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Aviation Alliances Impact in African Aviation Market Development

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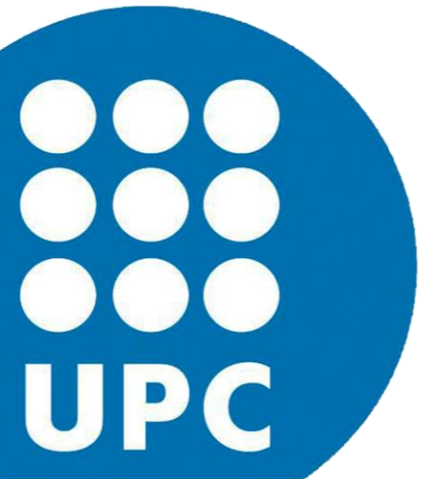

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Abstract

Even in this inauspicious situation, marked by a global pandemic, the need for connections between countries is not just a service required by the demanding side, but is a powerful tool for companies, institutions and even Nations to grow and create welfare.

Today, the fastest but most challenging way to connect one State to the other is through the air. Aviation is indeed the first way of transportation either when it is necessary to move valuable goods from point A to B or when there are customers willing to travel medium-to-long distances in very short times. However, the real challenge arises in those markets where, due to economic, political or organizational issues, is extremely difficult to build a resilient, efficient and safe network to allow people to fly freely. The first and most evident case in our era is Africa, where historical backgrounds are still restricting the economic development: the lack of reliable structures and an incomplete air liberalisation is causing the continent's backwardness.

Africa is a continent with an untapped potential, especially in the transportation field. Both intra-Africa and International connections would enable its States members to flourish in this globalized world. It is unquestionable that improving the existing air transportation system would increase in several ways each African Nation's welfare.

In this situation, alliances find virgin soil to proliferate, at least in theory. The very nature of this agreement is to extend the existing network of each of the undertakings, to have access to more resources that could be used for the advantage of the entire group increasing the efficiency of the combined operations. 30 million km^2, 54 states and thousands of domestic and international routes could be served better if only foreign carriers could overcome the plethora of issues which characterise the actual state of things.

But why has the situation come to this? Why have alliances not yet penetrated the market? and why the solution cannot come from local carriers?

The literature on African aviation covers many key themes that will be considered in the current analysis:

- How African air liberalisation has impacted on intra African trade flow?
- Is deregulation providing positive effects on local economies?
- How carriers' alliances could be beneficial for African aviation development? And for the market in general?
- Why should (and how could) African carriers enter an alliance?

All these topics are treated separately most of the time, first for a matter of complexity of each theme and second for the absence of a substantial literature to refer to. However, they are connected one to the other.

Objectives of the Thesis

Given this, the paper will start discussing how both internal and international African aviation liberalisation are enabling the development of alliances with/within African carriers and more generally, the blossoming of aviation sector in the continent. Consequently, it will be deepened how this transition to a more opened market has been influencing flights fares, considering all international flights from and to African States.

1. A review of the existing literature will highlight the key features of today's African aviation market, how it grew in the past decades, and what challenges it has to face for the future to come, exploring the causes for the sector underdevelopment.
2. It will be presented an introduction over carrier alliance/constellation, the benefits and entrepreneurial possibilities related to them; then, the main reasons why aviation carriers in African market should join one will be pointed out.
3. Before quantifying the effect of joining an alliance, a qualitative and graphical data analysis will be carried out.
4. Finally, econometric analysis will be performed to determine empirically how prices are influenced by the existence of alliances in today's international market from and to Africa.

1 The African Aviation Context

African aviation market structure has been analysed by many authors so far, however the existing literature focuses on specific areas within African market and does not analyse the market as a whole. There are several reasons for this, starting from the lack of information and the reliability of the available data. It should not be underestimated either the impact of previous economic closure and political myopia of the majority of African governments with respect to their own neighbour: such behaviour is still influencing their approach to the market and to globalization and analysing more than one of these National markets could be challenging if not risky.

Indeed, African aviation market is opening up, so that a comprehensive analysis of the situation will be possible. Moreover, it represents the base for this document to analyse and understand how African aviation market works as a unit and how it evolved through the selected years, considering also historical and socio-political aspects.

For this, the issues treated below will be discussed referring to the comprehensive situation of today's African aviation market, with no specific reference to how single States address them.

It has to be said that, despite the existing declarations and treaties, African market unification process is still under development and it is far for over, again mentioning the nationalistic politics affecting aviation management in the past decades. Many questions arise concerning the real possibility of creating a solid and efficient "pan-Africa" aviation market in the years to come, however it will be discussed how this process has been carried out and has now shown its effects both on political and economic sides.

At statal level, air transportation represents the future for long distance passenger and freight flows, so that building an efficient network to connect African countries with the world would make them increase their economic competitiveness and integration with the rest of the world, enhancing also internal benefits in terms of welfare and growth, leveraging on tourism and valuable minerals' transportation.

Up to now, Africa's contribution to the global aviation load in revenue passenger kilometres is extremely low, at 2.2% and, in a comparison with the other continents, Africa's growth rate both in revenue passenger kilometres and freight tons kilometres are ones of the lowest in the world, at 6% [1] compared to the 8% of the industry, but still the levels have been stable in these last years. Neither on the financial side, African aviation is performing adequately with respect to the world's standards: concerning the operating margin, the sector is led by North America with 9.1%, followed by Europe at 6.2%, Asia at 4.5% and Latin America at 2.7%; at last, Africa performed a 1.5% operating margin which is not lowest (Middle East with a -2%), but it is clearly far from being considered as competitive in the global scenario (IATA,2019).

On top of this, more than 80% of the combined intra-Africa and intercontinental flights are operated by foreign carriers (Official Airline Guide datasets; Heinz,2013; Dunn,2012; among others). Indigenous carriers are still facing the problem of taking an adequate slice of market share to be able to compete and to be profitable, at least on domestic routes, like foreign powers.

A 1.2 billion people continent, with a 67 million tourist flow per year is not able to respond (or just partially) to the market's requests and it will not for many years.

At the very origin of the current situation, there is the political background [2].

"While the virtues of air transport are widely known, non-physical barriers continue to impede air transport service expansion between African countries. These barriers mainly stem from restrictive regulatory arrangements which dictate how the service is rendered" [3].

Since African States' independence from European reigns, the majority of the newborn Nations created its own flag carrier, which, nowadays, has been clearly and widely recognized to be a hazardous move. Governments aim at increasing their Nation's wealth while exploiting the numerous advantages of the aviation sector, moving goods quickly and connecting a country first within its borders and then with

[1] This measure considers only the annual growth of African RPK and is not weighted or compared in any way to the overall growth of the market.
[2] By saying this, it is not excluded the economic factor: almost every State in the continent is still to be considered as underdeveloped, however, the focus here is on carriers' management and how governments have reacted to the changings in the African aviation sector.
[3] Abate 2013.

the world. However, African aviation presents (among many and less visible others) the following issues that are causing this market's instability and inefficiency:

Aviation freedom:

The nationalistic sense of flag carrier is still affecting, on different levels, the possibility to fly in most of African countries. Back in 1944, the Convention on International Civil Aviation (hereafter, Chicago Convention) established nine aviation rights [4], on the base of which two or more countries can create aviation arrangements for the utilisation of the respective airspace. A similar decree for African aviation is the Yamoussoukro Decision of 2002. Notwithstanding, the process of deregulation and sky liberalisation is still incomplete (and it will be further discussed in the next chapter).

As first consequence, foreign carriers are not attracted to establish commercial agreements with African countries since there are still lot of restrictions, which limit the possibility for these companies to enter new markets. At the same time this situation precludes African States and carriers from interacting with different economic and managerial realities.

Companies financing:

There is another key issue, concerning the financial source for African aviation companies. Airline is one of the most capital-intensive sectors. The requirement for a continuous cash flow in this sector comes from:

Fleet and its maintenance. Considering that African carriers, on average, possess the oldest and smallest fleet in the world (Ssamula,2009; Chingosho,2005), at least two important concerns could be raised. On one hand, the fleet's size is a strong limit for companies' expansion over the African continent first and then to the international context. However, fleet enlargement operations are the very reason why aviation industry is capital-intensive. States alone cannot satisfy just the needs of a single industry, investing the resources that are meant to be allocated for other basic public services. Then, maintenance. It does not have to be the panacea to structural and major safety problems, so that, for these carriers to grow, important interventions have to be realized to the current fleet situation.

[4] See Appendix 1 on aviation rights.

Fuel unstable cost, which, once more considering the size of most African carriers' fleet, could not be much negotiated with suppliers due to the absence of economies of scale (Heinz, 2013). Summing this up this to the acknowledged mismanagement and the fleet's utilisation inefficiencies, fuel cost represents a substantial challenge in African carrier's economy.

