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Check-in, departure and arrival times: Air cargo in Southern Africa?

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Check-in, departure and arrival times: Air cargo in Southern Africa?

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Abstract

In this paper we develop a methodology which is based on two important criteria - sensitivity in delivery time and value-to-weight ratio - to classify products relevant for air transport. Detailed trade data by mode of transport are used to check the loading of an average airplane between South Africa and the European Union. The product classification is applied to evaluate the potential for air cargo transport in Southern Africa. We find that especially export of products with high and medium air cargo relevance grew much faster than exports of bulky goods and non air cargo products. South Africa's most prominent export products to industrialized countries consist of diamonds, gold and platinum (HS71) which, however, are so precious that they tend to be transported in the hand baggage of a business or security person, because they leave the loading weight of an average airplane almost unaffected. When correcting South Africa's trade for these 'invisible outliers' in the loading freight we find that South Africa exports a much larger share of products with high air cargo relevance to its SADC partners than to industrialized countries. The results indicate that air cargo seems to be valuable option to overcome trade barriers associated with poor land transport infrastructure and corruption.

Keywords: Trade cost, time sensitivity, air transport, intra-African trade
JEL: F10, F14, F15, L93

1 Introduction

South Africa can be regarded as a small open economy. In the time since the end of Apartheid, its foreign trade has increased substantially, not least because of its expanding international relations. It can be expected that - given the future growth potential of South Africa and its African peers in the Southern African Development Community (SADC) - trade will increase substantially in the coming years. In particular, trade with the African continent is promising at the beginning of the 21st century. This

holds all the more as South Africa's trade with Africa today only plays a minor role in the country's trade profile, especially when compared to trade with Europe and other industrialized countries. There is much potential to be exploited on the African continent. To deal with future trade flows, policymakers and private investors have to make very sensitive decisions today. This is especially relevant since the intra-African transportation infrastructure is rather poor, both absolutely and in comparison with other continents. This makes trade with the continent rather expensive and cumbersome. The problem is magnified by a high prevalence of cross-border barriers which are associated not only with monetary transport cost but also with time costs, e.g. the delivery time caused by the poor transport network, high administrative requirements, and corruption problems at seaports and in general which increase the trade costs, making air cargo transport to save time that much more attractive in the region.

The previous literature on time costs and modal choice of transport has largely focused on time-sensitivity in the delivery of certain products. In this paper we develop a framework to systematically classify air cargo relevant products. The classification builds upon two important criteria: the time-sensitivity and the value-to-weight ratio of products. The argument behind this classification scheme is that in addition to delivery time the air premium, i.e. the additional cost of shipping via air cargo instead of sea cargo, is an important determinant to choose air cargo. For precious products with a high value-to-weight ratio the transport costs and the air premium becomes vanishingly small relative to the value of the product so that time sensitivity is not the primary determinant of the air cargo choice. For example, diamonds, gold and platinum have an outstanding value-to-weight ratio and are among the main export products of South Africa. However, also products with a relatively low value-to-weight ratio, for example fruits and vegetables, can be transported via air cargo due to their low storage life and, thus, the time-sensitivity. For these products the air premium becomes an even more important determinant when choosing the mode of transport.

Since it is almost impossible to find detailed data about intra-African air transport, we make use of a large database provided by the European Statistical Office, which includes value and volume data by product and mode of transport. The European Union is by far the largest trading partner of South Africa and absorbs almost 26 per cent of exports and, in this respect, covers to a large extent the trade structure of South Africa with respect to the product level. The data are used, first, to evaluate the loading of an average airplane between South Africa and the European Union in the period 2005 to 2010, and second, to derive average value-to-weight ratios and time-sensitivity measures at the product level. Based on these two measures, products are then classified into four groups

ranging from the non-air cargo relevant group to the group consisting of products with the highest probability to be shipped via air cargo.

This product classification is used to evaluate the prospects for air cargo transport in Southern Africa. We find that especially export of products with a high and medium air cargo relevance grow much faster than exports of bulky goods and non air cargo products. South Africa's most prominent export products to industrialized countries consist of diamonds, gold and platinum (HS71), which account for 17 per cent of the total export value. However, these products leave the loading weight of an average airplane almost unaffected. It seems that these 'invisible outliers' are so precious that they tend to be transported in the hand baggage of a business or security person. When correcting South Africa's trade for these 'invisible outliers' in the loading freight we find that South Africa exports a much larger share of products with high air cargo relevance to SADC partners (i.e. Zambia, Zimbabwe, and Mozambique) than to industrialized countries (i.e. EU, US, and Japan). Given these results, air cargo transport seems to be a valuable option to overcome trade barriers associated with infrastructure and corruption.

The paper is structured as follows. The next section gives a short review of the literature with respect to trade costs and explains the determinants of the modal choice of transport. In the third section we present the methodology and data used to classify products relevant for air transport. Section 4 discusses the results with respect to the potential of intra-African air cargo transport. The last section concludes the paper.

2 Literature review: trade costs and modal choice of transport

The sources of Africa's marginal participation in world trade are widely debated (Amjadi et al. 1996) and include a comparative advantage in primary products (Wood and Mayer 2001), inadequate income growth and poor geography (Rodrik 1997), high domestic barriers to international trade (Ng and Yeats 1996), and high transport costs associated with infrastructure (Lima and Venables 2001, Elbadawi 2001). Most studies empirically evaluate those trade costs based on the gravity model, which relates bilateral trade between any country pair to their economic masses and the distance between them. The augmented version of the gravity model includes variables quantifying factors influencing transport costs. Some of the variation in trade costs is shown to be due to distance and other geographical constraints (e.g. common border, remoteness, landlocked- and island status) and some reflect the costs of doing business abroad (common language, cultural similarity, colonial linkages). Hummels (2001) is a seminal contribution to the idea that time is a trade barrier in itself. He argues that time to the market has two effects on

trade: first, it is a determinant of the probability to enter the market. And second, time is also a determinant of the volume of trade when market entry is chosen and acts in a similar way as tariffs and transport cost. From a theoretical perspective, lengthy shipping times impose inventory holding costs (e.g. capital costs of goods when in transit and the need to hold buffer stocks to accommodate variation in arrival time) and depreciation costs which refer to the fact that newly produced goods are preferable to older goods. For fragmented production chains intermediate inputs are especially time-sensitive and this is shown to have important implications for location of production and the specialization pattern of countries.

The issue is insofar relevant for developing countries in Africa as the gains from intermediates trade are expected to be larger compared to final goods trade (Amiti and Konings 2007, Kasahara and Rodriguez 2008). In this respect, Harrigan and Venables (2006) argue that time costs are qualitatively different from monetary costs (e.g. freight charges) because in a multi-stage production process the difference arises due to uncertainties in delivery which can disrupt production. The consequence is that delivery time can force producers to order parts and components from nearby although they are more expensive (e.g. due to higher labor cost). Their model predicts that the efficient organization of production requires the agglomeration of all component suppliers next to the assembly plants. On the one hand, Berthelon and Freund (2008), indeed, find evidence for the fact that distance became more important in international delivery for 40 per cent of industries and 50 per cent of trade. They argue that the availability of the internet allows for better information about potential suppliers and might lead distance-sensitive products to become more substitutable and to be traded more intensively rather with local partners.¹

On the other hand, Nordas et al. (2006) point out that exporters far from major markets can compensate for their average lead time in two, not mutually exclusive ways. Either they can reduce lead-time by shipping their export via air cargo. Or they can specialize in products with a higher value-to-weight ratio, as airfreight is even much more expensive than sea cargo.² In line with this argumentation, Harrigan and Deng (2008) and Harrigan (2010) provide theoretical models which predict that a country is expected to have a

¹ Substitutable goods include homogeneous goods with higher sensitivity to price differentials, low-value bulky goods (i.e. goods with higher freight costs), and goods with higher tariffs.

² Air freight costs for US imports are on average 5.7 times higher than sea freight (Hummels and Schaur 2010). Nevertheless, the cost of air shipping a kilogram of cargo dropped significantly between 1955 and 2005 (Hummels 2007). The consequence is that the value of trade shipped by air grew faster than the weight of trade. Ohashi et al. (2005) find that freight forwarders would be willing to pay more than 1000 USD in terms of airport charges (cargo loading, customs clearance, and cruising time) to achieve a one hour reduction in the transport processing time (landing fees, line-haul cost).

comparative advantage in heavy goods in nearby markets and lighter goods in distant markets (that can be air-shipped); a result for which Harrigan and Deng (2008) find support from an empirical analysis of Chinese exports. By splitting the export markets into two distinct groups (nearby and far away), they show that China's export unit values are increasing in distance and are about 15 per cent larger in the far away group. Thus, for sufficiently high-value products the airfreight premium becomes vanishingly small making air transport more feasible.³

However, when time is an important determinant of international location of production it is obvious to consider opportunities for time savings. But where do time costs stem from? Recent literature shows that some of the time costs are associated with poor infrastructure (Limao and Venables 2001; Elbadawi 2001, Amjadi and Yeats 1995). Limao and Venables (2001), for example, point out that the quality of transport infrastructure (e.g. density of paved road network and rail network) is an important part of transport costs. They find that intra-Sub-Saharan African (SSA) trade costs are substantially higher (by 136 per cent) than those for non-SSA countries and that infrastructure accounts for nearly half of the transport cost penalty. Moreover, poor infrastructure can account for up to 60 per cent of the penalty for landlocked countries (see also Arvis et al. 2007). From this perspective air cargo seems to be a valuable option of transport in Southern Africa.

