AIR FREIGHT AND MERCHANDISE TRADE: TOWARDS A DISAGGREGATED ANALYSIS

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Abstract

During the past 30 years, air cargo has evolved from a by-product to a potential profit centre for airlines. However, the success in the air cargo business depends on a number of factors. The evolution of world merchandise trade and particularly, the trade in high-value goods, is one of the determinants of the demand for air freight services. This paper provides an insight into the relationship between air cargo and merchandise trade on an aggregated as well as on a disaggregated level. Special attention is paid to the air cargo flows between major regions. By combining several levels of the air cargo market, this paper explains part of the economic rationality behind the air cargo market structure. The results of this paper will lead to a better knowledge of the air cargo sector, not only by academics but also by industry actors.

Keywords: air cargo, time series modelling, regional air freight flows, error correction model, international trade

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1. INTRODUCTION

With on-going globalization, air cargo transport has developed very rapidly during the past 30 years. Some time ago, air cargo was considered as a by-product of passenger transport. Currently, however, it is gaining importance and a number of airlines specialized themselves in the air cargo business. Furthermore, a number of (smaller) airports now consider air cargo as their core business. At the same time, a number of industrial-economic evolutions took place in the sector, such as co-operation agreements.

As a product, air cargo is heterogeneous. There is the traditional air cargo on the one hand, transported in full freighters or passenger airplanes' belly, and express cargo on the other hand. Strictly separating both, however, is artificial, since there are overlaps. The increasing importance of full-freighter transport results from a combination of various factors: insufficient freight capacity linked to more severe security regulation aboard passenger planes, a tendency towards consolidation and scale increase, and the important imbalance between some incoming and outgoing air cargo flows.

For the volume of air cargo, measured in tonne kilometres, one can differentiate between potential and realized air cargo. Potential air cargo volumes can be seen as the demand for air cargo which is determined by economic activity and particularly by trade. Thus, when analyzing the macro-economic characteristics of air cargo it is also necessary to get an insight into the relationship between air cargo, economic activity and trade, which is the objective of this paper. Next to the potential air cargo volumes, realized air cargo or the supply of air cargo, can be considered. Air cargo supply is determined by micro-economic aspects, influencing the strategies of cargo airlines. The supply of air cargo is influenced in particular by available capacity, competition from other modes, especially maritime container transport, and the costs and yields of the cargo airlines which are also determined by their competitive position in the sector. For airline companies, additional profit can be generated by filling unused belly capacity with cargo. Cargo yield, which traditionally has been below that of passenger transport, has improved over the last couple of years, approaching that of passenger transport. This paper focuses on the macro-economic aspects of air cargo.

More specifically, this paper aims at studying the relationship between air cargo and merchandise trade on a disaggregated level, focusing on one of the most important routes for air freight. The disaggregated analysis is combined with previous research done on an aggregated level to explain the economic rationality behind the air cargo sector.

Section 2 provides an insight into the most important trends in the air cargo market on an aggregated level. More particularly, the evolution of worldwide air freight traffic, the imbalances in air cargo and trade flows and the most important goods categories shipped by air freight are discussed. In section 3 the focus lies on the relationship between air cargo and merchandise trade on a worldwide level. A time series model using co-integration theory and an error correction model is used to discover the underlying factors that influence the development of air cargo. A disaggregated analysis of the relationship between air cargo and trade on route level is carried out in section 4. Section 5 summarizes the most important conclusions of this research and makes a suggestion for further research in this area.

2. TRENDS IN THE AIR CARGO BUSINESS

2.1. EVOLUTION OF WORLDWIDE AIR FREIGHT

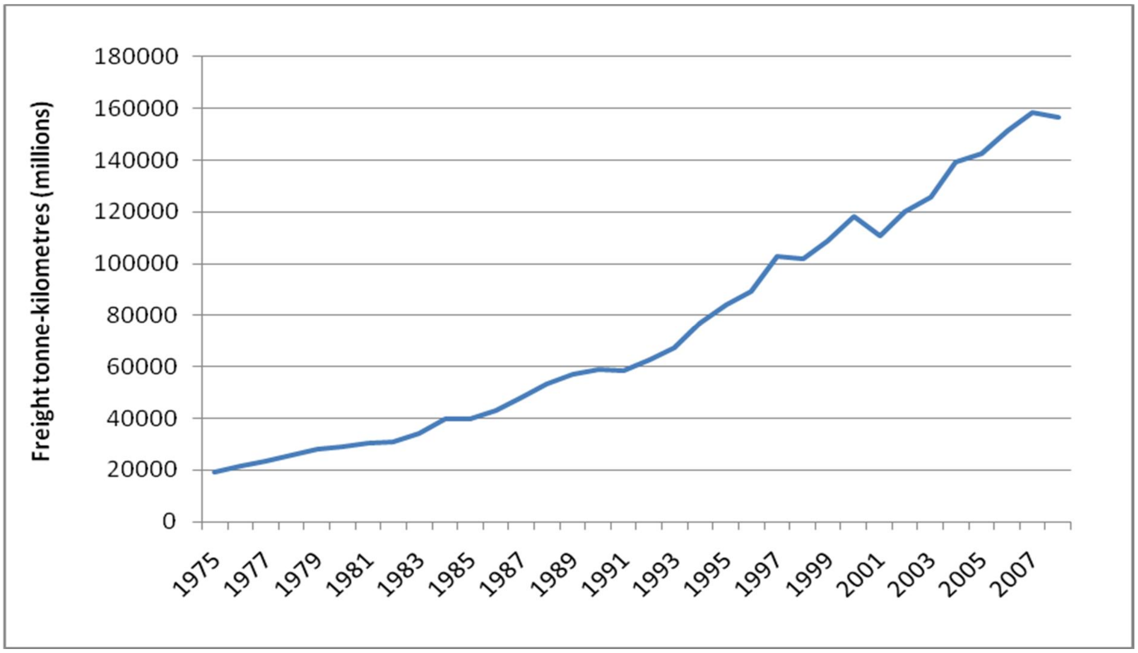
Figure 1 shows how worldwide air freight transport evolved from 1975 to 2008. It is clear from this figure that there was a strong increase in air freight during this period: from about 20 000 million FTKs in 1975 to 156 000 million FTKs[5] in 2008. The growth in FTKs is mainly due to the growth in freight tonnes carried, which increased stronger than the freight kilometres performed between 1975 and 2008. This strong growth of worldwide air freight results from a number of crucial developments at the demand and supply side of the (liberalised) international air freight market: a growing world trade, technological progress, increasing value/weight rate of goods, downward pressure on air freight yields, changing production processes (e.g. JIT, Make to Order), strategic importance of e-services, etc. The graph also illustrates the traffic decreases in 2001 and 2008 due to the September 11 effect and the worldwide economic crisis respectively. In section 3, it will be investigated which factors in the global economy are driving the demand for air freight.