The renewing of technology needed to satisfy the international standards is another issue for these carriers, since foreign competition is directing the market with higher standards and clearly African companies are not able to follow the trends. The impact of the internet to aviation sector, for example, is been fundamental for marketing, efficiency increase and collaboration purposes (between carriers/airports/third parties throughout all the value chain) and African situation is nowadays so far from being comparable to the rest of the world's.

For these reasons State-owned carriers suffer from chronic shortage of financing, since States, even with the enormous resources at their hands, cannot keep up with the industry changings and expectations (Ssamula,2009).

Companies ownership:

Along with the financial issue, State-owned companies' general management has been conducted under a restrictive and anti-economic perspective with respect to the profit and result orientation which characterise all modern firms (Njoya,2016). Governments are more likely to care about, in the first place, the country's development in all possible forms, from employment to tourism and exportation, and then local stakeholders' interests (Ssamula,2009).

In the last twenty years, a privatisation wave has characterised many African states and the previous, rigid parastatal managements have been replaced with more efficient private ownership, to permit local carriers to grow. The motivations and results could be generalized for almost every carrier which control (total or partial) has changed in this period.

Another capital problem that incentivized the privatisation process is the budgetary stress States were facing to support flag carriers; by issuing company's shares, governments were able to reduce such weight on public debt, as well as government borrowings and loan guarantees (Oyieke,2002). It is expected that privatisation can generates enough funds to be collected by the State on one hand, and that privatising

the company will ensure its operations to continue efficiently without depending much on government (Ahmed,2014). However, the literature is not unanimous with respect to the ultimate (either positive or negative) effect of privatisation to a company's performances, especially when considering the difficult context in which African carriers are [5]. As Myburgh (2006) suggests, privatisation is not necessarily the solution to African carriers' problems: it would be rather important to separate national interests from commercial ones.

As many authors suggest (Al-Kwifi,2019; Heinz, 2013; Irandu,2006; Rhoades,2004; among others), African companies should adopt different business models with respect to the current ones, not to simply increase performances, but to unleash the enormous potential this market has to offer.

Even if the market was asking for a change and the proper conditions to act were set, the process would take more than expected due to another limit that is still marking African aviation market: an uncomplete deregulation process.

1.1. African Aviation Deregulation: Why is it so important?

Especially for aviation industry, to deregulate the market would ensure several advantages for companies. Deregulation is the process through which regulations and restrictions are relaxed in a given industry and the main changing concerns the reduction or complete removal of the centralised entity in charge of ruling and providing guidelines in such industry. Generally, this process is carried out to enhance competition. As consequence, deregulation ushers opportunities to newcomers to enter a market (Mhlanga,2016), leading to an increase of quality of the offered services. Moreover, most of the authors celebrate the importance the liberalisation process for its contribution to the increase in passenger flow and fares reduction. Though recognizing the impact on traffic flow, Ismalia (2014) and Abate (2013) disagree on the clear cause-effect relation between liberalisation and fare reduction.

[5] Since the objective of the chapter is to picture African aviation market context, the point of presenting the privatisation problem is to emphasize the instability these companies were facing when privatisation process started, and which is affecting nowadays performances as well.

African aviation treaties:

Both at national and continental level, African countries already stipulated arrangements with other States, to allow mutual aviation freedom, so to sustain carriers' profit and extend their networks. Until last century, the most common tool used for aviation permissions was the Bilateral Aviation Safety Agreement (BASA). Opposite in terms of air liberalisation, these bilateral agreements created the base for today's international approach of every African State, however their restrictive nature led to flights' predetermined pricing, limited traffic capacity, null possibilities for competition (Goetz,2009; Ismalia,2014; Mhlanga,2016; Mylburgh,2006; Surovitskikh,2015) and, often, how revenue was split between carriers (Button & Drexler,2006). Back then, the main reason to implement such arrangements was to protect native carriers (Doganis,2002). Over the years, BASAs' restrictive nature provoked inefficiencies all over the industry. This is due to the suppression of competition on routes, forcing the designated carriers to operate just those routes specified in the bilateral agreement. Such strict bilateral approach generated an extended bottleneck in the development of the entire African air transport network (Irandu,2008). Under BASAs, some African capitals were not connected with direct flights and the only way was through European airports; in the eventuality of a connection, to fly out to Europe to reach another African city was still cheaper with respect to the direct flight (Irandu,2006). Abate (2013) argues that intercontinental passenger flow (45%) is far more sustained and developed than intra-African flow (22%) (51% and 28% are instead the numbers from AFRATS,2019); the huge gap between the two is closely related, first, to the absence of a common vision with respect to State-to-State aviation flow and then to the distrust of liberalisation positive effects on economy, so that a stimulus to enhance free air transport within the continent is required.

Consequentially, BASAs have to be replaced with more flexible agreements not to limit African aviation sector's expansion, but rather to support it.

The steps in this direction were carried out starting from 1984, in Mbabane, when the Economic Commission for Africa of the United Nations Economic and Social Council (ECA) set the basics to discuss about African aviation issues and how to sustain African carriers while creating a pan-African market, by reducing and, gradually, remove capacity, price and aviation rights constraints. The Declaration of Mbabane

ended with the creation of a committee, which purpose was to develop a common African approach in aviation liberalisation for those points listed above.

The second vital progress towards air liberalisation occurred in 1988, Yamoussoukro, Cote d'Ivoire. The Yamoussoukro Declaration proposed a general framework of air transport reform in Africa for the unification of what has been a fragmented aviation market since the "decolonisation wave". In order to achieve this, the representing States Members were asked to make all necessary efforts to integrate their airlines, within the term of eight years.

The unification proposal included joint companies' financing mechanism, systems of coordination for combined scheduling air services, a centralised databank and research programme and the promotion of regional carriers to operate less covered sub-markets. As another important development, the Yamoussoukro Declaration aimed at granting fifth freedom rights to African airlines during the implementation period.

Even though it has been clearly an ambitious project, the Declaration started all the initiatives to liberalise African air transport market.

However, this liberation movement had to be supported with a concrete legal basis to become of any practical use. In May 1994, came into force the so-called Abuja Treaty, which output was the document establishing the 106 articles used for the creation of the ultimate Yamoussoukro Decision (YD), the latest and most relevant treaty for African aviation unification and liberalisation. Of the 54 African states, 44 signed and formally ratified the Abuja Treaty and then became parties to the YD.

Finally, in 1999 these 44 African Member States adopted a "Decision Relating to the Implementation of the Yamoussoukro Declaration concerning the Liberalisation of Access to Air Transport Markets in Africa".

YD came into force on August 12th 2000 and became fully binding two years later, in August 2002. In the 12 articles are reported all the liberalisation measures that all State Members had to implement. Of those, the main points are highlighted as follow:

- article 3 states the provision of first, second, third, fourth and fifth freedom rights for scheduled and non-scheduled air services by eligible airlines (eligibility that is described in article 6 and specifically paragraph 9)

- liberalization of the intra-African air transport services is granted by gradually eliminating all non-physical barriers and restrictions on access, frequency, capacity and tariffs (articles 4 and 5)
- competition on a non-discriminatory basis (article 7), reciprocal commercial opportunities and the possibility of cooperative arrangements between carriers (article 11) are allowed.
- international safety standards have to be respected (article 6.12) and
- article 9 establishes the creation of a monitoring body to ensure the successful implementation if the Decision.

Moreover, in accordance with Article 2, YD has higher priority over all bilateral and multilateral agreements that were already in force.

YD and its effects on aviation market:

Given this, the Decision and its full application would constitute the pivotal element around which African aviation could blossom and start competing with the world. Most of the literature agree on the positive outcome consequent to the adoption of YD. Traffic volume increases significantly in the signatory countries (Ismaila,2014) as well as departure frequency (Abate,2013). Prices, instead, are lower on liberalised routes but not with the same magnitude of the previous parameters (Myburgh,2006). As direct consequence, the industry development encouraged African governments to strengthen the existing transportation infrastructures to ease the intra-African flow (Bassens,2012)

For what concerns less measurable effects, the introduction of YD in the signatory countries has contributed to attract and retain high quality employees, with the resulting improvement in the overall management of African aviation carriers (Njoya & Panayotis,2016; Amankwah-Amoah 2011). Service level and quality standards were spurred by the increasing competition on each liberalised route (Njoya,2016).

Despite the enormous benefits liberalisation had and can provide to the market, many authors point out also the negative effects YD and African air liberalisation in general is causing to the continent economic situation.