Hummels (2001) and Hummels and Schaur (2012) argue that time costs are associated with the net shipping time between trading countries' ports. Hummels (2001) finds that, on average, an increase in shipping time of one day is associated with a reduced probability that a country will export to the US by 1 per cent (all goods) to 1.5 per cent (manufactures) and estimates a tariff equivalent per day in transit of 0.8 per cent for US imports. Djankov et al. (2010), Nordas et al. (2006) and Hausman et al. (2005) point out that a significant part of time costs stem rather from moving goods from the factory to the ship. Djankov et al. (2010) use the Doing Business indicators from the World Bank and argue that 75 per cent of delays in transport are due to administrative hurdles, customs and tax procedures, clearances and cargo inspection within the exporting country. They point out that export times in sub-Saharan Africa are especially long, taking on average more than 40 days. The necessary time to fulfil all the requirements

³ Nordas et al. (2006) note that such products exist in most sectors e.g. cut flours, peas and herbs in the agricultural sector, brasseries and swimwear in the apparel industry. Their case study shows how trade in air transport services allows Kenya to exploit its comparative advantage in floriculture. While flowers were first transported by passenger flights, dedicated cargo flights became viable as export volume grew. However, due to the lack of demand for time-sensitive imports in Kenya south-bound flights run almost empty. See also Wilmsmeier et al. (2006) on the problem of unbalanced trade.

for exporting varies greatly across sub-Saharan Africa ranging from 16 days in Mauritius to 116 days in the Central African Republic. In a striking example, they estimate that if Uganda reduces its factory-to-ship time from 58 days to 27 (the median for the sample), exports would be expected to increase by 31 per cent. Freytag (2011) compares the trade costs of the South African economy to its African peers and finds that South Africa is in the midfield. According to the World Bank, in 2012 it required on average 6 documents, 16 days and 1,620 US Dollars per container to export and 7 documents, 23 days and 1,940 US Dollars per container to import respectively (World Bank and International Finance Corporation 2012). Compared however to competitors, i.e. other emerging nations (e.g. Brazil, China, Malaysia), South Africa performs poorly.⁴

The business environment in general can be defined as a nexus of institutions, policies, physical infrastructure, human resources, and geographic features that influences the efficiency with which firms and industries operate (Eifert et al. 2005). At firm level, it directly influences costs of production (Eifert et al. 2005, Edwards and Balchin 2008); at the industry level, it often relates to market structure and competition. Moreover, the impact is felt more heavily in traded sectors (e.g. manufacturing, high-value services) than in primary production because the former tend to require more intensively inputs of logistics, infrastructure, and regulation (Collier 2000, Eifert et al. 2005). However, doing business data are based on judgments of business consultants (e.g. lawyers, accountants, and business people) but not the firms who are exporting.⁵

In this respect, firm-level evidence suggests that there may be strong productivity gains from trade orientation of the manufacturing sector especially in African countries (Bigsten et al. 2004, Mengistae and Pattillo 2004, Bigsten and Söderbom 2006). High fixed costs associated with foreign market entry discourage firms from exporting, but once firms enter they are more likely to remain in the market (Bigsten et al. 2004). Li and Wilson (2009) use the doing business indicators and show that firms in time-sensitive industries are less likely to become exporters in countries where more time is needed to export. In addition, restrictive trade and customs regulation deter manufacturing firms from exporting (Clarke (2005) for eight African countries). Balchin and Edwards (2008) show that the business climate has an important direct effect on export participation in eight selected countries in Africa.

⁴ These administrative costs are also highlighted in the study by Mthembu-Salter (2008), who discusses the trade costs of South African trade with Zimbabwe.

⁵ Behar (2010) compares the Doing Business Survey with the World Bank's Enterprise Survey and finds substantial divergences in the responses to specific questions. He argues that consultants are likely to have a bias towards reporting trade costs.

At the country level, most recent studies focus on institutional and regulatory environment with trade facilitation measures covering, first, port efficiency and customs environment (Wilson et al. 2003, 2005, Sanchez et al. 2003, Clark et al. 2004, Wilmsmeier et al. 2006, Blonigen and Wilson 2008), second, regulatory environment (e.g. in the airline industry see Kasarda et al. 2004, Micco and Serebrisky 2004, Geloso Grosso and Shephard 2011, Sjögren and Söderberg 2011) and, third, (logistic and transport) service sector infrastructure (Francois and Wooton 2001, Nordas 2007, Hummels et al. 2009).

Wilson et al. (2003, 2005) and Clark et al. (2004) find that port efficiency is positively associated with international trade and an important determinant of maritime transport costs.⁶ More efficient seaports operate with lower freight costs (Sanchez et al. 2003). While Wilson et al. (2005) suggest that trade flows get larger when the exporter unilaterally improves its port efficiency, Clark et al. (2004) argues that some level of regulation at seaports is beneficial to keep quality and security conditions. Seaport efficiency is not just a matter of physical infrastructure; but they point out that rather organized crime negatively affects port services which, in turn, increases transport costs. Anderson and Marcouiller (2002) argue that corruption reduces the trade volume as insecurity increases the trade costs. According to Hallward-Driemeier et al. (2010), the average South African firm uses about 6 per cent of their overall management time capacity in negotiations and conversation with South African government officials; this is exactly the African median. The share of firms bribing officials is 17.5 per cent. Other case studies suggests that corruption is a major problem at some sea ports, e.g. in Durban and Maputo, with bribes representing up to a 14 per cent increase in total shipping cost and a 600 per cent increase in the monthly salary of a port official (Sequeira and Djankov 2008). Moreover, bribes are primarily determined by product characteristics: the probability of a bribe is higher for goods with low elasticity of import demand and increases with the storage cost in the port. Thus, high tariff goods and differentiated products are more likely while bulk cargo is less likely to be susceptible to bribery. Ranjan and Lee (2007) find that bilateral trade volumes are more affected by institutional quality (i.e. contract enforcement) in sectors which they classify as institutionally sensitive (based on the classification of Rauch (1999) on differentiated and more complex products compared to homogenous goods). Pomfret and Sourdin (2010) support the argument as well and add that in the presence of corruption, exporters prefer air-transport in order to minimize costs and delays. Corruption creates uncertainty about

⁶ According to Clark et al. (2004), port efficiency varies widely from country to country with some Asian countries (Hong Kong, Singapore) having the most efficient ports in the world, while some of the most inefficient ports are located in Africa (e.g. Ethiopia, Nigeria and Malawi).

timeliness of delivery especially for institution-sensitive goods (e.g. intermediates inputs in manufacturing).⁷ Given these arguments, air cargo can be a valid option for Southern Africa where institutional quality is still lower compared to other countries.

Nordas (2007) investigates the role of logistic services and shows that waiting time exist between each link in the logistic chain (which includes transport, tracking, freight forwarding, inventory handling, customs, testing and packaging). Not only the waiting time but also the market structure in the transport services sector has an important impact on trade flows (Francois and Wooton 2001, Fink et al. 2002, Hummels et al. 2009). Hummels et al. (2009), for example, argue that market power drives much of the variation in shipping prices. Carriers can charge larger mark ups on products with relatively inelastic import demand and where the costs of shipping represent only a small percentage of the price. A larger number of carriers competing on a route lowers the level of shipping prices and the ability of carriers to price discriminate. The literature on the contestability of markets argues that a small number of carriers on a traded route is not per se evidence of market power. In this respect, air cargo carriers can act as potential competitor in disciplining the pricing behavior in shipping liner conferences.

Reducing transport costs by increasing competition in air cargo services has been recently under discussion, although the work on the potential impact of reforming the airline industry has so far considered passenger services while only a few papers consider the air cargo component.⁸ Kasarda and Green's (2005) correlation coefficients suggest that liberalization of aviation services (i.e. the number of air service agreements) is associated with higher levels of air freight, although they point out that liberalization itself may not be sufficient if other conditions are not met. Customs inefficiencies and corruption play inhibiting roles, especially in many developing countries. Micco and Serebrisky (2004) evaluate the open sky agreements signed by the US and find that a more liberal air cargo market reduces transport costs significantly by around 8 per cent (which implies an increase in trade by around 10 per cent). Geloso Grosso and Shephard (2011) find for the Asia Pacific region that more liberal air services policies are positively associated with bilateral merchandise trade. They show that air transport policy matters more for manufacturing sectors producing time-sensitive products and parts and components.

⁷ They find significant industry specific effects for certain goods arriving by air while for goods coming by sea these dummies were almost not significantly different from zero (mostly primary products and simple processed goods (electrical equipment, clothing, rubber, plastic).

⁸ Sjögren and Söderberg (2011) find that forming alliances and more intense competition in the airline industry increases productivity.

In this respect, time cost can affect the choice of transport for certain goods.⁹ The most frequently applied models determine the modal choice of transport by estimating probit and logit models.¹⁰ McFadden et al. (1985) and Jiang et al. (1999) estimate freight demand functions but do not include determinants of transport services such as time and cost. Feo-Valero et al. (2003) publish one of the first studies considering the factors influencing the mode choice for Spanish exports to Europe in a price-time-reliability framework. Although they focus on shipping versus road transport (as a faster form of transport), they find that high-value sectors (i.e. vehicle parts and household appliances) are significantly affected by logistic services such as transit times and frequency of shipment, while transport costs (freight charges) are more important than transit time for low-value commodities (agroindustrial and ceramics products).

Hummels and Schaur (2010) build upon the volatility of demand argument by Aizenman (2004) and confirm that fast transport allows firms to smooth demand volatility by reducing the risk of having large quantities of stock during a low demand season. The likelihood that firms use air cargo increases with the volatility of demand but decreases with the air premium they must pay.

In this paper we aim to evaluate the prospects for air cargo transport in Southern Africa. Given the low quality of transport infrastructure, high time costs to export and import, and a comparatively higher degree of corruption we can expect that firms in Southern Africa operating in regional and global markets tend to consider overcoming these trade barriers by relying relatively more on air transport compared to other (industrialized) countries in the world.

3 A framework for classifying air cargo products

3.1 Methodology

The transportation costs of a product are mainly determined by the weight of the product and its value. Products can be traded via air, sea and certain other modes of transport (e.g. road, rail and inland waterway). The transportation costs vary with the mode of transport chosen. For products with a higher value-to-weight ratio transportation costs and the air premium explicitly are vanishing relative to the value of the product. Time

⁹ Hayakawa et al. (2011) point out that the ownership structure of the firm has an impact on the modal choice of transport. The result is related to the argument that multinationals which have knowledge of operating global supply chains choose air transport more intensively.

¹⁰ While the largest part of the literature either focuses on passenger transport (private versus public transport, bus versus rail) and on the selection of road versus rail transport for freight, the choice between sea shipping versus air freight is rather under-researched.

and distance to trading partners are also relevant determinants for the firm to choose the mode of transport. This means that also low value-to-weight products may be subject to air transport. Those products can be relatively heavy in weight, but time sensitive to production chains (intermediate inputs) such that air transport is chosen. Hummels (2001) derives a list of time-sensitive product groups by estimating the days/rate ratio of ocean shipping times and airfreight for the probability for air transport. For example *fresh products* or cut flowers, items with *immediate information content* (e.g. newspaper, documents and mail, personal computers) as well as goods with characteristics for which demand or the '*ideal types*' cannot be forecasted well in advance (e.g. toy, high fashion apparel) are to a higher extent time-sensitive. He finds that time-savings appear to be valued highly for product categories where parts and components are traded consisting of *office equipment (SITC 75)*, *electric power machinery (SITC 77)*, and *photographic equipment (SITC 88)*. Recent studies on the integration of East Asian countries into global value added chains argue that timeliness delivery is important especially when just-in-time production processes are applied to minimize storage costs.¹¹ Hummels (2001) show that for these categories, falling air shipping costs are equivalent to reducing tariffs. Hummels and Schaur's (2012) select time sensitive products at the ten-digit-HS level by filtering '*parts and components*' (for intermediate inputs) and find that an increase in that share for a given product results in an increase in the time sensitivity of that trade.