2.2. AIR FREIGHT AND TRADE IMBALANCES

While passengers normally make a two-way journey, air cargo is carried in only one direction: from production to distribution or consumption centres. This results in imbalances between incoming and outgoing cargo flows. These imbalances are influenced by export/import imbalances between regions or countries and may result in large variations in air cargo rates according to the traffic direction. (Zhang and Zhang, 2002, p. 179)

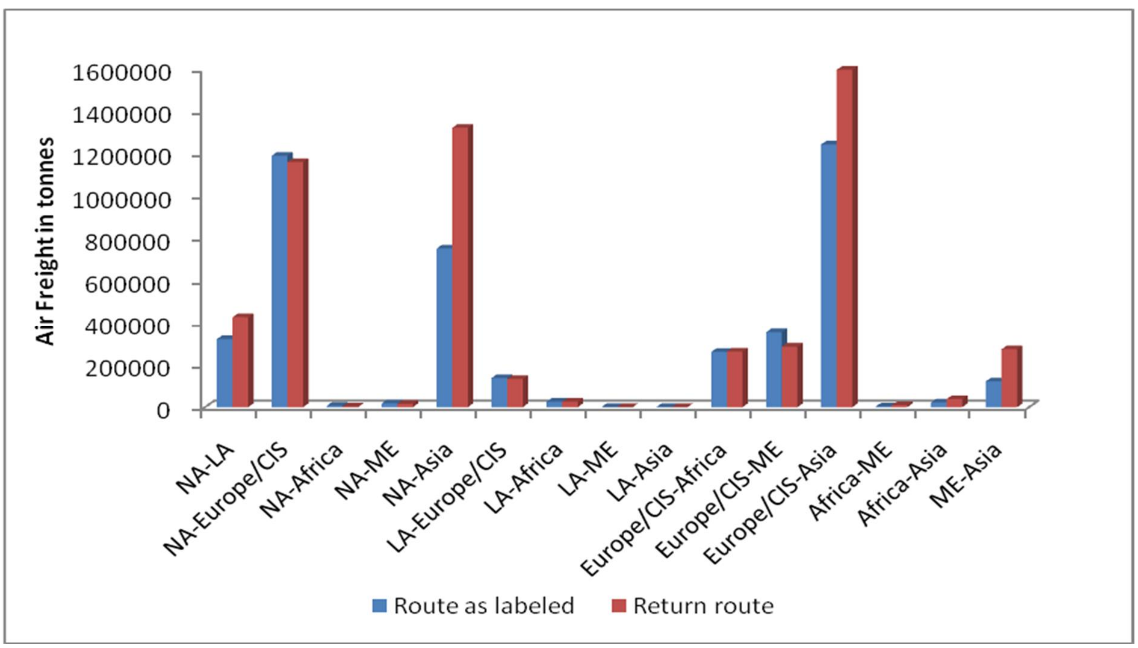
[5] A FTK is a Freight Tonne-Kilometre.

Figure 1: Evolution of Worldwide Air Freight Traffic in FTKs (millions), 1975-2008



Source: ICAO Journal, 1987-2006; ICAO Annual Report of the Council, 2008-2009

Figure 2: Air Freight Imbalances on Worldwide Routes (2008)



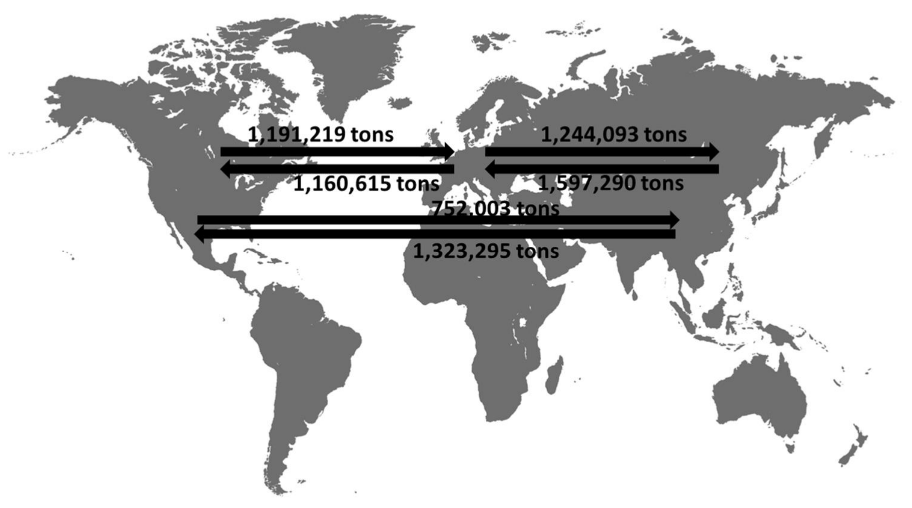
Source: own calculations based on ICAO TFS data

Figure 2 gives an overview of imbalances in air cargo flows between selected regional markets in 2008. The regional air freight volumes are calculated based on Traffic by Flight

Stage (TFS) data from ICAO. The figure shows that the most important routes[6] in terms of air cargo traffic are North America – Asia, Europe/CIS – Asia and North America – Europe/CIS. It is also clear from the figure that North America – Asia and Europe/CIS – Asia are the routes with the largest imbalance between incoming and outgoing air cargo flows. Between North America and Europe/CIS there is only a very small imbalance.

Figure 3 gives an overview of the air freight volumes in both directions on the three most important routes in terms of air freight. However, comparing[7] these inter-continental routes with the intra-continental air cargo traffic (see figure 4), it can be seen that even more goods are transported intra-continental than between the continents. Furthermore, it is also clear that there are large differences between continents regarding intra-continental traffic. Asia and North America for example generate enormous air cargo traffic flows while continents such as Africa and South America have rather small intra-continental traffic.

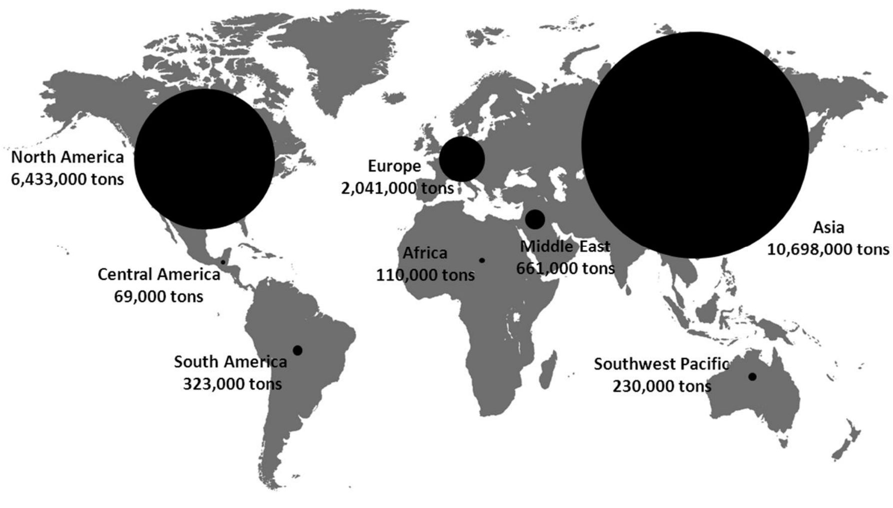
Figure 3: Air Freight Volumes on the Three Most Important Routes in Terms of Air Freight (2008)



Source: own calculations based on ICAO TFS data

[6] For the definition of the regions see Annex. Due to methodological reasons, Europe and the Commonwealth of Independent States were seen as one region.
[7] The comparison between figures 3 and 4 gives a good idea about the relation between inter- and intra-continental air cargo traffic. However, the interpretation of these figures should be done carefully since two different data sources were used.