One of the most distinctive effect African deregulation created is the bankruptcy of many small African flag carriers. With air liberalisation, these carriers suffered reduced profits and then, became unprofitable (Myburgh,2006). The entrance of foreign low-cost carriers (LCC) in African routes and the existing inefficient management, summed

up with the absence of adequate capital to sustain the business' continuity caused the collapse of many local carriers. Moreover, fares in shorter-distance and less-travelled city-pair markets were subject to an increase; same fate happened to concentrated markets operated for more than 60% by a single carrier (Goetz,2009). The competition-based system, that should have characterised the liberated market, has brought just little effects Button (2019): when comparing Yamoussoukro with non-Yamoussoukro signers, just under 5% of the former routes are competitive compared to around 10% outside of Yamoussoukro. Abate (2013) and Button (2019) argue that deregulation was effective only in high income regions, where big airlines pushed towards the implementation of YD guidelines, while in undeveloped regions air liberalisation has been seen as a threat to local activities and so opposed.

But is liberalisation really to be blamed for this?

In the majority of the cases, just the benefits from passenger volume increase should far outweigh any negative consequence for national airlines. Deregulating the market only provided the companies with a new choice for the future: whether local carriers prosper or suffer under liberalisation will depend in greater part on the quality of the management of those carriers and how they choose to respond to air liberalisation (Njoya & Panayotis,2016). This could be the "real" mistake a total liberalisation would lead to because once the industry is completely deregulated, companies would be free to take their own decisions and risks and clearly African companies do not have yet the managerial skills and experience to face such disruptive change. In the end, there is still an urgent need for at least some regulatory oversight over this industry, since it exhibits a tendency towards destructive competition (Goetz 2009) [6].

Since aviation sector is crucial for national economic growth and competitiveness it is necessary, especially in the intricate African context, to monitor the situation to provide both Nations and carriers a more suitable context into which create a sustainable aviation system.

[6] Even though the author in question refers to the American air liberalisation context, it seems to be very appropriate to the African situation as well.

2 Aviation Alliances

First step to enhance a more competitive aviation market is through air liberalisation. However, an even more effective system would transform African aviation network and all the sub-systems which are affected by its performances: it is the case (and it has been for the past 30 years) of aviation alliances.

2.1. The concept of alliance

With the term of aviation alliance, it is described the marketing join venture of two or more carriers, either competitors or not. By this agreement the participants are allowed to share resources with each other (either tangible assets like aircrafts or intangible ones like routes and marketing tools), with the common goal of increasing the group's overall profit. Depending on the depth of the arrangement, alliance's members might enjoy advantages like antitrust immunity (ATI), with the possibility to coordinate pricing and scheduling decisions. An even more inclusive cooperation arrangement is the complete joint venture (JV) of the carriers involved. Under a JV, the participants pool and then share revenues. To receive such grants, it must be provided evidence to government agencies that this coordination aims at improving the level of marketed service, so that the consumer is the main beneficiary and that competition is not threatened, again for a matter of consumer's rights protection perspective. Some argue that the inevitable collusion deriving from alliance related agreements might increase fares anyway. It is true but does not depend on the collusion itself or the alliance. Alliance members could still market the same route and they should act as competitors in that case. Antitrust authorities' main goal is to monitor these situations in which coopetitive [7] arrangements turn into collusive. Moreover, the very base of an alliance agreement, at least in theory, is to provide a better service to customers, primarily on two levels:

- By setting up prices, companies work on eliminating the double marginalization problem that affect the non-aligned cases. Although allied airlines are better coordinated than carriers that simply go interline, each carrier prices its segment

7 Term taken from Luo (2007)

independently, to maximize its own profit. Therefore, double marginalization issue is not actually fully solved (if not considering a JV, where the aim is to maximize the joint result). However, the overall result is that tickets from each segment are sold at lower prices, impacting directly the consumer.

- For what concerns the schedules, the coordination aims at providing a smarter timetable for the flights so that layover time is reduced and customer service is then improved.

Up to now, three main alliances are dominating the aviation panorama: Star Alliance, created by the partnership between United Airlines and Lufthansa; oneworld, founded by American Airlines and British Airways; SkyTeam, built around the Delta-Air France/KLM partnership.

Alliance, however, is not the only cooperative tool that carriers can rely on. BASAs are one of those, even though they are extremely restrictive and do not enable competitive advantages. Code sharing is one of the most common schemes used to make carriers combine their efforts to create a higher joint profit. Under a codeshare agreement, two (or more) carriers can market a flight of another carrier without having that route at their disposal. In this way, both carriers open up the partner's capacity by paying a fixed price per passenger in advance. Both parties win since the operating carrier fills up the planes and the other sells tickets.

2.2. What is the impact on the strategic process?

It is not strange nowadays to find competitors cooperating. The motivation is very simple: the markets' driving forces are so tightened that companies need to collaborate with each other to survive. Cooperative arrangements enable the participants to acquire knowledge, technologies and resources to create new businesses and opportunities while reducing costs and sharing risks with the partners.

Alliances could be considered the (almost) perfect symbiosis between competition and cooperation. Coopetition (Luo,2007) is the condition in which global players cooperate but still compete at the same time, creating a balance in those forces mentioned before. However, in contrast with the author, alliance agreements fall exactly in this case: while sharing resources with each other on a route, the same carriers compete on another. Alliances are said to contain only the cooperative parts, however, civil aviation is by nature a competitive sector, so that alliances only enable carriers to

face differently the fierce competition that fits the market. In addition, this entire situation is not static as aviation market and the environment are always in a continuous cycle of relaxation and contraction, which produces new tensions and creates unbalances between cooperative and competitive drives.

The reasons why aviation alliances took over in the last years are many: in this scene, carriers are no longer facing the market by themselves and they have the possibility to capture the synergies created by the entire group (Lazzarini,2004). Even though the final result is to create a group-based advantage, there is still the need to yield value to individual carriers in order to attract and retain members (Gomes-Casseres,2006) [8]. The most direct consequence of joining an aviation alliance is the extension of carriers' network. The mutual benefit of increasing the number of routes opens the (hypothetically unlimited) opportunity for carriers to connect their current passengers base to any place within the alliance's network. On the other hand, they can capture new customers by selling routes were not available before. Not only routes, but an alliance agreement guarantee its members to enjoy its resources commonly. Along with the physical assets, one of the most valuable resource that can be shared is the know-how, which differentiates alliances from any other cooperative arrangement [9]. As for code sharing, resource sharing among allied companies aims at increasing efficiency, mostly in ticketing and scheduling. With the efficiency increasing, the result of the joint operations and marketing activities are also expected to reduce unit costs due to economies of scale (Park, 2000). However, the intrinsically more pervasive nature of alliances enables carriers to improve performances even more (Luo,2007; Amankwah-Amoah, 2011). Beside quantifiable measure, customer service levels tend to increase when the alliance provide a single carrier-like service with respect to check-in and baggage handling (Brueckner, 2000).

Going back to the African case. In this scenario of inefficiency, instability and heterogeneity, carriers alliances might have a key role to reshape Africa aviation market. But how? And why it has not happened yet?

[8] In the mentioned document, the author was referring to a slightly different concept, which is the "constellation" of firms. However, it could be associated to what is described here since the discrepancies are just a matter of details.

[9] Joint venture in this term is not seen as a simple cooperative arrangement, but rather the merging of two companies, so that, beside the legal entities referring to each brand, the companies become part of the same group of companies and there is necessarily an exchange of know-how within the process.

All the continent presents a promising but volatile market base, difficult to be accessed due to all the barriers mentioned in the previous paragraph and offers unique destinations. It would need its carriers to enter an alliance to widen their networks [10]. Another green signal on alliances is the fact that African carriers can rely on a very narrow amount of resources, in all possible forms. Even tough, the numbers are clear: the just a few African carriers are involved in alliances. Moreover, the pros mentioned above could not be applied to African carriers in several ways.

In this regard, Lazzarini (2004) speculates [11] that minor carriers entering an alliance necessarily gain unequal benefits and cannot assume power positions in the same. When moving to African carriers, the situation would be much worse since their performances is far below the market average. Additionally, to enter an alliance, the potential new joiners must possess certain characteristics:

African carriers work in a local regulatory framework that do not allow to better coordinate schedules and price. African governments' restrictive conduct with respect to foreign carriers acts as the main deterrent. Even if the goal is to better distribute the market share among nationals carriers, the effect is instead the closure to new possibilities which would enable African carriers' development in the long run.

Infrastructures and safety issues are another reason. Some African nations and their carriers have been recognized by international entities as not complying to international safety standards. Beside eventual legal problems that might arise, alliances are not interested in offering the membership to carriers that do not possess adequate infrastructures to host a suitable number of passengers per year, that would allow the alliance to grow.