Evans and Harrigan (2005) argue that also for retailers demand in the apparel and textile industry timely delivery influences its choice of source countries. They show for the US apparel imports that products where timeliness is important grew much faster from nearby countries (e.g. Mexico) than from East and South Asia. Delivery time matters also for final products (e.g. *fast fashion*) for which demand is difficult to forecast.

While mostly agricultural goods are considered as bulk transport (e.g. wheat, flour, and rice), Djankov et al. (2006, 2010) evaluate a list of time-sensitive *agricultural products* focusing on fruits and vegetables (HS07 and HS08) which they select based on information on their storage life.¹² Empirical evidence reveals that a 10 percent increase in the delivery time (from the factory to the ship) is associated with a 2.4 per cent reduction of a country's export of time-sensitive goods (relative to time-insensitive

¹¹ See Ando and Kimura (2003) and Athukorala (2005) for a list of parts and components. In both classifications, parts and components trade is mainly observable in two product groups: the machinery and transport equipment sector (SITC 7, HS84-85, HS87-88) and miscellaneous manufactured articles (SITC 8, HS90-92).

¹² Those agricultural products with a minimum storage life of three weeks or less are time-sensitive (e.g. apricots, beans, currants, mushrooms). Correspondingly, time insensitive products are e.g. apples, potatoes, dried products.

goods). The reduction for agricultural goods is even higher at 6 per cent. Hummels and Schaur (2012) while filtering for 'fresh' products (for perishability) in their dataset, find that a higher share of fresh products in trade increases the use of air shipment.

Our methodology to classify products relevant for air transport is shown in figure 1. We use two dimensions to distinguish products into four groups: the value-to-weight ratio of products and the time sensitivity in the delivery. As a consequence, products can be clustered with respect to their relevance for air transport ranging from the non-relevant group to the group with the highest relevance. The value-to-weight ratio serves as a reference value for the air premium and distinguishes products with a high value-to-weight ratio for which air cargo is *sufficient* (group L and H) and products with a low value-to-weight ratio for which the additional air cost are comparably high (group N and M). However, the time sensitivity serves as an indicator for delivery time and distinguishes products into a group for which air cargo may become *necessary* (group M and H) and products for which delivery time matters less so that air cargo is rather no choice of transport option (groups N and L).

Figure 1: Categorizing air cargo products

		value-to-weight	
		low	high
Time sensitivity	low	Non air cargo relevance (group N)	Low air cargo relevance (group L)
	high	Medium air cargo relevance (group M)	High air cargo relevance (group H)

In this respect, products belonging to the non-air relevant group N may consist of bulky products that have a low value-to-weight ratio and relatively low time sensitivity. Products in the low-air relevant group L have a higher value-to-weight ratio but relatively low time sensitivity. The third group with medium air relevance (group M) is the most interesting one as it comprises products with low value-to-weight ratio but a high time sensitivity. The last group with the highest relevance for air transport (group H) consists of products with high value-to-weight ratio and high time-sensitivity. While for group H the air premium is *acceptable* (due to a higher value-to-weight ratio), the additional cost of air cargo is a relevant determinant for exporters of group M competing on world markets with products of a lower value-to-weight ratio.

In the absence of data concerning products actually traded within Southern Africa we have to rely on proxies and secondary sources. South Africa's trade data with its main trading partners comprises only value data, not volume data. We develop a statistical implementation using South Africa's trade with the EU as a proxy since equivalent data for South Africa's trade with Africa is not available. South Africa plays an outstanding role in the SADC region providing roughly 40 per cent of intra-SADC trade. However, compared to other countries, South Africa is by far less integrated within the region. Besides industrialized countries e.g. US and Japan and the emerging economies (BRICs), the European Union is the main trading partner of South Africa absorbing 26 per cent of its total exports in 2010 and, thus, largely determines the total trade structure of South Africa with respect to the products.

In the following we make use of the rich database provided by the European Statistical Office. The Eurostat database offers access to bilateral trade between the European member states and South Africa on the product level of the Harmonized System HS (Eurostat 2012a) and bilateral trade between the EU and South Africa on the product level by mode of transport (Eurostat 2012b). Both datasets include value and volume data. In the Eurostat (2012b) database the sum of all modes of transport add up to the total value traded between South Africa and the European Union. As argued above, the first criterion is the value-to-weight ratio. With this ratio we can relate the additional costs of air transport (air premium) to the products South Africa exports to the EU and the rest of the world. We use data on the EU's import from South Africa (i.e. South Africa's exports to the EU) to gain information on South Africa's export and production structure. We calculate the value-to-weight ratio and the time-sensitivity (i.e. the share of exports transported via air cargo) for each product group at the HS 2-digit-level (appendix 1 includes detailed information at the product level). In addition, we calculate the value-to-weight ratio for each product group transported via air and via sea cargo. The value-to-weight ratios deviate from year to year due to changes in price ratios. We use the average value-to-weight ratio for the period 2005 to 2010 to smooth out year to year variations and business cycle fluctuations in prices. Before clustering the products relevant for air transport we consider the loading of an average (2005-2010) airplane from South Africa towards the EU.

3.2 Descriptive statistics

Consider a number of South African firms exporting their products to the EU. When arriving at the airport exporters will be charged the transport price of their freight. Depending on the weight and the bulkiness of the export products the air premium leads

to a selection of products for air cargo at the *check-in desk*: for a subgroup of products the air premium is acceptable and thus, products are ready for loading. For some products another mode of transport will be chosen when the air premium is too high. Thus, we first analyze the loading of an average airplane by selecting the top 20 products based on their value-to-weight ratio. Second, when the airplane is ready for *departure*, we make a *cargo inspection* of the total freight by selecting the top ten products by weight and bulkiness, and thus, products which dominate the cargo freight. Most of the top ten products entering the airplane tend to be low value-to-weight products for which time sensitivity matters more. Finally, with the *customs clearance at arrival* in the EU we combine both the value-to-weight ratio and the time sensitivity of products and systematically classify air cargo relevant goods.

At check-in: we know that the air premium, i.e. the additional cost for shipping by air cargo instead of sea cargo, becomes small with increasing value-to-weight of the product. It tends to be obvious that products with high value-to-weight will be checked-in for air cargo transport. According to appendix 2, an average airplane from South Africa to the European Union has a value-to-weight ratio of 141.76 EUR per kg which is 342 times higher than the average value-to-weight ratio of the total export basket (0.41 EUR per kg). The average value-to-weight ratio of a sea cargo transport is comparably low (0.22 EUR per kg). This observation holds for all product groups: value-to-weight ratios are higher in an airplane than in a (container) ship. More interestingly, South Africa exports high value products classified as pearls, jewelry, and coins (HS71) with an outstanding value-to-weight ratio in air cargo of nearly 245 EUR per 100 g. Broken down by single goods we find that the product group consist mainly of diamonds (HS7102: 41 %), gold (HS7108: 34 %) and platinum (HS7110: 21 %).

Other products which belong to the high value-to-weight goods include aircraft and parts thereof (HS88) as well as optical, photographic, precision instruments (HS90) and clocks, watches and parts thereof (HS91). Each of these top four product groups has a higher value-to-weight ratio than the average airplane from South Africa to the EU and in sum account for nearly 80 per cent of the air cargo value shipped. But these four product groups make up merely 1.1 per cent of the total loading space in kg.

The high value-to-weight bundle ready for air cargo also includes, according to appendix 2, products of the apparel and clothing industry (HS61,62), silk (HS50), headgear (HS65), leather (HS42) and furskins (HS43) and pharmaceutical products (HS30), but nuclear reactors, boilers and machinery (HS84), ships and boats (HS89), and furniture and lamps (HS94) as well. Even when summing up the top 20 products with the highest value-to-weight ratio listed in the table roughly three quarter of the average airplane's

loading space remains to be filled, although the product list accounts already for nearly 90 per cent of the total air cargo value. The last two columns of the table show the time-sensitivity of the products, i.e. the share of total value (and total volume) shipped via air. Accordingly, 37.8 per cent of South Africa's total bilateral export value to the EU is sent via air cargo. But with respect to South Africa's export volume air cargo represents not more than 0.1 per cent. Except for a few product groups mentioned above (HS84, 89 as well as HS30, 61, 62) more than 50 per cent of each high-value product is shipped by air. The remaining three quarter of the loading space will be filled with products having necessarily a lower value-to-weight ratio. For these product groups the air premium is higher relative to the value of the products and, thus, become more important when choosing the mode of transport.

Cargo inspection at departure: When considering the loading of the average airplane from South Africa towards the EU by weight, a range of agricultural products will make use of most of the airplane's space (appendix 3). Fish and crustaceans (HS03) as well as edible vegetables (HS07) and fruits and nuts (HS08), live trees and plants (HS06) and meat products (HS02) consume slightly more than 50 per cent of loading weight. However, together they add no more than 1.5 per cent of the total air cargo value. Although, it can be expected that nuclear reactors, boilers and machinery (HS84), furniture and lamps (HS94) will fill out the loading capacity we also find some parts and components of electrical machinery (HS85) and vehicles (HS87) among the cargo loading. The top ten product groups (excluding high value-to-weight products of HS84 and HS94) add another 64 per cent to the air cargo weight but account for slightly less than 10 per cent of its total value.

Summing up, when loading the airplane with the top 30 products it reaches a capacity of 98.2 per cent of the value (89% according to appendix 2 and 9% according to appendix 3) and 90.1 per cent of the weight (27% due to products in appendix 2 and 64% due to products in appendix 3). However, most of the airplane's weighting capacity is consumed by lower value-to-weight products which tend to be time-sensitive, but some of the airplanes high value-to-weight products for which the air premium becomes vanishingly small (e.g. HS89) tend to have a lower time-sensitivity (e.g. only 2.3% of products in HS89 are shipped via air cargo) such that firms are not willing to pay the premium.