Figure 4: Intra-Continental Air Freight Traffic (Domestic and International, 2008)



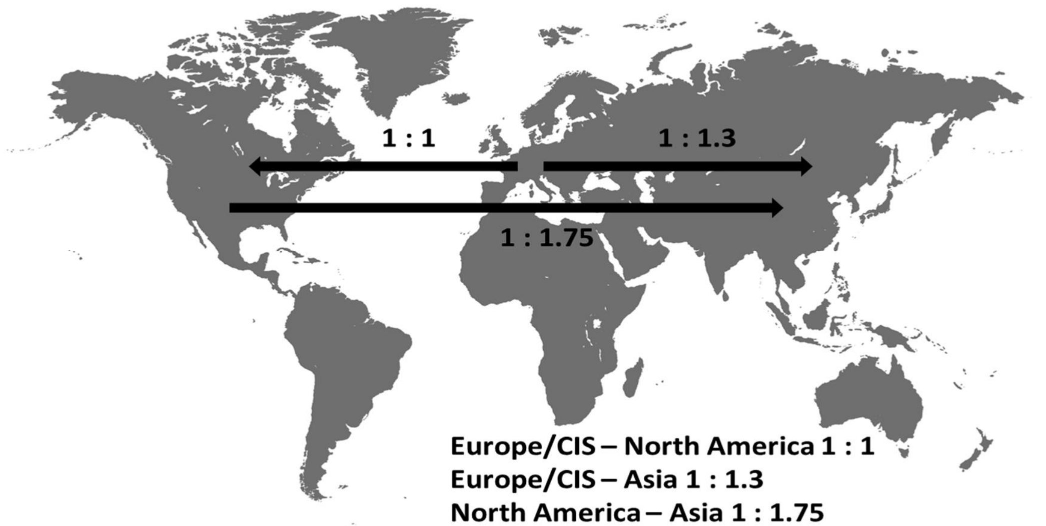
Source: IATA, World Air Transport Statistics, 2008

In figure 5 the air freight imbalances on the major routes in 2008 are expressed as export/import tonnages. Since the objective of this paper is to examine the relationship between air freight and trade on a disaggregated level, also regional trade flows are looked at. Figure 6 depicts the merchandise trade flows (in billion US$) between the three major routes in terms of air freight. These routes are also the most important ones in terms of trade value. There are trade imbalances on each of these routes. The route North America – Asia shows the largest imbalance. In section 4, the relationship between air cargo and merchandise trade is estimated for the route Europe/CIS – Asia.

2.3. COMMODITIES SHIPPED BY AIR FREIGHT

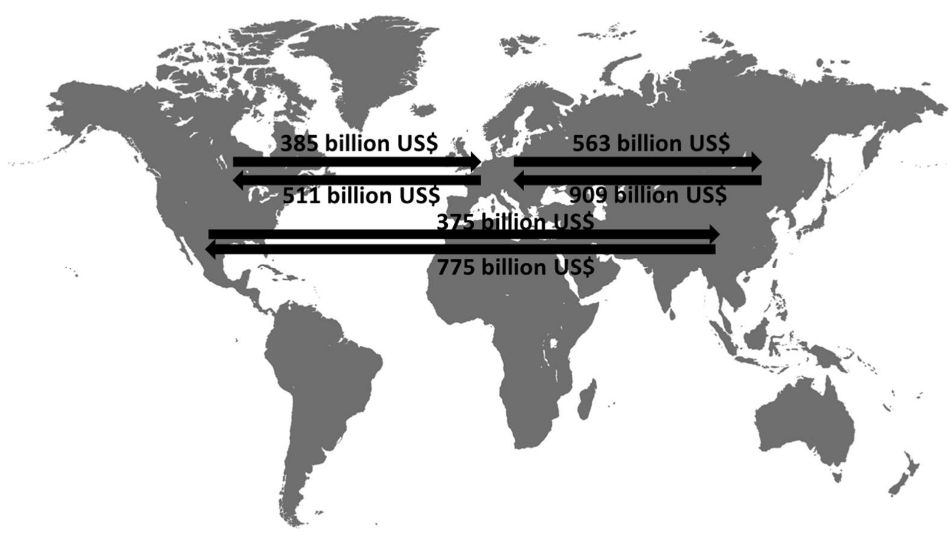
Table 1 represents the most important goods categories transported by air freight for different geographical markets in 2007. On a worldwide level, high-tech products represent the largest share. There are large differences between markets, e.g. the share of capital equipment in the air exports from Europe (EU-AS and EU-NA) is higher than its share in the air exports from North America (NA-EU and NA-AS). Capital equipment is the most important goods category in all the air exports from Europe. This difference is explained by the strength of European manufacturers of industrial machinery. (Clancy and Hoppin, 2006)

Figure 5: Export/Import Air Freight Tonnage Ratio[8] for the Three Most Important Routes in Terms of Air Freight (2008)



Source: own calculations based on ICAO TFS data

Figure 6: Merchandise Trade on Major Routes (2008)



Source: own calculations based on WTO data

[8] Explanation of export/import tonnage ratio: e.g. Europe/CIS to Asia, 1 : 1.3 – for every ton exported from Europe/CIS, 1.3 tons are imported back via airfreight.

The air exports from North America to Latin America are dominated by high-tech products. For its exports to Europe and Asia, high-tech products and capital equipment are the most important goods categories with only a small difference between them. Asia's air exports to Europe and North America, which are the largest air freight markets, mainly consist of high-tech products. These are also dominant in the intra-Asian air cargo traffic. The share of refrigerated foods in the freight traffic from Latin America to North America (LA-NA) is strikingly large.