Network extension needs to be associated with a sustainable number of passengers even in the case of a new route creation. If not, at least one company would not be inclined to participate in this operation. The lack of a solid base of customers willing to travel on a regular basis is one of the main issues when discussing about the entire African market, with the exceptions of the northern region and South Africa, that are considered as strategic areas.

[10] Not without a proper air liberalisation plan for the future
[11] Referring to the five hypotheses for his econometric analysis accessing the impact of carrier alliances in aviation market.

3 Methodology

The point of this section is to introduce the data that is going to be processed for the regressions later on. Before doing that, a deep understanding of the data's nature and structure, along with a proper data mining, have to be carried out to have at disposal only meaningful information.

All of the datasets have been taken from the Official Airline Guide (hereafter OAG) and cover the time span from January 2016 to December 2019. Here there is the first assumption: since this paper's aim is not to investigate how Covid-19 pandemic has influenced aviation business and its operations, the period from January 2020 on has not been included into the research.

Each row of data identifies a single route, connecting two cities in the case of the zero connection tables and three for the connecting tables. Information is collected monthly, for every year in the analysed period; the number of passengers, cabins and revenue of a line are calculated by summing up the single flights information while all price-related measures are evaluated as a mean of the values within the same month.

The so-called Traffic Analyzer (TA) datasets give crucial information to be used for the regressions and the empirical analysis of data. Among many other variables, the most important for this paper's sake are:

- public and operating carrier on a flight, for each segment of the same. This provides a first index of carriers' cooperation system, which is code sharing. The type and depth of coordination the groups of carriers can reach, affects drastically the efficiency and, consequently, prices Lazzarini (2004), Calzaretta (2017), Brueckner (2000, 2003, 2019).
- The fundamental data for this paper is of course the fare for a flight (expressed in USD). In these datasets, there are provided many measures of average price per flight, including first class, business, premium economy, discount economy and the online fares. After that, it is provided a summary measure indicating the mean of the previous ones.
- Distance (in km) is the third valuable measure that will enter the regression equation.

- Traffic analysers present also an indicator to distinguish those flights that are considered low cost or mainline, a difference that will be exploited in the regression for further considerations.

Both datasets provide departure and arrival information, specifying the airport, city, country, region and so the routing of the two of them.

In addition to these variables, it has been associated to departure, arrival and gateway cities decimal coordinates of latitude and longitude, necessary for the descriptive data analysis; just to the departure and arrival cities were then added two more variables, indicating each city's population and country's GDP per capita (again expressed in USD).

3.1. Assumptions

Alliances in the Datasets:

As the purpose of the paper is to see how alliances create new opportunities for companies and for the market, it should be drawn up a brief introduction about the number, structure and extension of the alliances included in the datasets.

In the considered period of time, only the three main alliances operating in today's aviation market are considered:

- SkyTeam
- Star Alliance
- Oneworld

According to this paper main objective, it could be useful to see the impact of another, minor alliance, which operates mainly in the so-called Vanilla Islands of which, beside Maldives islands are all considered as part of the African continent. The datasets provide all information related to each of the five companies within the alliance but refer to them as "not belonging to an alliance" (identified by a zero in the column of the alliance name and then replaced with the name "Independent" to avoid misunderstandings).

The Vanilla alliance was formed in September 2015 to promote tourism in the islands of Mauritius, Seychelles, Madagascar, Comoros, Réunion, Mayotte and Maldives, so that it was performing within the observed period. However, the alliance's contribution to the overall traffic volume is exiguous and it could not provide relevant

information about how alliances have an impact over flight prices, so it will not be considered throughout this paper.

For the same reason, the African Airways Alliance, under which Daallo Airlines and Jubba Airways equally share its benefits from 2015, will not be included in the analysis either.

On the contrary, African Civil Aviation Alliance could have been an interesting insight for this paper: the alliance, on the initiatives of South African Airways, Kenya Airway, Air Mauritius and RwandAir, was about to enter the market in 2019, however the effects (especially on prices and routes for these companies) will be evident only in the near future, so that it will not be included in this research, but it could still constitute the base for further investigations, in the favourable scenario of the new normality post covid-19. This alliance aims at competing with Ethiopian Airlines and would create new possibilities for fare reductions and routes increasing, so that States, consumers and (of course) companies could reach their own benefits.

Stops and Connections:

The analysis will consider two methods to connect cites:

- In the first place those pairs of cities connected by one direct flight, with no connections, change of vehicle or fuel stops. Moreover, the flight should not be a part of a larger route which includes other cities.
- A second analysis will be then performed over the flights presenting one stop, to better understand where the impact of entering an alliance lies, both for the companies and the market.

As did by Brueckner(2019), a route-related assumption will be only the *round-trip itineraries* allowed, meaning that all the analysed routes will start from a city and return to the same one, avoiding *open-jaw* trips.

Type of Service:

Both to simplify the analysis and to create a dataset with homogeneous data, the transport services that will considered is the passenger service, so that, mailing, cargo and charter flight services will not be used further in the paper. A first intuitive reason for not using all those other flights' types lies in the different pricing related to these services: a difference in price between two passenger routes could be compared in a

more direct way with respect to a difference in price for two distinguished services. Additionally, the civil transportation flights are also at the base of almost every existing research concerning the general aviation market, so that, a comparison with those results could be possible.

Data Mining:

This paper looks for patterns connecting flight prices and social-economic variables. Said that, prices either equal to zero or relatively low for international flights, have to be considered as not valid and should be taken away from the datasets. Same consideration should be applied to distances and more importantly, to the number of passengers. Performing additional and more complex cuts for the considered variables will be indeed tricky. The incredible and intrinsic heterogeneity of data makes almost impossible to adopt standard cuts, for many reasons:

- By nature, the market is composed by transatlantic flights (e.g., Africa-Americas) and smaller routes of a few hundreds of kilometres (like Africa-Europe routes), so that any kind of raw cut on distances would take off a relevant slice of data. Prices, as a direct consequence, could not be cut without a reasoned, market specific method.
- In those other papers exploring African aviation market, there are no references to data filtering systems on a global scale. The majority of these works focus on local businesses or specific routes, Nations or even airports, so that it will be not adopted any of the already tested data cleaning methods in this analysis.
- Due to the absence of the total number of seats on each aircraft (with the corresponding number of discounted economy, first and business seats missing as well) and impossibility to retrieve reliable information of such measure [12], it was not possible to evaluate in a proper way two variables that could have been used for thresholding and filtering: load factor and passenger yield.
- The number of passengers is another issue. Even identifying the regular passenger service flights, there are many anomalies concerning the actual

[12] Within OAG files, there is a type called "Scheduled Analyzer", which contains, among other variables, all the information related to seats per each flight. The paper was initially including also that kind of dataset, but it turned out that information from Traffic Analyzer and Scheduled could not be match properly, therefore only traffic-related information was kept.

number of people on many flights in the datasets and for this, a cut is needed. This problem could be associated to the way data are collected and then gathered.

In the light of these considerations, the most suitable solution to obtain only credible information out of the datasets is to evaluate the passenger-weighted fare (hereafter PWF), here calculated as the ratio between total mean fare and total number of passengers. Despite the main regression will be performed on discounted economy fares and passengers, the cut cannot be applied to DE measures, because it would generate altered values of PWF so that a lot more data lines would be eliminated even though valuable to the research.

This new variable should indicate which fare, compared to its associated passengers number, is to be considered as unrealistic. To call a price genuine or not, always keeping in mind the complex reality this market represents, should be subject of other studies which, however, will not be further deepened in this paper. Finally, the spectrum of data which will be analysed here lies within the 99% confidence interval chose over the 95% interval due to the excessive loss of data in the upper end of the distribution.