Customs clearance at arrival: As a consequence, to classify air cargo relevant goods systematically it is inevitable to consider the time-sensitivity in general but also for the products with high value-to-weight ratio. Table 1 shows that the average value-to-weight of the EU's total imports from South Africa for the period 2005 to 2010 is 41.4 EUR per 100KG, the average value-to-weight of the EU's total imports via air transport is 14,176

EUR per 100KG due to an outlier as argued above (HS71 with a unit-value of 413,970 EUR per 100KG). As HS71 is an important product group in South Africa's trade we cannot exclude it from the calculation. Thus, to distinguish between high and low value-to-weight products, not excluding the HS71 outlier, the median value-to-weight ratio (which is 423 EUR per 100KG) in EU imports from South Africa is appropriate rather than the average value-to-weight ratio. Accordingly, 50 product groups are above the median and belong to the high value-to-weight group (groups L and H in figure 1) and 50 product groups are below (groups N and M).

Table 1: Customs clearance at arrival: Time sensitivity and value-to-weight ratio

HS-products	Value-to-weight			Time sensitivity					
	EUR/ 100kg			(air cargo value/ total)			(air cargo volume/ total)		
	Total	Air cargo	Sea cargo	2005	2010	Average	2005	2010	Average
Total	41	14176	22	27.7	44.4	37.8	0.1	0.2	0.1
Non air relevant (N)	17	459	15	0.6	1.2	0.9	0.0	0.1	0.0
Low air relevant (L)	762	1466	717	3.1	1.6	2.5	1.1	1.2	1.3
Medium air relevant (M)	23	3344	15	9.4	29.6	31.4	0.2	0.2	0.2
High air relevant (H)	5970	33430	1287	61.5	81.6	73.6	10.2	18.8	13.2

Note: See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on Eurostat (2012a,b).

With respect to the time-sensitivity of products, table 1 shows that, on average, 37.8 per cent of the total export value from South Africa towards the EU is transported via air cargo. Air cargo tends to become even more important: the share of air freight in all transport modes has increased from 27.7 per cent in 2005 to 45 per cent in 2010. However, merely 0.1 per cent of the total export volume is sent by air. We cluster products into a group with high time-sensitivity and low time-sensitivity using the median of the air cargo transport value in total transport value, which is 10.7 per cent. The median splits the product groups for which more than 10.7 per cent of total export value is shipped by air (groups M and H in figure 1) and products with lower air transport probability (groups N and L).

According to table 1, products in the high air relevant group H justify a higher probability for being air shipped because of both their high value-to-weight ratios (on average 59.70 EUR per kg) but also with respect to the time-sensitivity (on average 74% of the export

value is shipped by air).¹³ Interesting to note are products belonging to the medium air relevance group M. Although air shipped, those products have a relatively low unit value (on average 0.23 EUR per kg) but these products have a higher time-sensitivity (on average 31.4% of the total value is shipped via air cargo). These product groups include some agricultural products with a relatively low value-to-weight, e.g. fish and crustaceans (HS03), a list of edible vegetables (HS07) (e.g. potatoes, tomatoes, onions, garlic, lettuce, chicory, carrots, turnips, cucumber, and frozen and dried vegetables)¹⁴, and sugar and confectionary (HS17). However, also ores, slag and ash (HS26) which contain a range of rare earth (e.g. manganese, copper, nickel, cobalt, aluminum, lead, zinc, tin, chromium, tungsten, uranium, titanium, and other rare earth) is included as well as some inorganic chemicals and products thereof (HS28,38), raw hides and leather (41) cotton (52), articles of stone, plaster and cement (HS68).

In contrast, the other two categories of products with non- and low air relevance contain products for which the delivery time is not as much important so that other modes of transport will be favorable. Products in the group with low air relevance have on average a higher value-to-weight ratio (7.62 EUR per kg) than products in the medium air relevant group (0.23 EUR per kg), but the time-sensitivity is comparatively below (2.5% of the value is shipped by air) such that air cargo is feasible with respect to the air premium but not necessary for reasons of time constraints. Accordingly, products in this group include rather time-insensitive agricultural products (e.g. dairy products, e.g. honey (HS04), vegetable extracts (HS13), and cocoa and preparations (HS18)), textile fabrics (e.g. wool and animal hair (HS51), carpets (HS57)), raw materials like nickel and copper (HS74,75) and manufactured articles e.g. vehicles (HS87) and ships and boats (HS89). Products in the non-air relevant group are as well time-insensitive (on average 0.9% is subject to air transport) but have by far the lowest value-to-weight ratio (on average 0.17 EUR per kg). Accordingly, group N consists of mineral fuels (HS27) and

¹³ According to the classification, group H consists of products with a high relevance for air cargo, e.g. some agricultural products such as live animals (HS01), meat (HS02), products of animal origin (HS05) and live trees and other plants (HS06), and some time-sensitive products from the apparel and clothing industry (HS60-65) but also leather and furskins (HS42,43), silk (HS50), textile fabrics woven (HS58) or impregnated (HS59). The product list contains also a range of part and components from the electrical machinery section (HS82-85), aircraft (HS88), optical parts (HS90), and clocks and watches (HS91), musical instruments (HS92) besides pearls, stones, coins (HS71). We also find pharmaceutical products (HS30), printed books and newspaper (HS49), and ceramic products (HS69) among them.

¹⁴ Interesting to note, edible fruits and nuts (HS08) have a relatively low probability to being exported by air (3 per cent of export is shipped by air) and show up in the non relevant air product list. Edible vegetables (HS07) emerging in the list with medium air cargo relevance tend to be more time-sensitive (38 per cent of export is transported via air cargo).

products thereof e.g. plastic (HS39), other raw materials¹⁵, all other preparations of agricultural and bulky products.¹⁶

3.3 Limitations

When using this classification scheme to analyze South Africa's exports to countries other than the European Union we need to be aware of several limitations. The classification is a rough approximation of product groups shipped between South Africa and the European Union, which will now be applied to trade within Southern Africa (SADC) and South African trade with the rest of the world.

South Africa is the largest exporter and importer in the SADC region. As argued in the previous section several factors affect firm's decision to choose a certain mode of transport. Those factors include geographical characteristics e.g. the distance to the trading partner: A higher distance makes air transport more viable due to longer shipping times. This implies rather a lower probability of air transport for intra-African trade, which occurs rather at shorter distances. On the other hand, the poor transport infrastructure available i.e. the poor quality of paved roads and rail, especially in the neighborhood, increases the probability to choose air freight. In addition, for nearly half of the countries within SADC which are landlocked (Zambia, Zimbabwe, Botswana, Lesotho, and Swaziland) sea transported products may be shipped by air. In addition, border barriers and customs procedures may hinder the transport to the port. In this respect, administrative constraints e.g. bureaucratic hurdles increases the time needed to export and, thus, firms may decide to choose air freight to limit the remaining transport time. Pomfret and Sourdin (2010) argue that in the presence of corruption, which is a severe problem in most of the countries in Southern Africa, exporters prefer air-transport in order to minimize costs and delays within the exporting country. Especially for institution-sensitive goods, i.e. more complex products for which the contract environment is important, corruption creates uncertainty about timeliness of delivery.

¹⁵ Metal products (e.g. iron, steel and articles thereof (HS72,73), aluminum (HS76), lead (HS78), zinc (79), and other base metals (81)), as well as wood, cork and products thereof (HS44,47,48), glasses (HS70).

¹⁶ Edible fruits (HS08), cereals (HS10,19), meat and fish (HS16), vegetables (HS20,21), coffee, tea, mat and spices (HS09), milling products (HS11), oil seeds and grains (HS12). The list contains also beverages and tobacco (HS22-24), organic chemicals (HS29), fertilizers (HS31), tanning or dyeing extracts (HS32), soap (HS34), and rubber (HS40).

4 Prospects for air cargo in Southern Africa

4.1 Boundaries of air cargo: South Africa's trade with industrialized economies and BRICs

The framework established above is used to evaluate the development of air cargo transport in Southern Africa. We first concentrate on South Africa's total trade with the world and make a comparison to South Africa's exports to the European Union and other main industrialized countries. The EU is by far the largest trading partner of South Africa absorbing almost 27 per cent of South Africa's exports. Together with the US and Japan, nearly 46 per cent of South Africa's exports are directed to the group of industrialized countries. The second largest group of trading partners includes the BRICs countries with China (11.4%), India (4.2%) and Brazil (1%) receiving almost 17 per cent of South Africa's products. The SADC countries account for roughly 13 per cent of South Africa's exports with the main trading partners being Zimbabwe (3%), Mozambique (2.6%), and Zambia (2.4%).

South Africa's total trade pattern by air cargo relevance is shown in table 2. The non-air relevant group, which includes a range of bulky products, is by far the largest group of South Africa's export bundle (in sum 41 per cent in 2010).¹⁷ Although South Africa's total exports have grown by 52 per cent in value in the last five years, the share of these bulky products grew at a much lower rate so that its relevance declined slightly. Although South Africa exports a much higher share of bulky products in the non-air relevant group to other SADC members (53% of exports in 2010) the importance tended to diminish since 2005 as well. South Africa's total export bundle contains 30 per cent of products with a high relevance for air transport (group H) and additional 18 per cent of products with medium air relevance (group M). These product groups have seen considerable export growth in the last five years. Especially the medium air relevant products with a relatively low value-to-weight ratio become to a higher extent subject to air cargo due to their time-sensitivity. Exports of these medium air relevant products (especially ores, slag and ashes (HS26) alone account for 14% in 2010) grew by 141% in the last five year. They do, however, not show up to a noticeable extent in South Africa's exports to SADC members (and in its imports in general), while exports of high air relevant products to its SADC members is at the same level compared to its total trade pattern.

In the group of time-sensitive products with high value-to-weight ratio (group H), the main product group is HS71 (pearls, precious stones, metal, including diamonds, gold and platinum), which account for nearly 17 per cent of South Africa's total export value. As shown for an average airplane from South Africa to the EU, these products make up

¹⁷ South Africa's export is made up of the following main categories 10% mineral fuels (HS27), 13% iron, steel and articles thereof (HS72,73), and 3% aluminum (HS76) in 2010.

an indiscernible percentage of the total cargo volume and capacity. When excluding HS71 from South Africa's total export bundle, the share of high air relevant products in total exports drops from 30 per cent to merely half the numbers (16% in 2010). This is obviously not the case for exports to other SADC members where the respective export figures remain at their initial level. Certainly, HS71 account for less than 0.1 per cent of South Africa's export to SADC.