Table 1: Commodity Share of Directional Air Freight Markets in 2007
(share of FEU[9]-kilometres, billions of FEU-kilometres)

	World	AS-EU	EU-AS	AS-NA	NA-AS	Intra-Asia	EU-NA	NA-EU	LA-NA	NA-LA
Billions of FEU-km	15.24	2.79	1.53	2.98	1.13	1.60	0.80	0.67	0.42	0.39
Refrigerated foods	5%	1%	3%	1%	4%	5%	3%	3%	41%	2%
Non-refrigerated foods	1%	0%	1%	0%	1%	1%	1%	1%	8%	0%
Consumer products	16%	22%	14%	15%	13%	16%	19%	15%	9%	16%
Apparel, textiles, footwear	17%	25%	9%	31%	3%	15%	12%	3%	19%	5%
High tech products	27%	32%	19%	36%	28%	35%	18%	24%	10%	36%
Capital equipment	19%	10%	37%	11%	26%	15%	32%	27%	6%	24%
Intermediate materials	12%	8%	15%	6%	21%	11%	14%	23%	4%	14%
Primary products	2%	2%	3%	0%	4%	2%	2%	3%	3%	3%

Source: Based on MergeGlobal world air freight supply and demand model, MergeGlobal Value Creation Initiative, 2008, p.36.

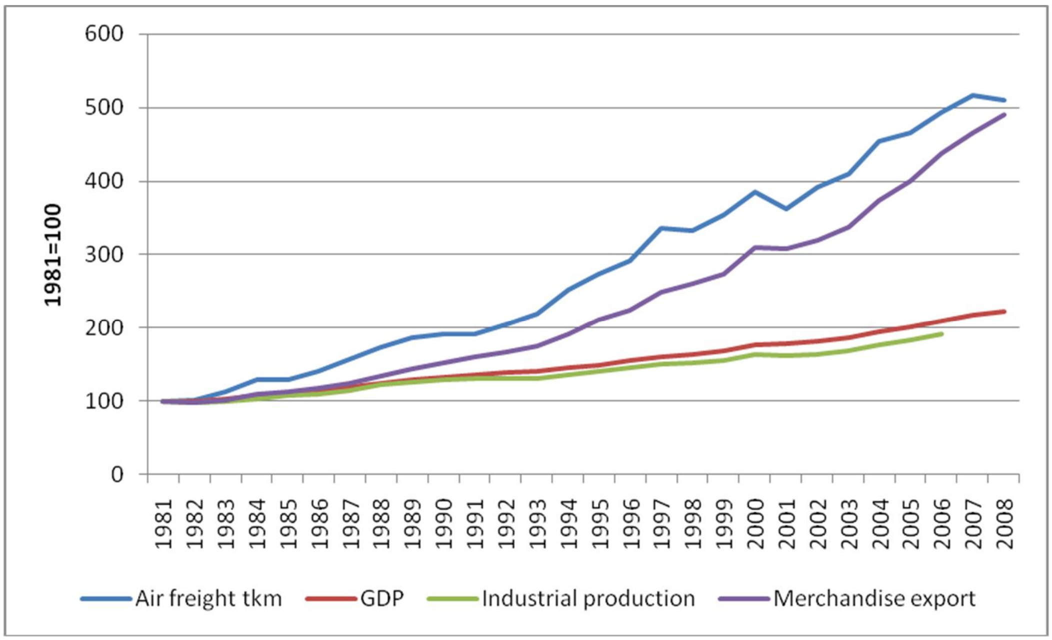
3. WORLD AIR FREIGHT AND MERCHANDISE TRADE[10]

As for general freight transport, also air freight is the result of economic activity. Traditionally the world demand for freight transport is related to world GDP. This relationship seems to work rather well for total freight flows, but is less straightforward for air cargo. One of the problems is that GDP is made up increasingly of services. According to the World

[9] A FEU is a forty-foot equivalent unit (2 TEUs).
[10] Based on Kupfer et al. (2010)

Development Indicators of the World Bank the share of services in total world value added was 53% in 1970 and reached nearly 70% in 2006. The evolution of GDP is therefore more and more driven by the services sector and less by activities which may generate air cargo. Sometimes the evolution of the world industrial production is suggested as an alternative for GDP to forecast trends in air freight cargo, but even this is a weak indicator. This is not only illustrated by figure 7, but can also be statistically formalized by using co-integration theory.

Figure 7: World Air Freight in TKM and World Economic Activity



Sources: Air freight in tkm: ICAO, GDP in constant USD of 2000: World Bank, Industrial Production: industry value added in constant USD of 2000: World Bank, Merchandise exports in USD of 2000: World Bank and IMF

One of the major problems in analysing time series which all show an upward trend, is to find out whether this trend is deterministic or stochastic[11]. This is traditionally done by unit root and/or stationarity tests. Time series with a deterministic trend are stationary and can be related to each other by simple ordinary least squares regressions taking into account the deterministic trend. Time series with stochastic trends and which are therefore not stationary can only be related to each other by a regression equation if they are co-integrated, which means that they should have a common trend. The seminal work of Nobel Prize winners Engle & Granger treats this in detail and Granger's Representation theorem states that co-

[11] Detailed information on testing unit roots, stationarity and co-integration can be found in a number of econometric handbooks such as Hamilton (1994), Hayashi (2000), Verbeek (2008), Franses (1998).

integrated series are related to each other by means of a very specific dynamic model, the error-correction model (ECM), which models the long run equilibrium relation between co-integrated series and the short run adjustments towards this equilibrium relationship. If non-stationary time series are not co-integrated, they cannot be represented by a simple regression and there is no long run equilibrium relation between them. Only their short term behaviour can be modelled in a statistically reliable way.

The first step in the analysis is to discover whether the trend in the time series under consideration is stochastic or deterministic. Traditionally this is tested by means of the following tests: Dickey-Fuller (DF), augmented Dickey-Fuller (ADF), Dickey-Fuller with de-trending (DFGLS), Phillips-Perron (PP), Kwiatkowski, Phillips, Schmidt, and Shin (KPSS), Elliot, Rothenberg, and Stock (ERS), and Ng-Perron (NP). If the time series have a stochastic trend, the next step is to test whether they are co-integrated or not. There are several tests for co-integration: Engle-Granger 2-step approach, Engle-Granger-Yoo 3-step approach, the dynamic ordinary least squares (DOLS) developed by Stock & Watson, the unrestricted ECM approach, and the Johansen co-integration test. Finally, if the series are co-integrated, their relation can be represented by an error correction model. If they are not co-integrated, there is no long run equilibrium relation which ties the series together.

Unit roots tests for world air freight in tkm (TKM), world GDP in constant prices (GDP), and world industrial production in constant prices (IP) revealed a stochastic trend in the series whether they were measured in levels or in logarithms. Several co-integration tests were applied indicating no co-integration between TKM and GDP, and between TKM and IP. This leads to the conclusion that there is no long run equilibrium relation between world air freight on the one hand and world GDP or world industrial production on the other hand.

