	30.99%	106
Brunei Darussalam	28.75%	107
Bangladesh	28.25%	108
Dominica	27.98%	109
Trinidad and Tobago	27.74%	110
Uganda	27.37%	111
Ghana	27.21%	112
Bahamas	25.63%	113
Togo	24.22%	114
Sierra Leone	22.93%	115
Cambodia	22.55%	116
Nepal	18.40%	117
Central African Republic	16.97%	118
Honduras	16.43%	119
Angola	15.28%	120
Venezuela	12.07%	121
Burundi	11.42%	122
Liberia	9.83%	123
Djibouti	6.71%	124

APPENDIX 3: E-FREIGHT FRIENDLINESS INDEX

Country	EFFI Score	EFFI Rank
United Arab Emirates	47.37%	1
Denmark	41.60%	2
Hong Kong	41.59%	3
Singapore	40.18%	4
Sweden	39.77%	5
Korea, Republic of	39.31%	6
Canada	38.70%	7
Netherlands	38.61%	8
South Africa	37.71%	9
United States	37.70%	10
Finland	37.14%	11
Austria	36.34%	12
France	36.32%	13
Belgium	36.16%	14
Norway	35.78%	15
Germany	35.76%	16
Spain	34.96%	17
Chinese Taipei	34.93%	18
Italy	34.67%	19
Switzerland	34.29%	20
Thailand	34.22%	21
United Kingdom	33.93%	22
Japan	33.70%	23
Mauritius	32.89%	24
Hungary	32.72%	25
Australia	32.50%	26
Malta	32.48%	27
Albania	32.14%	28
Latvia	31.61%	29
Israel	31.39%	30
Luxembourg	31.36%	31
Chile	31.35%	32
Romania	31.33%	33
New Zealand	31.20%	34
Costa Rica	30.95%	35
Poland	30.92%	36
Ecuador	30.88%	37
Georgia	30.42%	38
Guatemala	30.41%	39
Oman	30.34%	40

Country	EFFI Score	EFFI Rank
Morocco	30.33%	41
Dominica	30.32%	42
Saint Lucia	30.29%	43
Slovenia	30.23%	44
Nicaragua	30.15%	45
Nigeria	30.11%	46
Ghana	30.08%	47
Algeria	30.08%	48
Fiji	30.02%	49
Uruguay	30.01%	50
Bolivia	30.01%	51
Kyrgyzstan	30.00%	52
Turkey	20.88%	53
China	18.19%	54
Qatar	16.98%	55
Greece	16.68%	56
Peru	16.63%	57
Bermuda	15.68%	58
Viet Nam	15.45%	59
Bulgaria	15.30%	60
Barbados	15.25%	61
Ethiopia	13.09%	62
Egypt	12.23%	63
India	11.81%	64
Sri Lanka	6.61%	65
Saudi Arabia	6.39%	66
Lithuania	6.33%	67
Kenya	5.55%	68
Mexico	4.56%	69
Czech Republic	3.80%	70
Malaysia	3.68%	71
Pakistan	3.53%	72
Ireland	3.44%	73
Macedonia, the former Yugoslav Republic of	3.26%	74
Estonia	2.32%	75
Croatia	2.25%	76
Portugal	1.61%	77
Brazil	1.25%	78
Iceland	1.11%	79
Colombia	1.05%	80
Russian Federation	1.03%	81
Nepal	0.94%	82

Country	EFFI Score	EFFI Rank
Bangladesh	0.93%	83
Panama	0.86%	84
El Salvador	0.84%	85
Dominican Republic	0.75%	86
Lebanon	0.67%	87
Slovakia	0.67%	88
Myanmar	0.57%	89
Cyprus	0.52%	90
Jordan	0.49%	91
Antigua and Barbuda	0.45%	92
Trinidad and Tobago	0.43%	93
Bosnia and Herzegovina	0.39%	94
Bahrain	0.38%	95
Philippines	0.32%	96
Kuwait	0.31%	97
Djibouti	0.30%	98
Jamaica	0.17%	99
Bahamas	0.16%	100
Honduras	0.16%	101
Eritrea	0.16%	102
Armenia	0.15%	103
Uganda	0.14%	104
Venezuela	0.12%	105
Kazakhstan	0.11%	106
Ukraine	0.10%	107
Cameroon	0.08%	108
Argentina	0.07%	109
Congo	0.07%	110
Benin	0.06%	111
Indonesia	0.06%	112
Suriname	0.06%	113
Côte d'Ivoire	0.04%	114
Belize	0.01%	115
Brunei Darussalam	0.01%	116
Congo, the Democratic Republic of the	0.01%	117
Cambodia	0.00%	118
Madagascar	0.00%	119
Comoros	0.00%	120
Rwanda	0.00%	121
Angola	0.00%	122
Azerbaijan	0.00%	123
Belarus	0.00%	124

Country	EFFI Score	EFFI Rank
Burkina Faso	0.00%	125
Burundi	0.00%	126
Central African Republic	0.00%	127
Cook Islands	0.00%	128
Gabon	0.00%	129
Gambia	0.00%	130
Kiribati	0.00%	131
Liberia	0.00%	132
Paraguay	0.00%	133
Sierra Leone	0.00%	134
Togo	0.00%	135

APPENDIX 4: INTERPRETATION OF SCATTER PLOTS AND TREND LINES

Many of the figures presented in this report show the relationship between two variables. Each pair of data values is plotted as a point, and a trend line is used to show the average relationship between them, based on the common statistical technique known as ordinary least squares. This methodology is commonly used in the social sciences, but it is important to be aware of its limitations and interpretation.