Table 2: South Africa's trade clustered by air cargo relevance of product groups

	SA - World					SA - SADC				
	growth			Excl. HS71		growth			Excl. HS71	
	2005	2010	2005-10	2005	2010	2005	2010	2005-10	2005	2010
Exports										
Total	46,988	71,447	52.1	-	-	5,013	8,947	78.5	-	-
of which (%):										
Non	44.3	41.3	41.6	54.2	49.4	58.5	53.0	61.9	58.5	53.1
Low	10.7	11.4	62.4	13.1	13.7	7.4	8.9	113.1	7.4	8.9
Medium	11.1	17.6	140.9	13.5	21.0	6.0	6.2	85.0	6.0	6.2
High	33.9	29.7	33.4	19.2	15.9	28.1	31.8	102.5	28.0	31.8
Imports										
Total	50,234	74,898	49.1	-	-	1,596	3,753	135.2	-	-
of which (%):										
Non	33.5	40.3	79.2	34.3	40.7	29.6	72.4	477.0	41.6	80.1
Low	12.3	10.6	28.0	12.6	10.7	11.0	6.1	29.6	15.5	6.7
Medium	5.1	4.4	28.2	5.2	4.4	23.4	3.2	-67.6	33.0	3.6
High	49.0	44.7	36.0	47.9	44.1	36.0	18.2	18.9	9.9	9.7

Note: Total trade figures in millions of USD excluding exports and imports of HS 99 other commodities n.e.s. South Africa exports of HS71 amount to 18.2 per cent (2005) and 16.5 per cent (2010). The imports of HS71 contain 2.2 per cent (2005) and 1.1 per cent (2010). In trade with SADC, South Africa exports less than 0.1 per cent, but imports by between 29 per cent (2005) and 9.5 per cent (2010). See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on ITC (2012).

Considering South Africa's imports from the world compared to imports from SADC members it becomes obvious that South Africa tends to be the hub in the region delivering pearls and stones from SADC to the rest of the world, while redirecting machinery and electrical equipment from the rest of the world to its SADC partners. South Africa's imports of goods with the highest probability of air cargo (group H) account for 45 per cent. Mainly machinery, electrical equipment and parts thereof (HS84,85) are imported by South Africa (27% of total imports) from the rest of the world, while South Africa's high air relevant imports from SADC is rather made up of pearls, gold and platinum. HS71 alone accounts for 29 per cent of imports from SADC in 2005, but shrinks to level of 10 per cent in 2010. Excluding these HS71 products from the

import bundle, the importance of air transportable products from SADC members to South Africa vanishes to a level of 10 per cent and remains far below the trade flows into the opposite direction (32% of South Africa's exports to SADC in 2010) which consist mainly of machinery, electrical equipment and parts thereof (HS84,85 account for 21% in 2010).

South Africa's trade by air transport probability with the rest of the world is shown in more detail in appendix 5 and 6. In appendix 5 we find that South Africa's trade with industrialized countries, especially with the EU, contains a much larger share of products with a considerable extent of air relevance (35% of exports belong to the group with the highest air cargo probability). Exports of medium air relevant products to the EU (14.2% of exports) have even grown faster (by 48% since 2005) than South Africa's total exports to the EU (10% since 2005). To the contrary, products in the non-air relevant group have decreased from 43.5% in 2005 to 38% in 2010. A similar picture emerges for South Africa's imports: more than 50 per cent of products South Africa imports from the EU belong to the group with high air relevance. In South Africa's trade with other industrialized countries (i.e. the US and Japan) air transportable products are even more important than in trade with the EU.¹⁸ In general, exports and imports of products with a high relevance for air cargo transport are considerably above the level in South Africa's total trade.

The air cargo relevance in South Africa's trade with industrialized countries is in contrast to trade with BRIC countries (appendix 6), mainly due to the fact that South Africa specializes in trade with resource-intensive products. However, when differentiating resource-intensive products by time-sensitivity and value-to-weight ratio we find that only in trade relations with Brazil and India do resource-intensive exports belonging to the non-air relevant group dominate. More than 70 per cent of South Africa's exports to both countries are made up of products that have rather a non-existent probability to be transported via air cargo.¹⁹ However, the picture changes dramatically when considering South Africa's trade relations with China: two thirds of exports to China belong to the medium air relevant group. Not surprisingly, the most important products delivered to

¹⁸ In 2010, 38% of South Africa's exports to the US consist of products with a high relevance for air transport, although export of these products grows at a below average rate (of total trade which is 44.3% since 2005) of 15%, the importance of air transportable products in trade with the US drops remarkably since 2005. The contrary is the case for South Africa's exports of high air relevant products to Japan, which increases from a level of 37% in 2005 to even 53% in 2010.

¹⁹ While 60% of total exports to India are mineral fuels (HS27), the export bundle to Brazil is rather a broad mix of 16% mineral fuels, 17% iron and steel (HS72) and 10% aluminum (HS76) as well as 12% chemicals (HS29). The relatively large share of export of air transportable goods to India in 2005 is due to an outlier: aircraft and parts thereof (HS88) accounted for 20% of total exports to India in this year.

China are ores, slag and ashes (HS26 which include the complete range of rare earth). These product groups alone account for 54 per cent of total exports to China.

Compared to South Africa's exports to industrialized countries, the importance of products with a high relevance for air transport in trade relations with BRICs countries is far below the average level South Africa is exporting. Nevertheless, the relevance for air cargo transport remains for South Africa's imports from BRICs. Especially imports from China contain an outstanding proportion of products with high air relevance (75% in 2010). Mainly machinery, electrical equipment and parts thereof (HS84,85) contribute 44% to South Africa's imports from China. A remaining part of 15% of imports from China includes fabrics of the apparel and clothing industry as well as footwear (HS59 - 64). However, South Africa's imports from Brazil contain a rather larger share (i.e. 18 per cent) of meat and preparations thereof (HS02,05) in addition to machinery and electrical equipment which account for 20% of imports from Brazil. India is rather a provider of pharmaceutical products (HS30) which account for 8% of imports next to machinery and electrical equipment (13%).

4.2 South Africa's air cargo trade with SADC partners

Relative to South Africa's exports to industrialized countries which consists of a large part of air transportable goods (especially diamonds, gold and platinum in HS71) and to its exports to emerging BRICs countries which consists of bulky resource-intensive products, South Africa's trade with SADC members with respect to air transportable goods lies somewhere in between. Table 3 summarizes the exports and imports figures with South Africa's main SADC trading partners Zambia, Zimbabwe and Mozambique, which absorb 2.4%, 3%, and 2.6% of South Africa's exports respectively. Although South Africa's exports to all three countries include a relatively large share of bulky non-air transportable products (around 50 per cent)²⁰, time-sensitive products with a high value-to-weight ratio relevant for air cargo transport (group H) become even more important. The largest share of these high air relevant products is directed from South Africa to Zambia (with 38% of total exports to Zambia). In trade with Zimbabwe and Mozambique, the share of air transportable products is slightly lower, i.e. 30 per cent of South Africa's total exports to each of the countries. Noteworthy, mainly machinery, electrical equipment and parts thereof (HS84,85) play a dominant role accounting for more than

²⁰ Noteworthy, while South Africa's exports to Mozambique in this product group is largely dominated by mineral fuels (HS27) with 17%, the export bundle to Zambia and Zimbabwe is even more diversified, including at least 10% fuels and several other products like plastics (HS39), fertilizers (HS31), iron, steel and articles thereof (HS72,73) as well as animal and vegetable fats and oils (HS15).

28% of South Africa's exports to Zambia, and comparatively lower levels (18% and 22% respectively) in trade with Zimbabwe and Mozambique.

Table 3: South Africa's trade with Zambia, Zimbabwe, and Mozambique

	SA - Zambia			SA - Zimbabwe			SA - Mozambique		
	2005	2010	growth 2005-10	2005	2010	growth 2005-10	2005	2010	growth 2005-10
Exports									
Total	849	1,750	106.1	1,162	2,155	85.6	992	1,893	90.9
of which (%):									
Non-air	47.6	45.8	98.5	65.0	56.7	62.0	68.0	53.3	49.6
Low-air	9.8	10.7	125.2	6.6	9.0	151.3	6.7	9.6	176.6
Medium-air	7.8	5.0	33.7	6.2	5.6	68.1	3.6	6.9	263.4
High-air	34.8	38.4	127.2	22.2	28.7	139.6	21.7	30.1	165.1
Imports									
Total	204	289	41.5	488	191	-60.8	30	528	1639.6
of which (%):									
Non-air	7.5	6.9	30.4	20.6	52.6	0.0	45.6	94.8	3511.2
Low-air	43.9	58.6	88.9	16.7	13.8	-67.7	3.7	0.4	81.4
Medium-air	39.4	11.7	-58.1	54.8	22.4	-84.0	36.3	2.4	15.2
High-air	9.2	22.8	250.2	7.8	11.2	-44.0	14.4	2.5	195.9

Note: Total trade figures in millions of USD excluding exports and imports of other commodities n.e.s. (HS99). See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on ITC (2012).

In contrast to South Africa's trade with industrialized countries, exports of products such as diamonds, gold and platinum included in HS71 figure out to be relatively unimportant in South Africa's export to SADC members. This observation holds also for South Africa's imports from Zambia, Zimbabwe and Mozambique in which HS71 account for less than 0.4 per cent.²¹ In this respect, it is even more remarkable that South Africa's exports of the remaining air cargo relevant products to other SADC members grew at above average (relative to total exports) rates in the last five years. Especially exports of air cargo relevant products to Mozambique increased by 165 per cent in the respective period, which lies far beyond the growth rate of total trade (91%). Comparable numbers can be observed for exports to Zambia (127% compared to 106%) and to Zimbabwe (140% compared to 86%). However, South Africa's imports from the selected SADC partners differ substantially, with air cargo relevant products at a comparatively low level (i.e. 11.2% of imports from Zimbabwe, 2.5% of imports from Mozambique), except for

²¹ Except for an outlier in trade with Zimbabwe in 2010, HS71 accounts for 7% of total imports.

trade relations with Zambia for which HS71 suddenly emerged with 6.8% in the import statistics in 2010.

Given the fact that exports of diamonds, gold, platinum and all other pearls and stones included in HS71 leave the loading space and volume of an average airplane largely unaffected, they account for less than 1 per cent of the total volume shipped, it is reasonable to correct South Africa's trade flows by the invisible outliers in the air cargo freight. Results are reported in table 4.