As air cargo consists mainly of international traffic of high value goods, the evolution of world air freight can be better explained by an indicator for world international trade in high value goods. This is approximated by the volume of world merchandise exports (MERCH) as a global indicator of international trade in combination with the share of manufactures in the total value of merchandise exports (SHAREMANU)[12]. An increase of the latter can be the result of an increasing share of manufactures in the volume of merchandise trade, an

[12] As an alternative the share of office and telecom equipment in the value of total merchandise exports was considered but this was rejected as this resulted in multi-collinearity due to the high correlation with the evolution of the volume of merchandise exports.

increase of the value of the manufactures, or a combination of both. All co-integration tests indicated that TKM, MERCH and SHAREMANU are co-integrated. For the error correction specification, the best results were obtained with the logarithm of TKM and MERCH and by adding a dummy variable for the crisis in 1991 induced by the higher oil prices and the Gulf War (DUM91), a dummy variable for the structural impact of 9/11 (DUMBREAK), and a dummy for the impact of the financial crisis of 2007 the consequences of which became clear from 2008 onward (DUM2008).

This gives the following ECM model:

$$\begin{aligned}&\Delta \ln TKM_t = \beta_1 \Delta \ln MERCH_t + \beta_2 \Delta SHAREMANU_t + \beta_3 \Delta DUM91_t + \beta_4 \Delta DUMBREAK_t + \\ &+\beta_5 \Delta DUM2008_t + \delta(\ln TKM_{t-1} - \alpha_0 - \alpha_1 \ln MERCH_{t-1} - \alpha_2 SHAREMANU_{t-1} - \alpha_3 DUM91_{t-1} - \\ &-\alpha_4 DUMBREAK_{t-1} - \alpha_5 DUM2008_{t-1}) + \varepsilon_t\end{aligned} \quad (1)$$

Where:

TKM	world air freight in tkm (ICAO)
MERCH	world merchandise export in USD of 2000 (World Bank and IMF)
SHAREMANU	share of manufactures in the value of world merchandise exports
DUM91	=1 in 1991
	=0 in other years
DUMBREAK	=1 from 2001
	=0 before 2001
DUM2008	=1 from 2008
	=0 before 2008

Δ are first differences, ln indicates logarithms, and ε is the stochastic error term.

The long run equilibrium relation is given by

$$\ln TKM_t = \alpha_0 + \alpha_1 \ln MERCH_t + \alpha_2 SHAREMANU_t + \alpha_3 DUM91_t + \alpha_4 DUMBREAK_t + \alpha_5 DUM2008_t \quad (2)$$

Table 2: DOLS Estimation of the Long Run Relationship between World Air Freight and World Merchandise Exports

Sample (adjusted): 1983 2007
Included observations: 25 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=2)

		Coefficient	Std. Error	t-Statistic	Prob.
C	α_0	-0.352621	0.205264	-1.717892	0.1115
LNMERCH	α_1	0.977122	0.048301	20.22985	0.0000
SHAREMANU	α_2	1.010488	0.199940	5.053954	0.0003
DUM91	α_3	-0.066246	0.030391	-2.179768	0.0499
DUMBREAK	α_4	-0.070223	0.031744	-2.212168	0.0471
DLNXMERCH(1)		0.130266	0.330227	0.394475	0.7002
DSHAREMANU(1)		0.333607	0.610623	0.546339	0.5948
DDUM91(1)		-0.003808	0.016517	-0.230561	0.8215
DDUMBREAK(1)		-0.027513	0.046033	-0.597672	0.5612
DLNXMERCH(-1)		-0.074783	0.340557	-0.219589	0.8299
DSHAREMANU(-1)		-0.056812	0.394483	-0.144017	0.8879
DDUM91(-1)		-0.009554	0.019449	-0.491236	0.6321
DDUMBREAK(-1)		0.013636	0.033163	0.411179	0.6882

R-squared	0.997715	Mean dependent var	5.557736
Adjusted R-squared	0.995430	S.D. dependent var	0.466625
S.E. of regression	0.031543	Akaike info criterion	-3.768893
Sum squared resid	0.011940	Schwarz criterion	-3.135078
Log likelihood	60.11117	Hannan-Quinn criter.	-3.593100
F-statistic	436.6806	Durbin-Watson stat	1.810744
Prob(F-statistic)	0.000000		

As the sample is rather small, the long term co-integrating relation is estimated using the Stock-Watson DOLS-method (Stock & Watson, 1988, 1993). The results are reported in table 2. As a consequence of this estimation method the adjusted sample ends in 2007 which means that the impact of DUM2008 could not be estimated in the long run relationship.

The short run adjustments are estimated given the DOLS-estimates for α_0, ..., α_4 and are reported in table 3.

The error correction model reveals that the change in world air freight is due to the current change in world merchandise exports, the current change in the share of manufactures and an error correction term which is an adjustment to deviations from the long run equilibrium in the previous period. The adjustment speed, which is given by δ=-0.75 is rather high.

Table 3: Error Correction Model for World Air Freight and World Merchandise Exports

Dependent Variable: D(LNTKMICAO)
Method: Least Squares
Sample (adjusted): 1984 2008
Included observations: 25 after adjustments

		Coefficient	Std. Error	t-Statistic	Prob.
DLNMERCH	β_1	1.0817	0.0765	14.1462	0.000
DSHAREMANU	β_2	0.6820	0.2881	2.3673	0.028
DDUM91	β_3	-0.0832	0.0260	-3.1958	0.004
DDUMBREAK	β_4	-0.0437	0.0181	-2.4193	0.025
DDUM2008	β_5	-0.0603	0.0277	-2.1745	0.041
RESIDLONGRUN(-1)	δ	-0.7483	0.1627	-4.5983	0.000

R-squared	0.7885	Mean dependent var	0.0604
Adjusted R-squared	0.7381	S.D. dependent var	0.0499
S.E. of regression	0.0255	Akaike info criterion	-4.3036
Sum squared resid	0.0137	Schwarz criterion	-4.0156
Log likelihood	64.0985	Hannan-Quinn criter.	-4.2180
Durbin-Watson stat	1.7659		

with

RESIDLONGRUN = lnTKM + 0.353 - 0.977*lnMERCH - 1.0105*SHAREMANU + 0.066*DUM91 + 0.070*DUMBREAK

The elasticity of air freight with respect to merchandise exports is not significantly different from 1 neither in the long run equilibrium relation, nor in the short run adjustment. So a one per cent change in world merchandise exports will result in a one per cent change in air freight. An increase of the share of manufactures in the value of merchandise exports with one percentage point, will lead in the long run to a one per cent increase in air freight as α_2 is not significantly different from 1. In the short run the impact will be smaller than 1. There has clearly been a negative impact in 2001 as a consequence of 9/11 which has led to a structural downward shift in air freight. Figure 8 gives the actual value of air freight (in logarithms) and the fitted values calculated with the estimated error correction model within the sample for the years 1984-2008.