The most important point to keep in mind in interpreting these kinds of figures is that only two variables are included in the relationship. A fully specified econometric model relating, say, air connectivity to GVC participation would include many more variables, to account for the myriad factors that affect GVC participation. Leaving these other variables out of the analysis can cause bias to the extent that they are associated with the included variables. A second issue is that the figures only identify correlations (associations) in the data, not a causal relationship running from one variable to another. Again, the possibility of circular causation, for instance that greater GVC participation gives countries an incentive to build up their air connectivity, means that results may be biased. Econometricians can correct for these kinds of effects in a fully specified model, but simple graphical associations always need to be interpreted with caution.

The reason for not developing fully specified models that could deal with these two issues is that they are highly technical, and best left for future academic research. The emphasis here is on identifying some key characteristics of the data to inform industry actors and policymakers, in the knowledge that future work will develop more robust approaches.

In light of these caveats, the most appropriate way to interpret the figures is qualitatively: for instance, that an increase in one variable is associated with an increase in the other. However, it is also possible to use the slope of the trend line to provide a quantitative interpretation, in terms of a given change in one variable being associated with a given change in the other. For indicative purposes only, and subject to the above caveats, we present interpretations below for all figures where that is appropriate:

- Figure 1: A one point increase in the ACI is associated with a 115% increase in the value of trade. If we also take logarithms of the ACI, the relationship is that a 1% increase in the ACI is associated with a 6.33% increase in the value of trade.
- Figure 8: A one percentage point increase in the proportion of LPI respondents rating infrastructure quality as "very good" or "good" is associated with a 0.15 percentage point increase in GVC participation.
- Figure 9: A one percentage point increase in the proportion of LPI respondents rating service provider quality as "very good" or "good" is associated with a 0.12 percentage point increase in GVC participation.
- Figure 16: A one percentage point increase in the ATFI is associated with a 0.37 percentage point increase in the EFFI.
- Figure 17: A one percentage point increase in the ATFI is associated with a 2.30% increase in the value of trade.
- Figure 18: A one percentage point increase in the EFFI is associated with a 2.46% increase in the value of trade.
- Figure 19: A one point increase in the ACI is associated with a 4.40 percentage point increase in GVC participation. If we also take logarithms of the ACI, the relationship is that a 1% increase in the ACI is associated with a 0.16 percentage point increase in GVC participation.

- Figure 20: A one point increase in the ACI is associated with a 2.00 percentage point increase in GVC participation. If we also take logarithms of the ACI, the relationship is that a 1% increase in the ACI is associated with a 0.07 percentage point increase in GVC participation.
- Figure 21: A one percentage point increase in the ATFI is associated with a 0.39 percentage point increase in GVC participation.
- Figure 22: A one percentage point increase in the ATFI is associated with a 0.15 percentage point increase in GVC participation.
- Figure 23: A one percentage point increase in the EFFI is associated with a 0.46 percentage point increase in GVC participation.
- Figure 24: A one percentage point increase in the EFFI is associated with a 0.15 percentage point increase in GVC participation.
- Figure 25: A one percentage point increase in the ATFI is associated with a 0.86% increase in unit value as a proxy for price.
- Figure 26: A one percent increase in per capita GDP is associated with a 0.02 point increase in the ACI. If we also take logarithms of the ACI, the relationship is that a 1% increase in per capita GDP is associated with a 0.34% increase in the ACI.

APPENDIX 5: COUNTRY CODES USED IN FIGURES

Country Name	ISO Three Letter Country Code
Argentina	ARG
Australia	AUS
Brazil	BRA
Canada	CAN
China	CHN
Chinese Taipei	TWN
Costa Rica	CRI
Ethiopia	ETH
France	FRA
Germany	DEU
India	IND
Indonesia	IDN
Ireland	IRL
Italy	ITA
Japan	JPN
Jordan	JOR
Korea (Rep.)	KOR
Mexico	MEX
Russian Federation	RUS
South Africa	ZAF
Thailand	THA
Turkey	TUR
United Kingdom	GBR
United States of America	USA
Vietnam	VNM

APPENDIX 6: ABBREVIATIONS USED IN THE REPORT

Abbreviation	Long Form
ACI	Air Connectivity Index
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
ATFI	Air Trade Facilitation Index
AWB	Air Waybill
EFFI	EFreight Friendliness Index
EU	European Union
EUR	Euro
EVAD	Export Value Added Database
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GVC	Global Value Chain
HS	Harmonized System
LDC	Least Developed Country
Log	Logarithm
LPI	Logistics Performance Index
MENA	Middle East and North Africa
MRIO	Multi-Region Input Output Table
NAFTA	North American Free Trade Agreement
NEC	Not Elsewhere Classified
OECD	Organization for Economic Cooperation and Development
PCA	Principal Components Analysis
TiVA	Trade in Value Added
UN	United Nations
USD	United States Dollar
WTO	World Trade Organization