The relevance of the remaining time-sensitive products with high value-to-weight ratios in trade with SADC members is even more remarkable. Especially South Africa's export bundle to selected SADC members includes more products subject to a high probability of air cargo than in exports to selected industrialized countries. Except for exports to the European Union for which high air cargo relevant products account for 22.3% in 2010, and thus, slightly above the respective level in South Africa's export bundle to the rest of the world (compare table 2), air cargo relevant exports account for not more than 14% of exports to the US and even less than 3% in trade with Japan.

4.3 Prospects for intra-SADC air cargo transport

South Africa tends to export a larger share of products with high air relevance to their neighboring SADC partners than to industrialized countries and emerging BRIC countries when correcting trade flows by invisible outliers in the airplane's loading capacity. Although South Africa is the largest trading country in SADC and, thus, dominates overall intra-SADC trade flows to a high extent, it is crucial to check whether South Africa's air cargo relevant trade deviates from trade among the SADC partners. Thus, the trade pattern of SADC members (which includes South Africa) by air transportable product groups is shown in more detail in table 5. Here we compare intra-SADC trade, i.e. the bilateral trade between all SADC members, with the SADC member's exports and imports to and from non-SADC members and with SADC's world trade. Both intra- and extra-SADC trade add up to SADCs total world trade.

Although intra-SADC trade accounts for roughly a fifth of SADC's total trade (13% of exports and 20% of imports are delivered within SADC), it is noteworthy that intra-SADC total exports and imports grow at much higher rates in the last five years than SADC's trade with non-SADC members. While intra-SADC exports grew by 105 per cent from 2005 to 2010 we find a growth rate of somewhat below 80 per cent for exports to non-SADC members.

Table 4: The air cargo intensity of South Africa's trade – corrected for invisible outliers in the loading capacity

	EU		US		Japan		Brazil		China		India		Zambia		Zimbabwe		Mozambique	
	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Exports																		
Non-air	52.6	45.0	49.1	33.7	43.8	47.1	69.3	70.1	37.2	25.0	46.8	79.3	47.6	45.9	65.0	56.7	68.0	53.4
Low-air	10.0	15.8	11.0	38.7	37.0	17.3	1.9	0.7	10.2	5.5	2.3	1.8	9.8	10.7	6.6	9.0	6.7	9.6
Medium-air	12.8	16.9	19.6	14.1	17.6	33.2	12.0	10.7	48.3	68.2	20.7	15.8	7.8	5.0	6.2	5.6	3.6	6.9
High-air	24.6	22.3	20.2	13.5	1.6	2.4	16.8	18.6	4.2	1.4	30.2	3.1	34.8	38.4	22.2	28.7	21.7	30.1
HS71	17.4	16.0	34.9	28.6	35.6	51.7	0.1	0.0	0.8	3.1	13.7	2.4	0.1	0.0	0.0	0.0	0.0	0.0
Imports																		
Non-air	20.9	27.3	20.4	24.5	11.9	12.5	32.4	29.5	15.7	18.5	43.9	51.1	7.5	7.4	20.6	52.8	45.8	94.8
Low-air	17.7	15.2	10.0	10.8	35.9	39.0	14.3	11.9	2.9	3.7	19.8	15.1	43.9	62.9	16.8	13.9	3.7	0.4
Medium-air	3.9	4.2	5.8	5.7	1.9	2.4	7.6	13.3	3.7	3.7	7.5	4.3	39.4	12.5	54.9	22.5	36.4	2.4
High-air	57.5	53.3	63.9	59.0	50.4	46.1	45.7	45.3	77.7	74.2	28.8	29.5	9.2	17.1	7.7	10.8	14.2	2.5
HS71	0.5	0.3	1.5	0.4	0.0	0.0	0.0	0.0	0.3	0.5	2.3	1.9	0.0	6.8	0.1	0.4	0.3	0.0

Note: Trade figures exclude exports and imports of HS71. See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on ITC (2012).

Even more remarkable is that the growth of intra-SADC trade (exports as well as imports) occurred especially in those product groups we have classified as relevant for air cargo transport (i.e. the medium and high air probability products). In more detail, compared to growth of intra-SADC's exports (105% as argued above), exports of products belonging to the group with high air relevance grew at a similar rate, but medium air relevant products increased by 171 per cent in the respective period. Both the growth rates for medium and high air relevant products outperformed the corresponding growth rates for SADC's exports to non-SADC members, which increased by 135 per cent (medium air group) and 16 per cent (high air group).

Table 5: SADC trade clustered by air cargo relevance of product groups

	Intra-SADC			SADC - world			Extra-SADC		
	2005	2010	growth 2005-10	2005	2010	growth 2005-10	2005	2010	growth 2005-10
Exports									
Total	10,234	20,945	104.7	89,565	163,221	82.2	79,331	142,275	79.3
of which (%):									
Non	46.0	43.9	95.2	53.0	55.9	92.2	53.9	57.6	91.8
Low	11.3	10.4	89.8	7.9	11.1	158.4	7.4	11.3	171.9
Medium	10.8	14.3	170.9	9.3	12.3	140.1	9.2	12.0	135.4
High	31.9	31.4	101.2	29.8	20.7	26.4	29.6	19.1	16.0
Imports									
Total	14,743	28,034	90.2	83,341	141,990	70.4	68,597	113,956	66.1
of which (%):									
Non	46.9	49.0	98.4	36.4	41.2	92.9	34.1	39.3	91.3
Low	14.4	12.5	64.4	14.2	12.1	45.1	14.1	12.0	40.8
Medium	9.2	10.7	122.1	5.6	5.9	79.7	4.8	4.7	62.3
High	29.5	27.8	79.7	43.8	40.9	58.8	46.9	44.1	56.0

Note: Total trade figures in millions of USD excluding exports and imports of other commodities n.e.s. (HS 99). Half of intra-SADC export and SADC exports to the world stem from South Africa. The difference between intra-SADC exports and imports tends to be due to an underreporting of export products maybe for reasons of tax avoidance. See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on ITC (2012).

When correcting SADC import and export flows by invisible outliers (i.e. diamonds, gold, platinum and all other pearls and stones included in HS71), we find that in intra-SADC trade the importance of the high air relevant product group remains at a level of 27 per cent, while in SADC members exports to the rest of the world (extra-SADC) the share of high air relevant products dropped to half the level, i.e. from 30 % to 14 % in 2005 and from 19 % to 8 % in 2010, when excluding the 'invisible outliers'. Table 6 shows that diamonds, gold, platinum and

other pearls (HS71) are even less relevant for intra-SADC trade than in trade with the rest of the world.

Table 6: The air cargo intensity of SADC trade - corrected for invisible outliers

	Intra-SADC				SADC - World				Extra-SADC			
	Exports		Imports		Exports		Imports		Exports		Imports	
	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010	2005	2010
Non	48.8	46.0	48.5	50.1	63.6	63.2	36.9	41.9	65.9	65.9	34.5	39.9
Low	11.9	10.9	14.9	12.8	9.4	12.6	14.4	12.3	9.1	12.9	14.3	12.2
Medium	11.4	15.0	9.5	11.0	11.2	13.9	5.7	6.0	11.2	13.7	4.9	4.8
High	27.9	28.1	27.0	26.1	15.7	10.3	43.0	39.8	13.9	7.5	46.3	43.1
<i>HS71</i>	5.6	4.6	3.3	2.4	16.8	11.6	1.5	1.8	18.2	12.6	1.1	1.7

Note: Trade figures exclude exports and imports of diamonds, gold and platinum (HS71). See appendix 1 and 4 for detailed information on product categories

Source: Calculation based on ITC (2012).

5 Conclusions

In this paper we evaluate the prospects for air cargo transport in Southern Africa. South Africa becomes even more incorporated in global value chains with time-sensitive products to be exported. Given the low quality of transport infrastructure, high time costs to export and import, and a comparatively higher degree of corruption, we argue that firms in Southern Africa operating in foreign markets may consider overcoming these trade barriers by relying more on air cargo compared to other (industrialized) countries in the world.

We developed a framework to systematically classify air cargo relevant products. The classification builds upon two important criteria: the time-sensitivity and the value-to-weight ratio of products. The argument behind this classification scheme is that the air premium, i.e. the additional cost of shipping via air cargo instead of sea cargo, becomes vanishingly small for products with a high value-to-weight ratio (e.g. diamonds, gold, and platinum) irrespective of the time sensitivity. However, also products with a relatively low value-to-weight ratio (e.g. fruits and vegetables) can be subject to air cargo mainly due to low storage life and, thus, the time-sensitivity. For these products the air premium becomes even more an important determinant when choosing the mode of transport.

Since detailed data about intra-African air transport are lacking, we make use of a large database provided by the European Union which is by far the largest trading partner of South Africa and, in this respect, covers to a large extent the trade and production structure with respect to the product level. We first evaluate the freight of an average airplane to derive average value-to-weight ratios and time-sensitivity measures at the product level according to

which products are then systematically classified. The classification is, secondly, used to analyze the prospects for air cargo in Southern Africa.

We find that especially export of products with high and medium air cargo relevance grew much faster in the last five years than exports of bulky goods and non air cargo relevant products. South Africa's export bundle consists of diamonds, gold and platinum (HS71), which account for 17 per cent of the total exports value and rises to one third in trade with industrialized countries, especially the US and Japan. These products, however, leave the loading weight of an average airplane almost unaffected (less than one per cent of the five year average air cargo volume to the EU). Therefore, it seems that these 'invisible outliers' are so precious that they tend to be transported in the hand baggage of a business or security person since its loading accounts for more than three quarters of the value of an average airplane. When correcting South Africa's trade for these 'invisible outliers' we find that South Africa exports a much larger share of products with high air cargo relevance to SADC partners (i.e. Zambia, Zimbabwe, and Mozambique) than to industrialized countries (i.e. EU, US, and Japan). The results indicate that air cargo transport seems to be a valuable option to overcome trade barriers associated with infrastructure and corruption.