The driving force behind world air freight evolutions is clearly merchandise trade and especially the trade share of manufactures. This means that forecasts of world air freight will rely heavily upon the future evolutions of factors affecting trade, which can be grouped as illustrated in Figure 9.

Figure 8 – Actual and Fitted Air Freight Values

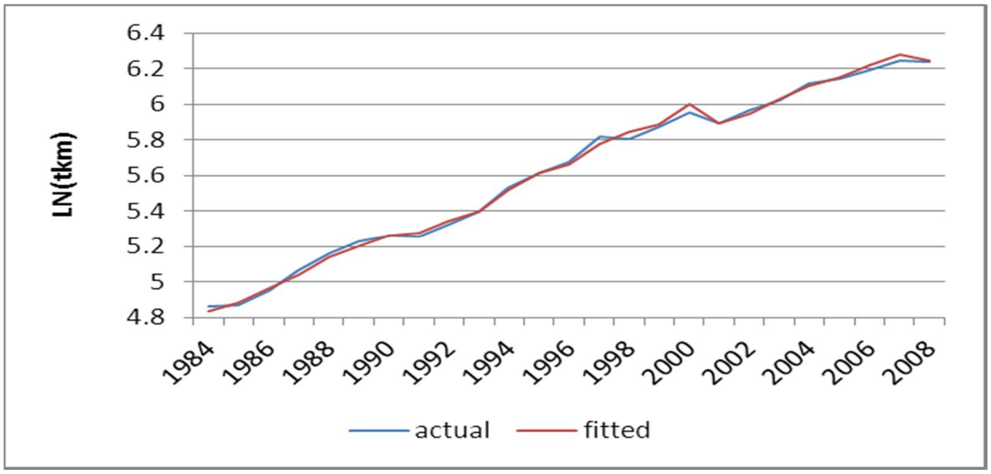
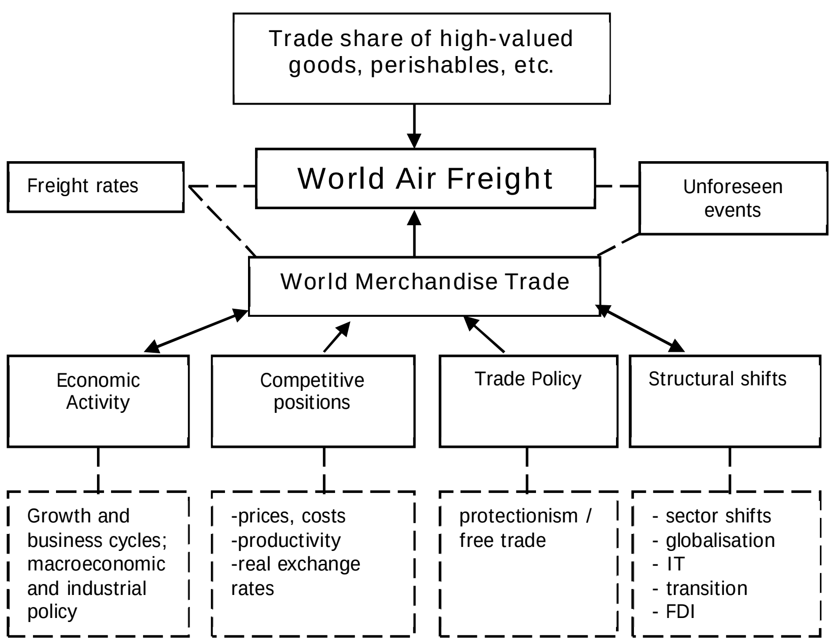


Figure 9: Factors affecting World Air Freight and World Merchandise Trade



Factors stimulating economic activity will, ceteris paribus, lead to more trade whereas slowdowns of economic growth will also hamper international trade. Shifts in the international competitive position of countries do not necessarily entail changes in the total volume of world trade but will have an impact on the trade pattern. The reduction or abolition of protectionist policy measures and the stimulation of free trade will not only increase world trade, but will also have an impact on the trade directions. Finally, there are a number of structural shifts which have consequences for world merchandise trade.

Although some general trends can be recognised, there remains a lot of uncertainty on a number of factors which will impact the world economy:

- Will globalisation continue at the same pace or will trade be sculpted by a new regionalism?
- Will economic policy stimulate free trade or will there remain some protectionist attitude?
- Will the emerging economies be able to decouple fully from the North or will the world economy also in the future continue to be dominated by the United States?
- Will trade imbalances continue to exist at the same magnitude as they are today?
- What policy measures will be taken to come to a more sustainable economic growth?
- Will Europe be able to cope with its ageing population?
- What will be the role of the public sector not only specifically for airport infrastructure investment, but also generally to support a social economy?
- How will oil prices evolve over time?
- What are the perspectives for the poorest among the poor, especially sub-Saharan Africa?
- Etc.

These open questions will have an impact on world and regional economic growth and on the magnitude and direction of the trade flows of the different commodities. It might be worthwhile to include the transport price of air freight and of the best alternative, i.e. maritime shipping, in the analysis. At the supply side there is room for investigating the effect of oil price changes and capacity adjustments, and the way individual airlines adjust their strategy in order to determine their competitive position. Moreover, due to the imbalances on trade routes, resulting in imbalances between incoming and outgoing cargo flows, an analysis of the air cargo market on a disaggregated level is needed. This is the aim of the next section.

4. A DISAGGREGATED ANALYSIS

The ECM and the long run relationship showed that there is a link between air freight and trade on world level. However, due to the imbalances and differences between routes that were discovered in section 2.2 of this paper, the question arises whether the relationship between air freight and trade is also valid on a disaggregated level. A first step in answering this question was to analyse the relationship on a route basis. As the route between Asia and Europe/CIS[13] is one of the most important air freight routes and significant growth on this route is expected in the future, it was decided to concentrate on this route.

As merchandise exports and the share of manufactures in merchandise trade were found to be significant in the aggregated analysis, the analysis was first carried out with those two explanatory variables. However, as the share of manufactures in merchandise trade turned out not to be significant, the export in manufactures in USD of 2000 was used as explanatory variable. This can be motivated with the goods categories included in trade in manufactures, such as iron and steel, chemicals, other semi-manufactures, machinery and transport equipment, textiles, clothing, which better reflect the goods transported by air than merchandise export.

A pooled regression analysis was used as this, first of all, gives more efficient estimators. Moreover, because the number of observation is already limited, a pooled regression analysis has the advantage to leave more degrees of freedom to work with.

Finally, this leads to the most general form for a pooled regression analysis between air freight and trade in manufactures:

$$\ln(AIR_i) = \gamma_0 + \gamma_{1,i} + \gamma_{2,i}\ln(MANU_i) + \varepsilon_i \qquad (3)$$

where

i = 1 for Asia to Europe/CIS

i = 2 for Europe/CIS to Asia

$\varepsilon_i \sim IID(0, \sigma^2_\varepsilon)$, ln indicates logarithms and ε is the stochastic error term.