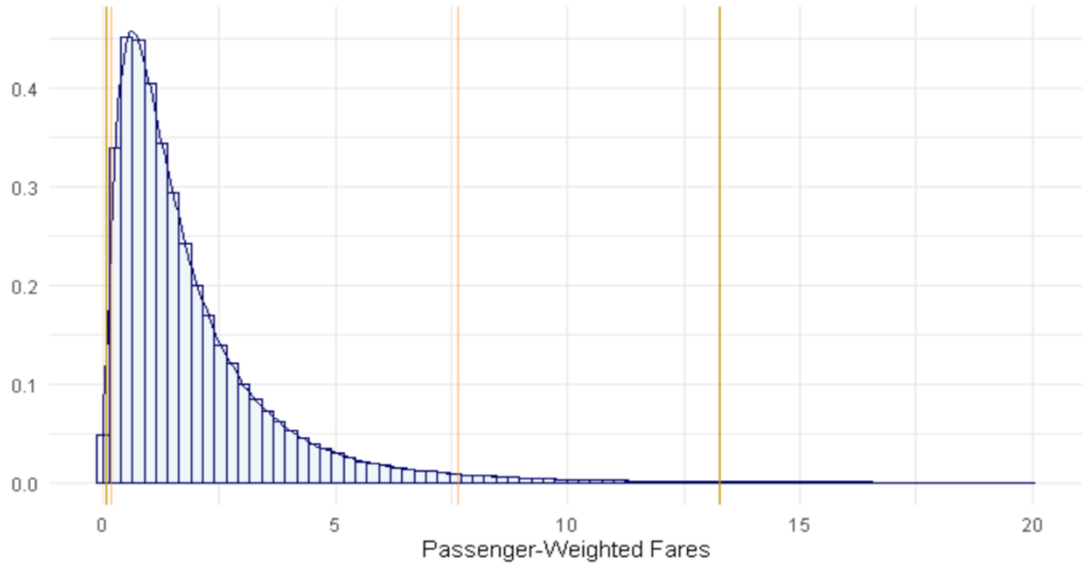

Figure 1- Passenger Weighted Fare Density and Confidence Intervals (95%, the internal, and 99% the external interval)

Even with this cut, there are two more issues to deal with:

- The number of passengers on many flights are still too few if we consider the length of the trips and the prices for those routes. To solve the problem, it will be introduced a lower limit, arbitrary, of one hundred passengers per flight. Considering the majority of flights in this specific market, it is reasonable to believe that a plane with less than one hundred passengers is just half filled or almost and so, not credible for further processing.
- Credibility also affects fares. Even though low-cost carriers took over the market for shorter lengths (North Africa-Europe connection is an example), fare that are, on a monthly base, below 80 euros, will not be considered as realistic. Again, here a purely arbitrary threshold has been used.

City pairs:

Another step that has to be done before going to the regressions. To collapse all the rows originated from the same city or arriving at the same city, operated by the same carrier, for the same month and year, into one, as the initial datasets provide a routing considering airports (as it should). For example, all the flight involving Paris could have one of the five different airport's names and codes:

- Paris Charles de Gaulle Apt (CDG)
- Paris Orly Apt (ORY)
- Paris Beauvais Tillé (BVA)
- Paris Chalons-Vatry Airport (XCR)
- Le Bourget (LBG)

The point of this operation is to create a subset with only cities pairs of origin-destination, to simplify a little bit the analysis and to focus the attention on the cities, not airports. Once the datasets are modified and adjusted, all the rows will present unique cities pairs for each month and year of the considered time span, a sum of monthly passengers carried and total number of cabins per type, an average of all kinds of fares included in the original datasets and of course, the carriers and alliances operating each route.

3.2. First Expectations

Now that the adjustments are implemented, it is possible to proceed with a descriptive data analysis, to better understand how the market is structured. However, it is possible to anticipate some of the main outcomes just looking quickly at the datasets:

- Despite African aviation progress in the recent years, alliances are still loath to include African carriers in their cooperation schemes. A vast bulk of flights is operated by the same foreign carrier throughout the entire route. Of the remaining, the most popular solution sees two non-African carriers operating a route. Then, those routes operated by different vectors are still not affected so much by alliances, as the numbers below show, in the table on the right.

Same Carrier	Flights
0	25788
1	200573

Alliance On Route	Flights
0	20453
1	5335

Table 1 – Number of flights operated by a single carrier on the left (dummy =1) and the presence of alliances in the remaining flights on the right.

Of the 226361 flights remained after the filtering process in the one connection routes, only 25788 are operated by different carriers on its segments and, of those, only 5335 involve alliances' agreements.

Even in the direct flights, there is a quite consistent slice of routes operated by independent carriers, however the proportion is much lower and a more visible "alliance effect" could be detected as shown in table 2.

Alliance	Flights
Independent	41882
Star Alliance	19809
SkyTeam	9480
Oneworld	4682

Table 2- Gateway to Gateway flights per each alliance.

In the comprehensive scenario, these considerations lead to think that the overall effect of alliances over prices will be limited and other variables will better explain why prices changed through the considered years.

- Low cost is another dummy variable that will be used in the regressions. Below, is shown the number of rows that are considered low cost or, alternatively, mainline. It is evident the dominance of mainline flights in this market, so that the dummy is not going to explain much about the reason why price fluctuate.

Low Cost	Flights
0	71984
1	3869

Low Cost	Flights
0	224309
1	2052

Table 3- GTG flights vs. connecting on the presence of low cost

4 Descriptive Data Analysis

Before going to the regressions and the empirical analysis, it will be performed a qualitative insight, to understand how data is distributed in the sample. As already discussed in the previous paragraph, some results will not be surprising, and they will be pointed out here with more details through graphical representation.

4.1. Alliances

The most important issue in this paper is to analyse alliances impact and penetration into African aviation market. The first graph represents the number of carriers belonging to each alliance in the analysed period. It clearly appears that, among all carriers operating African routes, only a small percentage is involved in alliance agreements. Deepening the analysis, it is possible to show how many African carriers joined these organization: the yellow parts in the second plot represent the number of

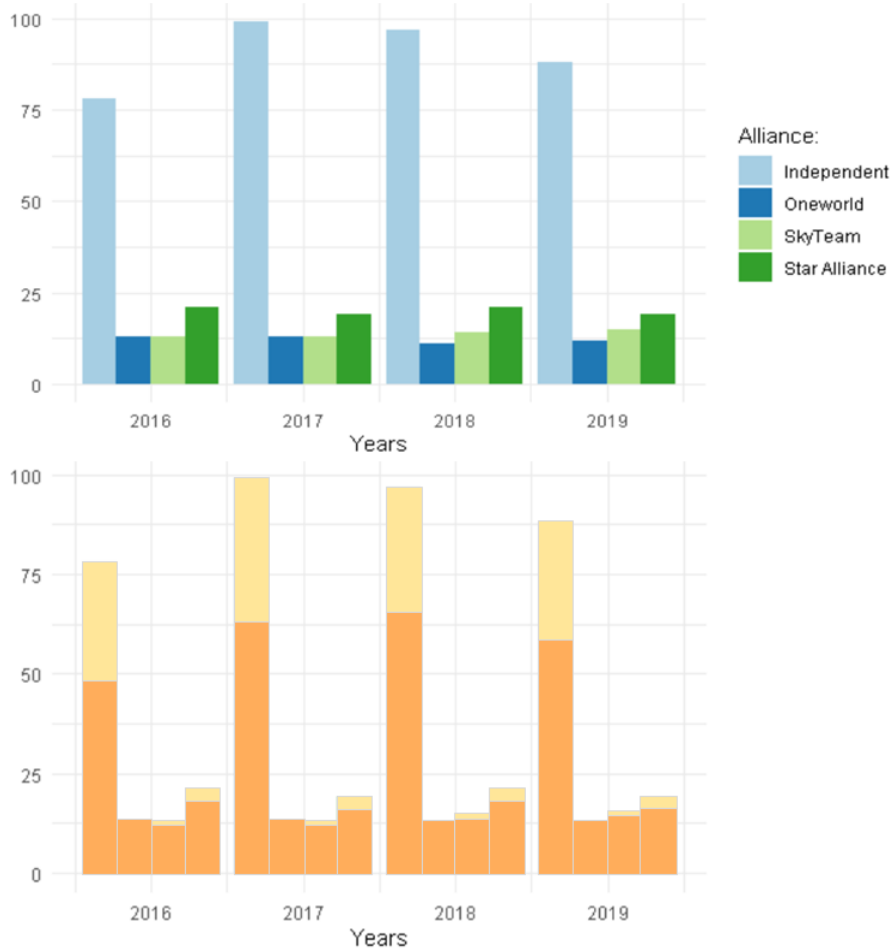

Figure 2- Number of Carriers per Alliance (above); African carriers divided into the same alliances (below)

African carriers associated to an alliance, while the orange ones are foreign carriers [13]. In line with the contents of the previous chapter, the almost absence of African carriers in the international alliances is here confirmed. Table 4 provides a numeric insight on the impact of alliances in the African market, in terms of total passengers carried, number of routes in the network and number of African countries connected by aviation services.