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Appendix 1: South Africa's exports to the EU by product group and air cargo relevance

Classific.		Air cargo exports SA-EU				Value-to-weight (EUR/100KG)			Time-sensitivity	
HS	Air	100KG	%	1000EUR	%	Total	Air	Sea	Air cargo/Total Value	Volume
Total		547299	100.00	7721791.0	100	41.4	14175.7	21.8	37.8	0.1
01	H	148	0.03	440.6	0.01	2525.4	3000.5	2128.9	78.6	67.8
02	H	8407	1.54	8517.6	0.11	832.9	1014.5	752.3	31.4	25.8
03	C	144916	26.48	58978.5	0.76	356.6	403.5	339.2	28.2	24.9
04	L	2	0.00	2.9	0.00	563.9	1499.6	510.6	3.7	12.9
05	H	621	0.11	1407.2	0.02	1211.6	2412.8	650.1	62.5	34.0
06	H	33048	6.04	17687.3	0.23	467.3	551.6	383.1	45.8	39.7
07	M	16739	3.06	6481.2	0.08	93.7	387.4	59.1	38.3	9.6
08	N	94612	17.29	30273.0	0.39	98.0	322.7	90.5	2.7	0.8
09	N	313	0.06	236.5	0.00	196.6	1017.6	190.6	2.0	0.5
10	N	144	0.03	27.1	0.00	75.3	775.4	69.4	3.9	0.7
11	N	14	0.00	4.0	0.00	41.9	314.1	40.3	1.0	0.1
12	N	515	0.09	1449.5	0.02	173.1	2564.0	167.5	5.9	0.4
13	L	76	0.01	141.7	0.00	555.3	1872.8	507.1	10.7	3.3
14	N	19	0.00	13.2	0.00	93.8	3577.9	91.6	3.5	0.3
15	N	65	0.01	43.1	0.00	280.1	921.8	290.7	1.2	0.6
16	N	230	0.04	128.5	0.00	383.0	596.8	381.7	0.9	0.7
17	M	232	0.04	241.2	0.00	128.8	944.3	96.5	17.0	3.0
18	L	74	0.01	82.7	0.00	764.1	1139.1	752.2	5.2	4.0
19	N	21	0.00	13.9	0.00	138.7	708.0	136.9	1.3	0.3
20	N	1416	0.26	563.6	0.01	100.3	376.0	102.5	0.6	0.1
21	N	1478	0.27	1107.6	0.01	239.9	918.2	216.9	8.2	2.6
22	N	2759	0.50	1362.5	0.02	160.1	524.3	167.0	0.3	0.1
23	N	30	0.01	34.5	0.00	116.5	1081.0	158.4	2.2	0.2
24	N	86	0.02	202.3	0.00	326.2	1529.6	319.6	3.2	0.6
25	N	4070	0.74	196.1	0.00	22.9	185.0	22.7	0.1	0.1
26	M	4422	0.81	457520.2	5.93	17.4	396726.3	10.8	35.6	0.0
27	N	1924	0.35	325.6	0.00	7.1	725.3	7.0	0.0	0.0
28	M	767	0.14	21648.8	0.28	199.1	42648.7	109.4	15.1	0.1
29	N	407	0.07	4376.7	0.06	96.5	16361.9	111.5	2.3	0.0
30	H	971	0.18	9366.5	0.12	2387.0	10547.3	1340.7	43.5	10.8
31	N	81	0.01	80.3	0.00	45.1	2041.4	42.6	2.6	0.1
32	N	1863	0.34	3285.2	0.04	218.0	1847.4	167.5	10.2	1.3
33	H	2858	0.52	11567.2	0.15	585.8	4061.8	419.6	29.5	4.3
34	N	295	0.05	278.2	0.00	168.2	977.2	154.0	4.3	0.8
35	H	209	0.04	3085.9	0.04	2331.4	20504.6	394.9	84.7	12.6
36	H	99	0.02	440.4	0.01	1450.1	4850.5	746.6	47.0	16.6
37	H	94	0.02	1889.8	0.02	2088.6	18428.6	741.8	66.8	14.4
38	M	3037	0.55	11213.5	0.15	137.3	3472.7	205.1	11.9	0.5
39	N	3783	0.69	4386.0	0.06	173.5	1230.3	166.1	5.5	0.8
40	N	1286	0.23	1284.6	0.02	293.1	1036.9	279.4	1.4	0.4
41	M	1439	0.26	13795.7	0.18	312.4	9655.4	237.6	20.8	0.7
42	H	1487	0.27	6578.5	0.09	3419.6	4489.3	1825.2	76.0	58.8
43	H	126	0.02	507.5	0.01	2057.3	4094.0	930.5	63.4	35.0
44	N	689	0.13	943.3	0.01	70.1	1300.6	70.0	1.6	0.1
45	H	63	0.01	138.8	0.00	1822.7	2302.3	1756.9	19.0	14.3
46	N	11	0.00	22.6	0.00	150.3	2431.5	146.9	2.2	0.2
47	N	16	0.00	3.9	0.00	54.7	165.7	54.8	0.0	0.0
48	N	885	0.16	736.7	0.01	60.1	839.0	59.9	0.6	0.0
49	H	1801	0.33	3103.0	0.04	1014.4	1743.9	687.3	51.6	30.6
50	H	7	0.00	14.4	0.00	2394.9	2213.8	2128.9	72.4	76.2
51	L	493	0.09	1277.7	0.02	454.6	2530.8	446.8	1.3	0.2
52	M	394	0.07	519.4	0.01	318.5	1616.9	285.9	11.2	2.3
53	N	4	0.00	7.9	0.00	302.1	2402.0	372.4	1.7	0.2
54	N	533	0.10	693.5	0.01	381.5	1764.8	349.9	9.6	1.7
55	N	188	0.03	214.8	0.00	178.5	1933.5	161.8	8.6	2.5
56	N	403	0.07	400.7	0.01	240.5	1396.7	237.8	2.5	0.6
57	L	233	0.04	275.9	0.00	543.5	1162.9	593.3	4.0	1.8
58	H	317	0.06	1497.5	0.02	681.2	5238.3	402.1	42.1	6.2
59	H	407	0.07	1106.1	0.01	1149.8	2651.0	738.9	47.5	22.3
60	H	121	0.02	152.3	0.00	753.4	1319.9	574.3	41.3	24.4

Appendix 1 cont.

Appendix 1 cont'd.

Classific.		Air cargo exports SA-EU				Value-to-weight (EUR/100KG)			Time-sensitivity	
HS	Air	100KG	%	1000EUR	%	Total	Air	Sea	Air cargo/Total Value	Volume
61	H	554	0.10	2342.9	0.03	2092.2	4216.5	1571.4	30.8	15.0
62	H	1086	0.20	3796.5	0.05	2058.6	3495.4	1629.3	37.6	22.6
63	H	1607	0.29	5013.7	0.06	1419.7	3131.1	698.7	54.0	24.6
64	H	205	0.04	440.5	0.01	1190.1	2212.7	991.7	23.8	13.5
65	H	179	0.03	366.2	0.00	2425.9	2898.4	1480.7	82.4	72.6
66	L	60	0.01	92.2	0.00	568.3	1594.7	548.0	4.0	1.5
67	H	227	0.04	697.4	0.01	2916.6	4066.1	1733.3	80.7	60.7
68	M	2683	0.49	13531.1	0.18	270.8	5434.3	131.1	37.0	2.4
69	H	2010	0.37	3520.9	0.05	456.6	1756.0	294.5	39.8	10.5
70	N	494	0.09	534.3	0.01	190.2	1127.1	190.5	1.4	0.2
71	H	2453	0.45	6043974.4	78.27	413969.7	2453985.6	3696.2	89.6	15.7
72	N	12966	2.37	1300.5	0.02	86.6	275.3	81.5	0.1	0.1
73	N	4072	0.74	3754.2	0.05	129.4	938.8	121.5	5.7	0.8
74	L	1547	0.28	1091.0	0.01	437.0	1497.2	440.2	0.9	0.6
75	L	138	0.03	356.0	0.00	1109.7	4163.3	1079.5	2.5	0.8
76	N	3819	0.70	2818.9	0.04	232.1	791.1	236.5	1.4	0.4
78	N	11	0.00	35.7	0.00	166.8	2995.8	152.6	6.5	0.7
79	N	7	0.00	4.4	0.00	193.0	472.2	177.1	2.4	1.7
80	H	4	0.00	20.0	0.00	511.1	6184.7	397.8	18.7	2.7
81	N	593	0.11	3008.4	0.04	421.8	5162.7	418.9	8.8	0.7
82	H	2943	0.54	13041.3	0.17	2676.1	4454.8	1159.7	75.8	46.0
83	H	1060	0.19	1699.7	0.02	677.7	1844.2	531.4	28.3	10.9
84	H	80261	14.66	406064.0	5.26	2047.5	5083.5	1584.9	21.5	8.7
85	H	11701	2.14	105957.4	1.37	1669.7	9458.5	1084.6	33.5	6.1
86	N	377	0.07	275.3	0.00	351.6	739.0	342.2	5.9	2.6
87	L	17323	3.17	25575.0	0.33	901.0	1560.3	818.4	3.1	1.8
88	H	1368	0.25	60677.7	0.79	37791.3	43454.4	7923.2	86.4	74.4
89	L	58	0.01	429.2	0.01	2755.5	5610.4	2342.1	2.3	1.0
90	H	2259	0.41	60367.6	0.78	10289.9	27281.6	2116.4	76.7	29.4
91	H	10	0.00	221.4	0.00	16965.7	22739.6	2128.9	74.8	58.1
92	H	28	0.01	81.1	0.00	1976.1	3488.1	1112.5	52.4	34.4
93	M	277	0.05	913.6	0.01	422.9	6833.0	368.1	13.6	1.7
94	H	49424	9.03	249053.8	3.23	2301.8	5127.9	416.5	90.4	43.6
95	H	480	0.09	1699.4	0.02	992.6	3512.5	805.0	31.4	8.8
96	H	535	0.10	1069.2	0.01	721.7	2270.5	546.2	29.9	10.8
97	H	1262	0.23	7347.5	0.10	2384.8	5930.8	840.0	71.5	28.8

Note: calculations are based on averages in the period 2005 to 2010. Time sensitivity is calculated as the share of air cargo transport (value or volume) in total transport (value or volume). See appendix 4 for a list of products at HS classification.

Source: Calculation based on Eurostat (2012a,b).