AIR: Air freight in tons[14] , MANU: Export in manufactures in USD of 2000[15]

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[13] For the definition of the regions see Annex. Due to methodological reasons, Europe and the Commonwealth of Independent States were seen as one region.

[14] Own calculations based on ICAO TFS data

[15] Own calculations based on WTO, IMF and World Bank data

The results of the regression analysis are shown in table 4.

The results of the disaggregated regression analysis reveals that the elasticity of air freight with respect to trade in manufactures for both routes is higher than on world level. This difference, however, arises due to the disaggregated nature of the analysis on route level. On world level, routes with high as well as low elasticity's were included which compensated each other to result in a kind of average elasticity.

Table 4: Pooled Results on the Routes between Asia and Europe/CIS

Dependent Variable: LN(AIR)
Method: Pooled Least Squares
Sample: 1999 2008
Included observations: 10
Cross-sections included: 2
Total pool (balanced) observations: 20

Variable		Coefficient	Std. Error	t-Statistic	Prob.
C	γ_0	4.750341	0.599811	7.919731	0.0000
LN($MANU_1$)	$\gamma_{2,1}$	1.446654	0.119539	12.10189	0.0000
LN($MANU_2$)	$\gamma_{2,2}$	1.733240	0.180884	9.582035	0.0000
Fixed Effects (Cross)					
C_AE	$\gamma_{1,1}$	0.555841			
C_EA	$\gamma_{1,2}$	-0.555841			

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.939180	Mean dependent var	13.63152
Adjusted R-squared	0.927776	S.D. dependent var	0.394437
S.E. of regression	0.106003	Akaike info criterion	-1.473839
Sum squared resid	0.179787	Schwarz criterion	-1.274693
Log likelihood	18.73839	Hannan-Quinn criter.	-1.434964
F-statistic	82.35665	Durbin-Watson stat	1.656708
Prob(F-statistic)	0.000000		

Additionally, table 4 shows that the elasticity between air freight and trade in manufactures differs between the routes. As the difference is not very large, the Wald test was applied to see whether the difference between the coefficients $\gamma_{2,1}$ and $\gamma_{2,2}$ is significantly different from zero. However, the null hypothesis ($\gamma_{2,1} = \gamma_{2,2}$) can neither be rejected nor accepted, which is why it was decided that for the analysis it is assumed that coefficients for both routes are not the same. Moreover, the difference in the elasticity can be explained by the fact that the percentage of high valued goods in the exports of manufactures from Europe to Asia is higher than in exports of manufactures from Asia to Europe. As especially high-valued goods are transported by air, it is thus likely that the elasticity between air freight and trade in manufactures is higher on the route between Europe and Asia than on the return route.

Figure 10 and 11 show the actual values of air freight and the fitted values calculated with the disaggregate model. Especially on the route from Asia to Europe/CIS there is still room for improvement in the model. In general, we see that the model fit on route level is not as good as on world level. The problem on route level is that not necessarily all goods categories belonging to the manufactures are transported by air. Goods as for example paper, iron and steel and fertilizers are transported rather by sea than by air. In contrast to the route level, on the aggregated world level, routes where a high percentage of trade in manufactures is transported by air were aggregated with routes where the percentage is relatively small. However, on route level we do not have this compensation. To get more accurate results the next step would be to not only look at the trade in manufactures on the routes but also to analyse the specific configuration of air freight on those routes, to eventually be able to find a better proxy for trade than that of trade in manufactures.

Figure 10: Actual and Fitted Air Freight Values for Europe/CIS – Asia

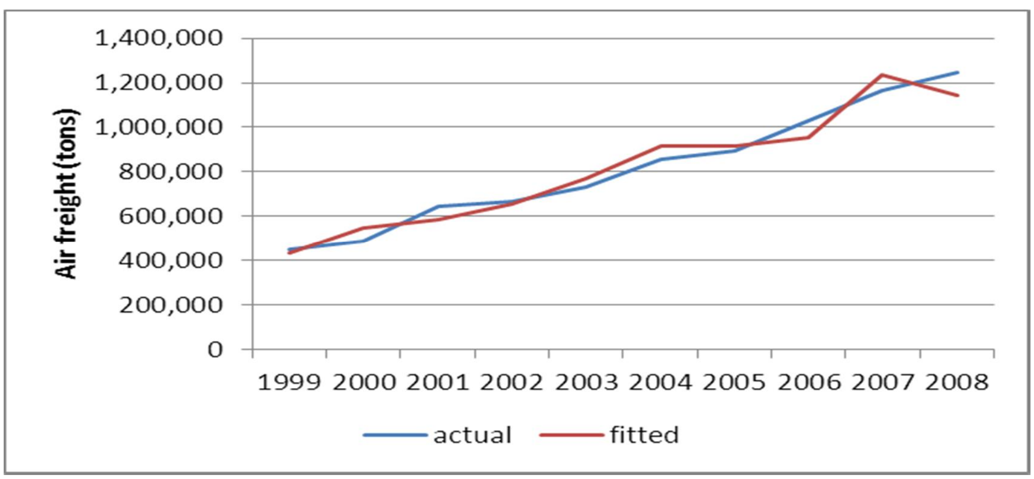
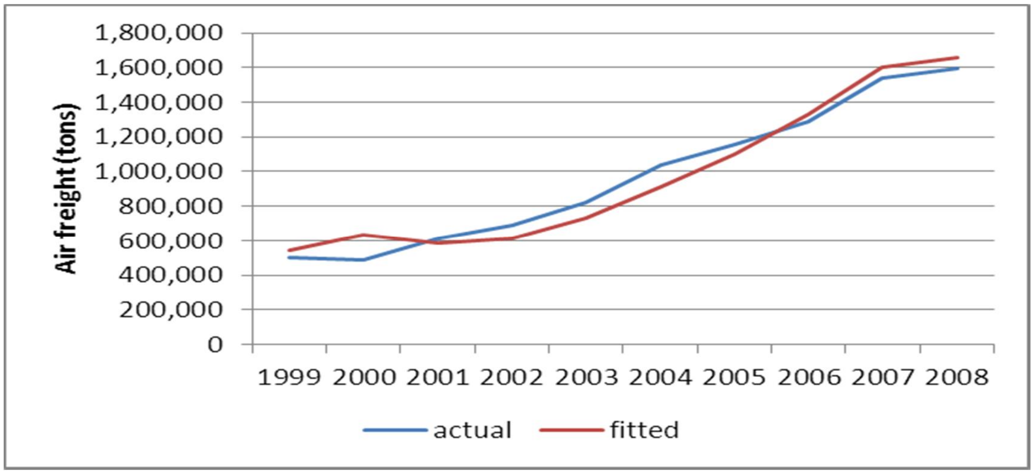


Figure 11 – Actual and Fitted Air Freight Values for Asia – Europe/CIS



5. SUMMARY AND CONCLUSIONS

Air freight transport has developed very rapidly over the last decade. While previously, air cargo was regarded as a by-product of passenger transport, a lot of traditional carriers consider it now as an instrument that adds positively to the ultimate goal of profit maximization. In addition, a number of carriers and airports became specialists in the air cargo market. Their success or failure depends on a number of factors. The future evolution of world merchandise trade is crucial and especially the trade in high value goods needs close monitoring. Special attention should be paid to the imbalances on trade routes, which results in imbalances between incoming and outgoing cargo flows.