	2016			2017			2018			2019			
	Total Passengers	Routes	African Countries	Total Passengers	Routes	African Countries	Total Passengers	Routes	African Countries	Total Passengers	Routes	African Countries	African Carriers in Alliances (DEC 2019)
Oneworld	1,595,717	696	22	1,612,303	743	21	1,428,537	600	21	1,430,755	647	21	/
SkyTeam	1,970,068	941	42	2,331,403	965	40	2,665,965	1,004	40	2,594,713	1,012	42	Kenya Airways
Star Alliance	3,609,231	1,508	48	4,000,690	1,680	49	4,421,885	1,803	49	4,723,521	1,941	49	Ethiopian Airlines; Egyptair; South African Airways.
Grand Total	**7,175,016**	**3,145**		**7,944,396**	**3,388**		**8,516,387**	**3,407**		**8,748,989**	**3,600**		

Table 4 - Alliances numbers overview 2016-2019

The dependent variable for the regressions will be the average price for each international flight. For obvious reasons, it is expected that price will increase as the distance between cities increases. But how alliance influence prices on a region-to-region base? As follow, the average flights prices are displayed divided into macro

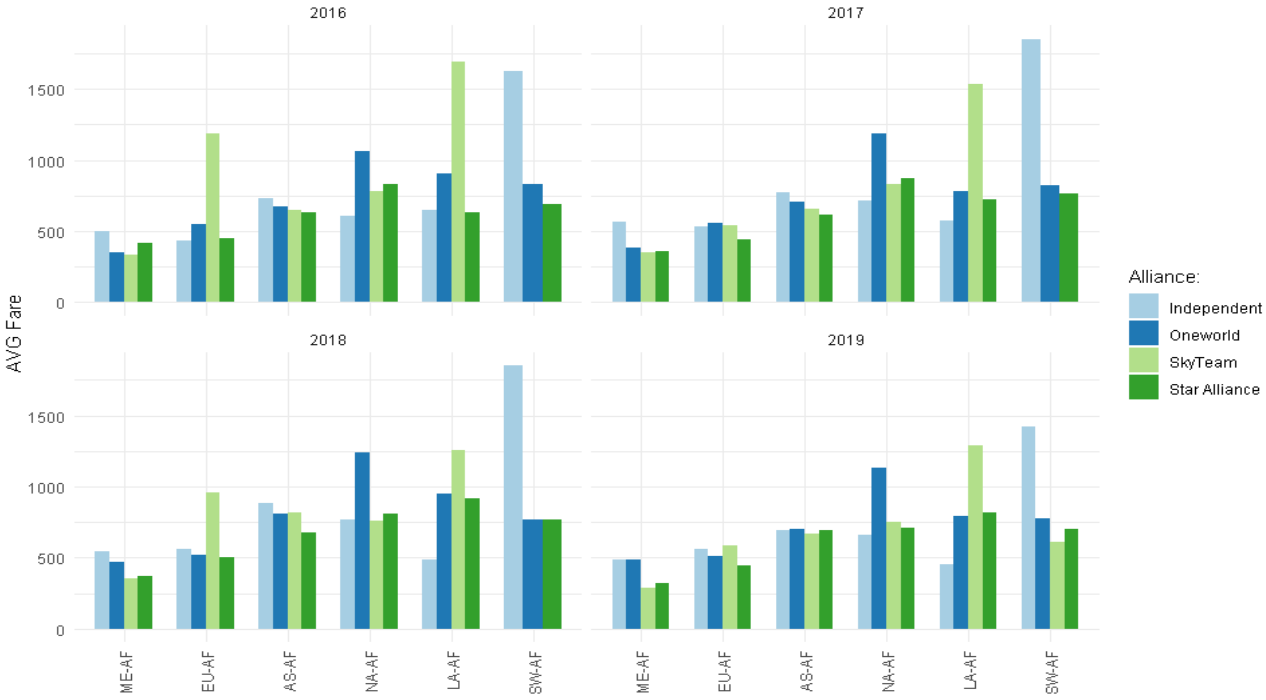

Figure 3 - Average fare for macro regions, divided by alliances.

[13] To be noted that "Independent" carriers (so the ones not associated to any alliance) are listed as they were actually in an alliance, as the legend on the right shows, but it is purely a graphical solution.

regions [14] and alliances. It is not possible from figure 3 to deduct a pattern or anticipate a possible result for the regression, however price seems to be affected positevely by the presence of alliances in almost every area.

Another reason why joining an alliance is certainly the possibility for a carrier to improve its presence in the market, by increasing the number of routes that could be operated or marketed. Now, it will be presented the evolution of the key players in the African aviation market by analysing the number of routes operated by each of them.

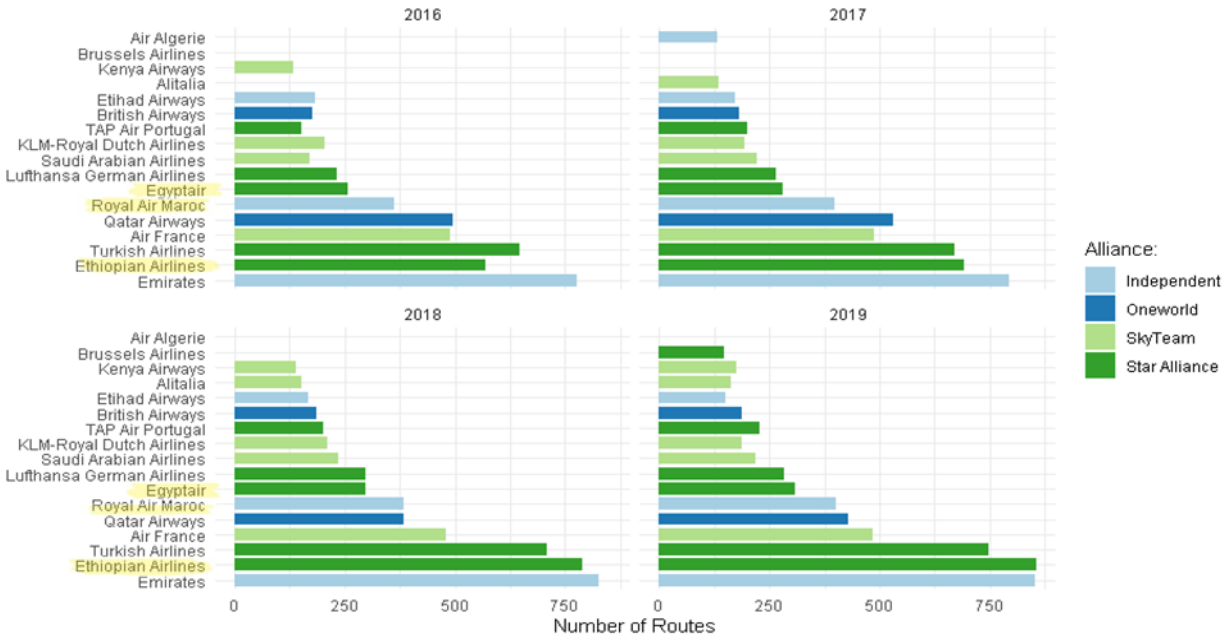

Figure 4- Routes for each carrier, divided by alliance. Highlighted in yellow, African carriers.

The importance of the data presented in figure 4 is evident: being part of an alliance extends a carrier's network by increasing the number of routes it operates. Beside Emirates, a worldwide and already consolidated company, the key players in African market are associated to alliances, so that, to penetrate this market, a newcomer should join an alliance to gain new routes. The case of Royal Air Moroc is extremely peculiar and could be considered as an exception. Despite not being into an alliance [15], the Moroccan Government's (which owns 95% of the company) favourable approach to liberalisation and its ability to stipulate agreements with European countries made this carrier flourish and create a vast network, throughout Europe.

[14] See Appendix 2.
[15] Royal Air Moroc was not associated to an alliance during the analysed period, however it joined Oneworld alliance 1st April 2020, source the alliance's website.

Another measure used to determine an airline's performance is for sure the number of passengers carried.