Appendix 2: Check-in South Africa: high value/weight products in an average airplane to EU

HS group	Value-to-weight			Air cargo				Time-sensitivity	
	Total	Air cargo	Sea cargo	Air cargo/total					
	EUR/100KG			EUR	%	100KG	%	% value	% weight
TOTAL	41.4	14175.7	21.8	7721790993	100.00	547299	100.0	37.8	0.1
71	413969.7	2453985.6	3696.2	6043974368	78.27	2453	0.45	89.6	15.7
88	37791.3	43454.4	7923.2	60677709	0.79	1368	0.25	86.4	74.4
91	16965.7	22739.6	2128.9	221422	0.00	10	0.00	74.8	58.1
90	10289.9	27281.6	2116.4	60367601	0.78	2259	0.41	76.7	29.4
42	3419.6	4489.3	1825.2	6578532	0.09	1487	0.27	76.0	58.8
67	2916.6	4066.1	1733.3	697443	0.01	227	0.04	80.7	60.7
89	2755.5	5610.4	2342.1	429154	0.01	58	0.01	2.3	1.0
82	2676.1	4454.8	1159.7	13041314	0.17	2943	0.54	75.8	46.0
01	2525.4	3000.5	2128.9	440557	0.01	148	0.03	78.6	67.8
65	2425.9	2898.4	1480.7	366237	0.00	179	0.03	82.4	72.6
50	2394.9	2213.8	2128.9	14373	0.00	7	0.00	72.4	76.2
30	2387.0	10547.3	1340.7	9366451	0.12	971	0.18	43.5	10.8
97	2384.8	5930.8	840.0	7347488	0.10	1262	0.23	71.5	28.8
35	2331.4	20504.6	394.9	3085856	0.04	209	0.04	84.7	12.6
94	2301.8	5127.9	416.5	249053753	3.23	49424	9.03	90.4	43.6
61	2092.2	4216.5	1571.4	2342913	0.03	554	0.10	30.8	15.0
37	2088.6	18428.6	741.8	1889756	0.02	94	0.02	66.8	14.4
62	2058.6	3495.4	1629.3	3796473	0.05	1086	0.20	37.6	22.6
43	2057.3	4094.0	930.5	507452	0.01	126	0.02	63.4	35.0
84	2047.5	5083.5	1584.9	406063967	5.26	80261	14.66	21.5	8.7
Top 20	-	-	-	6870262819	88.97	145125	26.52	-	-

Note: The average airplane is based on the averages of the period 2005 to 2010. Time sensitivity is calculated as the share of air cargo transport (value or volume) in total transport (value or volume). See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on Eurostat (2012a,b).

Appendix 3: Cargo inspection at departure: an average airplane from South Africa to the EU

HS group	Air cargo				Time-sensitivity		Value-to-Weight		
	100KG	%	EUR	%	Air cargo/total		Total	Sea cargo	Air cargo
					% weight	% value			
							EUR/100KG		
TOTAL	547299	100.00	7721790993	100.00	0.1	37.8	41.4	21.8	14175.7
03	144916	26.48	58978532	0.76	24.9	28.2	356.6	339.2	403.5
08	94612	17.29	30273032	0.39	0.8	2.7	98.0	90.5	322.7
84	80261	14.66	406063967	5.26	8.7	21.5	2047.5	1584.9	5083.5
94	49424	9.03	249053753	3.23	43.6	90.4	2301.8	416.5	5127.9
06	33048	6.04	17687290	0.23	39.7	45.8	467.3	383.1	551.6
87	17323	3.17	25574957	0.33	1.8	3.1	901.0	818.4	1560.3
07	16739	3.06	6481197	0.08	9.6	38.3	93.7	59.1	387.4
72	12966	2.37	1300501	0.02	0.1	0.1	86.6	81.5	275.3
85	11701	2.14	105957392	1.37	6.1	33.5	1669.7	1084.6	9458.5
02	8407	1.54	8517570	0.11	25.8	31.4	832.9	752.3	1014.5
26	4422	0.81	457520230	5.93	0.0	35.6	17.4	10.8	396726.3
73	4072	0.74	3754222	0.05	0.8	5.7	129.4	121.5	938.8
Top ten	348206	63.62	716044923	9.27	-	-	-	-	-

Note: The top ten excludes HS84 and HS94 because they show up in appendix 2 as well. The average airplane is based on the averages for the period 2005 to 2010. Time sensitivity is calculated as the share of air cargo transport (value or volume) in total transport (value or volume). See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on Eurostat (2012a,b).

Appendix 4: List of products classified according to air cargo relevance

Non-air relevance (low value-to-weight and low time-sensitivity):

08 edible fruits and nuts, 09 coffee, tea, and spices, 10 cereals, 11 products of the milling industry, 12 oil seeds and oleaginous fruits, grains, plants, 14 vegetable plaiting materials, 16 preparations of meat, fish or crustaceans, 19 preparations of cereals, flour, 20 preparations of vegetables, fruit, nuts, plants, 21 miscellaneous edible preparations, 22 beverages, spirits and vinegar, 24 tobacco, 25 salt, sulphur, earths and stones, plastering materials, lime and cement, 27 mineral fuels, oils and products of their distillation, 29 organic chemicals, 31 fertilizers, 32 tanning or dyeing extracts and their derivatives, 34 Soap, organic surface-active agents, washing preparations, lubricating preparations, 39 Plastics and articles thereof, 40 Rubber and articles thereof, 44 Wood and articles thereof, 46 Manufactures of straw, of esparto or of other plaiting materials, basketware and wickerwork, 47 Pulp of wood or of other fibrous cellulosic material, 48 Paper and paperboard, 53 Other vegetable textile fibres, 54 Man-made filaments, 55 Man-made staple fibres, 56 Wadding, felt and nonwovens; special yarns; twine, cordage, 70 Glass and glassware, 72 Iron and steel, 73 Articles of iron or steel, 76 Aluminium and articles thereof, 78 Lead and articles thereof, 79 Zinc and articles thereof, 81 Other base metals, cermet, 86 Railway or tramway locomotives, rolling-stock and parts.

Low air relevance (high value-to-weight and low time-sensitivity):

04 Dairy produce; birds' eggs; natural honey, 13 Lac; gums, resins and other vegetable saps and extracts, 18 Cocoa and cocoa preparations, 51 Silk, 57 Carpets and other textile floor coverings, 66 Umbrellas, sun umbrellas, walking-sticks, 74 Copper and articles thereof, 75 Nickel and articles thereof, 87 Vehicles other than railway or tramway, 89 Ships, boats.

Medium air relevance (low value-to-weight and high time-sensitivity):

03 Fish and crustaceans, 07 Edible vegetables and certain roots and tubers, 17 Sugars and sugar confectionery, 26 Ores, slag and ash, 28 Inorganic chemicals, 38 Miscellaneous chemical products, 41 Raw hides and skins (other than furskins) and leather, 52 Cotton, 68 Articles of stone, plaster, cement, asbestos, and 93 Arms and ammunition.

High air relevance (high value-to-weight and high time-sensitivity):

01 Live animals, 02 Meat and edible meat offal, 05 Products of animal origin, 06 Live trees and other plants, 30 Pharmaceutical products, 33 Essential oils and resinoids; perfumery, cosmetic, 35 Albuminoidal substances; modified starches; glues; enzymes, 36 Explosives; pyrotechnic products, 37 Photographic or cinematographic goods, 42 Articles of leather; saddlery and harness, 43 Furskins and artificial fur, 45 Cork and articles of cork, 49 Printed books, newspapers, 50 Silk, 58 Special woven fabrics, 59 Impregnated, coated, covered or laminated textile fabrics, 60 Knitted or crocheted fabrics, 61+62 Articles of apparel and clothing accessories, 64 Other made up textile articles, 65 Footwear, gaiters, 67 Prepared feathers, artificial flowers, 69 Ceramic products, 71 Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation, jewellery; coin, 80 Tin and articles thereof, 82 Tools, implements, cutlery, 83 Miscellaneous articles of base metal, 84 Nuclear reactors, boilers, machinery and mechanical appliances, 85 Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, 88 Aircraft, spacecraft, and parts thereof, 90 Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof, 91 Clocks and watches, 92 Musical instruments, 94 Furniture; bedding, mattresses, 95 Toys, games and sports requisites, 96 Miscellaneous manufactured articles, 97 Works of art, collectors' pieces and antiques.

Note: Products according to harmonized system (HS) classification.

Source: own compilation based on Eurostat (2012a,b).

Appendix 5: The air cargo intensity of South Africa's trade with industrialized countries

	SA - EU			SA - US			SA - Japan		
	2005	2010	growth 2005-10	2005	2010	growth 2005-10	2005	2010	growth 2005-10
Exports									
Total	16,930	18,667	10.3	4893	7060	44.3	5149	6425	24.8
Non-air	43.5	37.8	-4.1	32.0	24.1	8.4	28.1	22.7	1.0
Low-air	8.2	13.2	77.3	7.2	27.6	454.0	23.7	8.4	-56.0
Medium-air	10.6	14.2	47.7	12.8	10.1	13.7	11.3	16.0	76.9
High-air	37.7	34.7	1.6	48.0	38.3	14.9	36.8	52.9	79.0
Imports									
Total	18,532	22,741	22.7	4,417	5,730	35.9	2,385	3,100	30.0
Non-air	20.8	27.2	60.8	20.1	24.4	65.1	11.9	12.5	36.3
Low-air	17.6	15.2	5.8	9.8	10.8	48.6	35.9	39.0	41.4
Medium-air	3.9	4.1	30.6	5.7	5.7	35.8	1.9	2.4	66.1
High-air	57.7	53.5	13.6	64.4	59.2	24.9	50.4	46.1	19.0

Note: Total trade figures in millions of USD excluding exports and imports of other commodities n.e.s. (HS 99). See appendix 1 and 4 for detailed information on product categories.

Source: Calculation based on ITC (2012).

Appendix 6: The air cargo intensity of South Africa's trade with BRICs

	SA - Brazil			SA - China			SA - India		
	2005	2010	growth 2005-10	2005	2010	growth 2005-10	2005	2010	growth 2005-10
Exports									
Total	318	717	125.6	1369	8132	494.2	1170	2981	154.7
Non-air	69.2	70.0	128.3	36.9	24.2	289.1	40.4	77.4	388.0
Low-air	1.9	0.7	-19.6	10.2	5.4	213.2	2.0	1.7	117.8
Medium-air	12.0	10.7	101.1	47.9	66.1	718.7	17.9	15.4	120.0
High-air	16.9	18.6	148.4	4.9	4.4	426.2	39.7	5.4	-65.4
Imports									
Total	956	1048	9.6	4926	11460	132.6	1075	2813	161.7
Non-air	32.4	29.5	-0.4	15.6	18.4	173.3	42.9	50.1	206.2
Low-air	14.3	11.9	-8.9	2.9	3.6	190.9	19.3	14.8	100.3
Medium-air	7.6	13.3	92.3	3.7	3.7	128.5	7.4	4.2	49.1
High-air	45.7	45.4	8.8	77.7	74.4	122.5	30.5	30.9	165.4

Note: Total trade figures in millions of USD excluding exports and imports of other commodities n.e.s. (HS 99). See appendix 1 and 4 for detailed information on product categories

Source: Calculation based on ITC (2012).