The disaggregated analysis for the routes between Europe/CIS and Asia shows a strong positive relationship between air freight and trade in manufactures in both directions. The elasticity between air freight and trade, however, was found to be higher on the route from Europe to Asia than on the return route. However, the problem on route level that was encountered is that not necessarily all goods categories belonging to the manufactures are transported by air. Goods as for example paper, iron and steel and fertilizers are transported rather by sea than by air. In contrast to the route level, on the aggregated world level, routes where a high percentage of trade in manufactures is transported by air were aggregated with routes where the percentage is relatively small. On route level, on the other hand, we do not have this compensation. Therefore, in a next step, it would be interesting to look at the specific commodities shipped by air freight on route level, in order to study the relationship between the trade in those specific goods and the air freight volumes on a certain route. In addition, the disaggregated analysis should be carried out for other routes that are important for air freight, e.g. the routes between North America and Asia and those between North America and Europe/CIS. Moreover, further research should include the fact that air cargo carriers often fly in triangles in order to improve their average load factor.

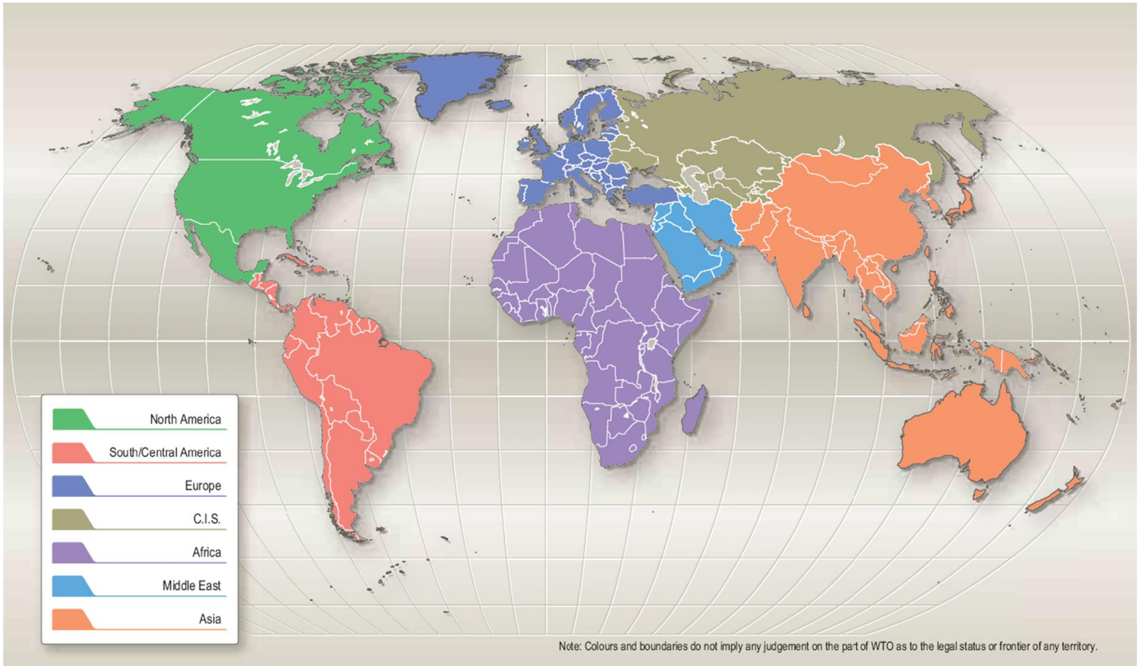
Furthermore, it should be mentioned that the analysis in this paper has been focused on the demand side of air freight. A change in demand can, however, also have repercussions on the supply side of air transport. To have a better understanding of the commercial side of the air transport business an in-depth analysis of individual carriers at business economic level should be carried out, e.g. on the way cargo yield and profitability are influenced by changes in demand and supply for air cargo.

REFERENCES

- Clancy, B. and Hoppin, D. (2004), 'After The Storm – The MergeGlobal 2004-2008 World Air Freight Forecast', *Air Cargo World*, 94 (5), 22-53.
- Franses, P.H. (1998), *Time series models for business and economic forecasting,* Cambridge: University Press.
- Hamilton, J.D. (1994), *Time Series Analysis*, Princeton University Press.
- Hayashi, F. (2000), *Econometrics*, Princeton University Press.
- IATA (2008), *World Air Transport Statistics,* 53rd edition, IATA: Geneva.
- ICAO (1987-2006), 'Annual Review of Civil Aviation', in ICAO, *ICAO Journal* (various editions).
- ICAO (2008-2009), *Annual Report of the Council*.
- ICAO (1999-2008), *Traffic by Flight Stage database*.
- Kupfer, F., Meersman, H., Onghena, E., Van de Voorde, E. (2010), 'World Air Cargo And Merchandise Trade', in Macário, R., Van de Voorde, E. (ed), *Critical Issues in Air Transport Economics and Business,* Routledge, 98-111.
- MergeGlobal Value Creation Initiative (2008), 'End of an era? – Why the 'super spike' in fuel prices may signal the end of 'super growth' in air freight', *American Shipper*, 50 (8), 32-47.
- Stock, J.H. and Watson, M. (1988), 'Testing for common trends', *Journal of the American Statistical Association*, 83, 1097-1107.
- Stock, J.H. and Watson, M. (1993), 'A simple estimator of cointegrating vectors in higher Order integrated systems', *Econometrica*, 61, 783-820.
- Verbeek, M. (2008), *A Guide to Modern Econometrics*, 3rd edition, John Wiley & Sons. Ltd.
- World Trade Organization (2000-2009), *International Trade Statistics*, various editions, Geneve: WTO Publications.
- Zhang, A. and Zhang, Y. (2002), 'A model of air cargo liberalization: passenger vs. all-cargo carriers', *Transportation Research Part E,* 38 (3-4), 175-191.

Annex - Definition of Regions according to the WTO

An example for 2008:



See also for the definitions of the regions: http://www.wto.org/english/res_e/statis_e/its2009_e/its09_metadata_e.pdf

Source: World Trade Organization, 2009, p.239.