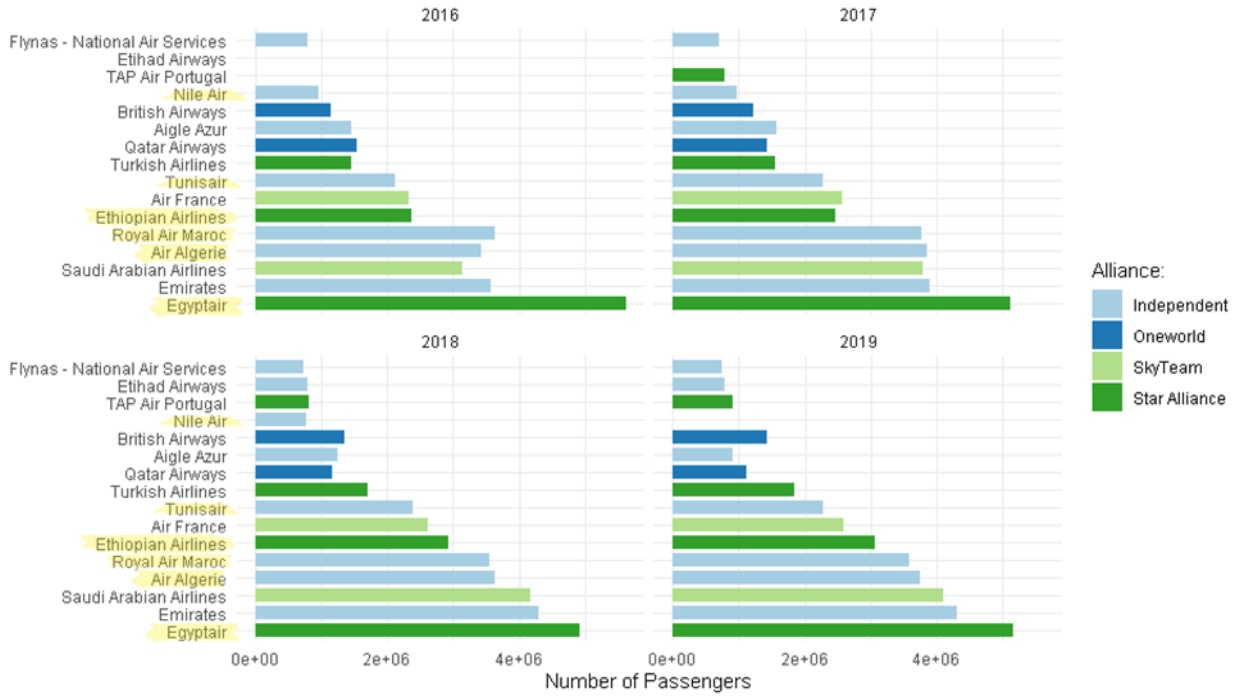

Figure 5 - Number of Passengers for each alliance, by carriers. Highlighted in yellow, African carriers

As well as for the routes, the role of figure 5 is to connect each carrier's results with the influence the corresponding alliance had on such results. Regardless the fierce competition from foreign carriers, the ones operating a high share of the market, measured in passengers, are African, specifically from the northern area, but unfortunately for the main objective of the thesis, those carriers (expect Egyptair and Ethiopian Airlines) were not associated to alliances between 2016 and 2019. To be noticed that, in the referenced literature, it was described a different scenario for what concerns the balance of powers: Ethiopian Airlines and South African Airways were, not even ten years ago, the unquestioned drivers for African aviation market and now Ethiopian is no longer in the top three and the SAA is neither in the chart. This is just to point out the incredible changing African aviation has been through in the last years.

4.2. Market Analysis

African aviation sector is not booming as the rest of the world due to those political, economic and social issues. Nevertheless, African market has been opening up (although slowly) to new possibilities.

A first overview shows that the majority of the routes is operated by a single carrier/pair of carriers and, as the number of competitors in a route increases, the number of routes per each decrease. Even if it sounds logical to have more routes operated by one carrier/pair of carriers, there is a huge gap in numbers between less competitive routes (i.e., the red line) and more competitive ones (the blue line). This is the confirmation that aviation rights are not yet extended to too many carriers, so to create monopolies. Even though, the positive slope for each line indicates the entire market is expanding, in all its competitive forms.

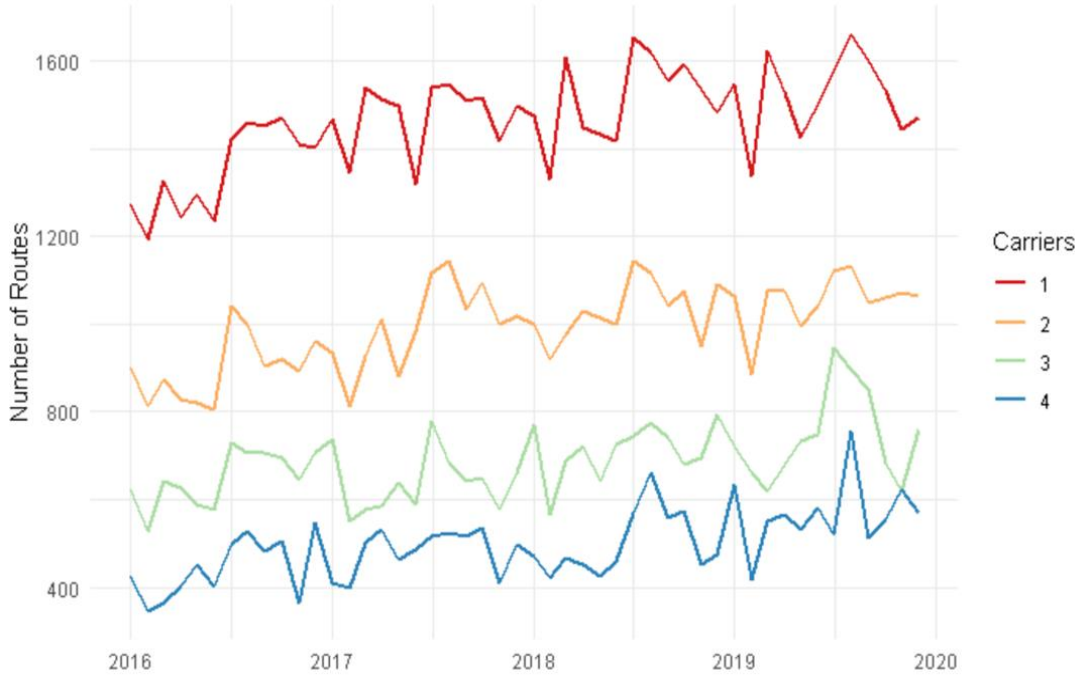

Figure 6- Number of routes per competition level

The second graph illustrates the average price per Km throughout the analysed period, divided again for level of competitiveness. In line with the economic theory, the average price per Km is decreasing as the number of competitors on a route increase, while monopolies enable carriers to raise the prices. The seasonality is transversal and repeated approximately every 6 months.

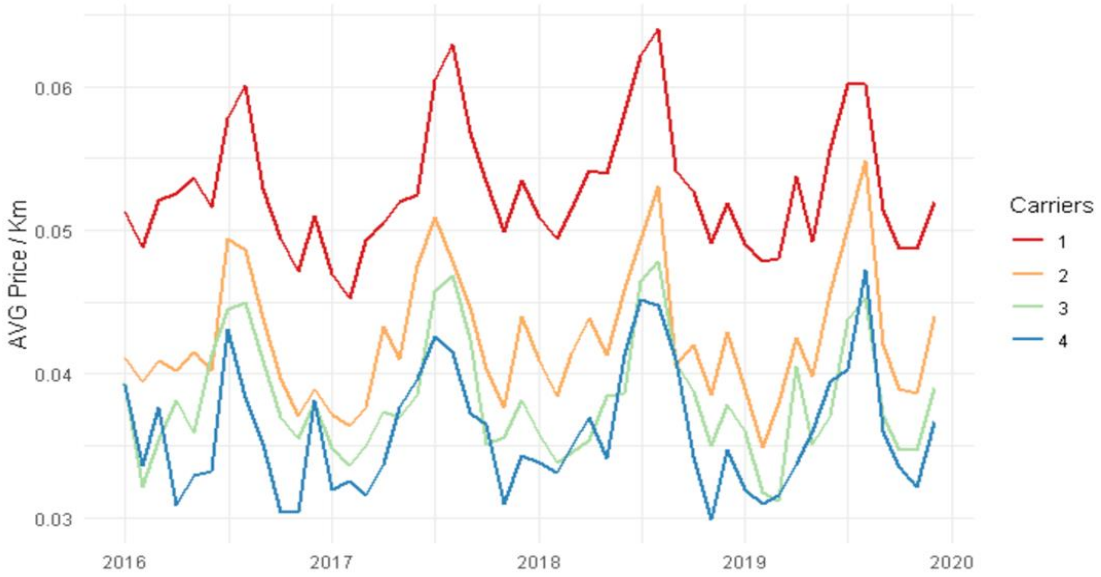

Figure 7 - Average price per Km per level of competition

For both of these graphs is displayed the situation up to 4 carriers/pairs on a route, even though the maximum amount in the dataset is 12 pairs of carriers operating on a single route. At that level, the curves are almost indistinguishable from the 4 carriers line, meaning that prices/Km cannot be lower that a certain threshold and the number of routes per carrier pair stabilises.

A similar graph can be created to describe another competition-related matter. Figure 8 investigates which is the number of routes operated by at least one aviation alliance. Like figure 7, the quantity of routes operated by a single alliance, which are

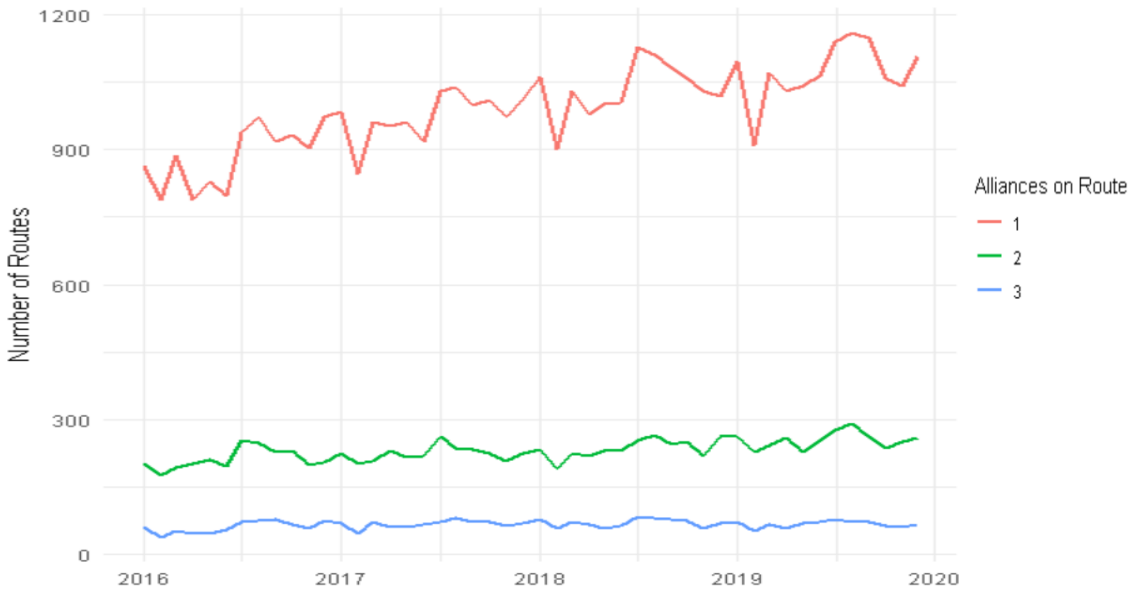

Figure 8- Number of routes operated by one or more alliances

kind of monopolies, is by far higher with respect to the cases when two or three alliances

are in the same route. The main difference regards the annual growth rate that, in this situation, is positive only in the monopoly, while in the other market conditions it is almost flat. This suggests that alliances tend to maintain a dominant position on own routes and that is it difficult for them to access new routes controlled by rival alliances.

To make the comparison complete, also the average price km should have been drafted. However, the results are not as significant as the ones shown in figure 7, so it was decided not to show them. Differently from figure 7, the data revealed that price is not so sensitive to the existence of many alliances operating the same route and the curves representing the levels of competitiveness were almost overlapped.

According to the expectations, the connecting flights are definitely more than direct flight, both for air freedom limitations and for distances issues that require at least a stop for refuelling. On what discussed earlier on African aviation deregulation process and its objectives, there should have been a higher increase in the number of

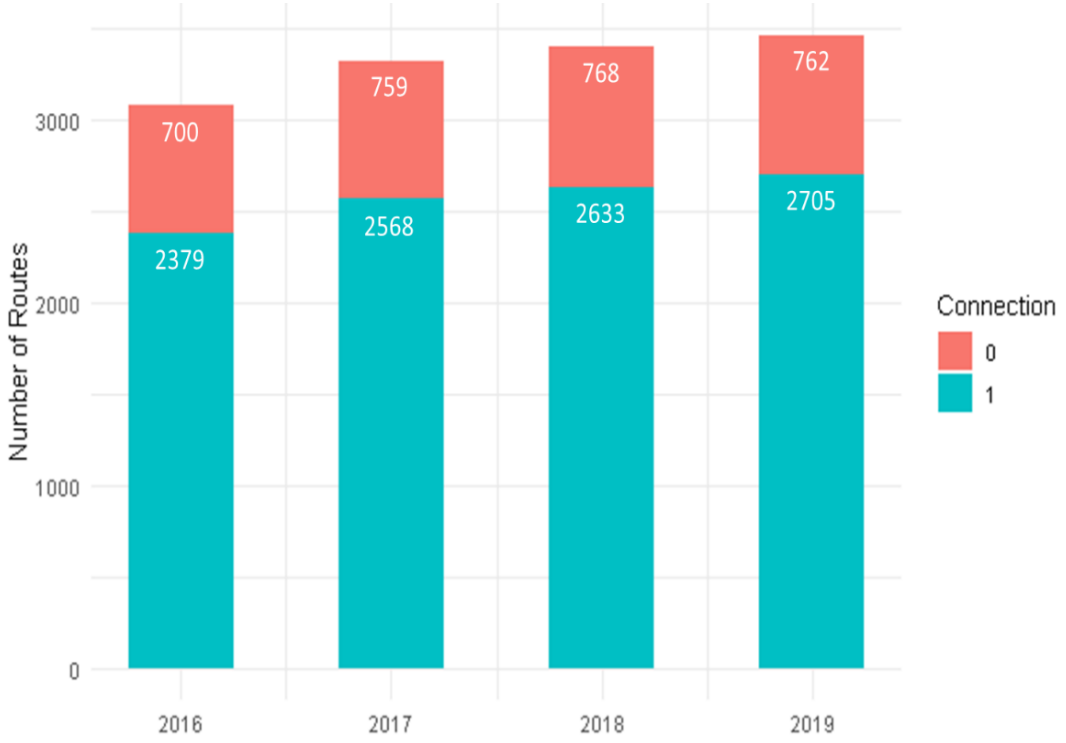

Figure 9- Number of African routes from 2016 to 2019

connections with other countries, but again political and economic issues limited African aviation market expansion outside the continent.

Deepening the analysis on the number of routes, the increase is due primarily to new Europe-to-Africa connections. With the following graphs, it will be investigated the connection between these two continents, to exhibit how commercially important it

is for African aviation market. Starting from the number of opened routes, it is possible to see that Europe-to-Africa market is much more developed with respect to the remaining destinations.

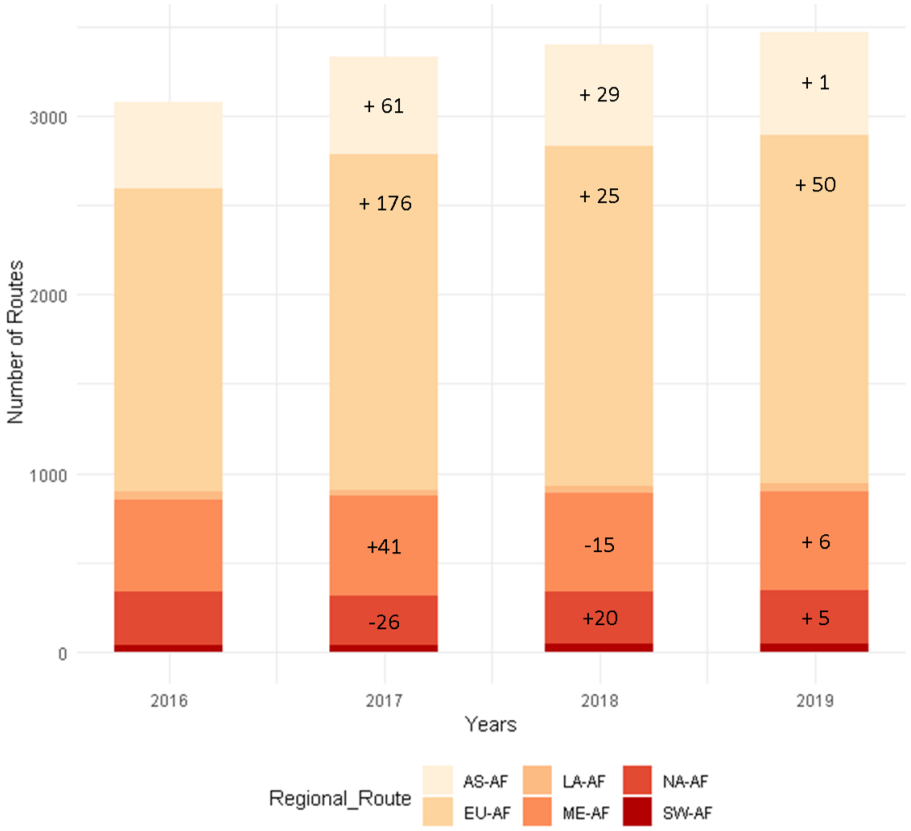

Figure 10- Number of Routes in a Continent-to-Continent comparison and annual increases

The same routes graph of figure 9 can be exploded into macro regions and the result is presented in figure 10. Africa-Europe connection counts more than 1800 routes, which are (every year) more than the sum of the remaining routes. The labels highlight the annual difference in routes with respect to the previous year, for each of the macro regions [16]. Digging deeper into the data, a more detailed analysis could be performed to measure the real impact of Africa-Europe routes over African aviation market, by displaying how passengers are split among these macro regions. A further examination shows how alliances are impacting on both routes and passengers' flow.

As follow, the relation between Africa and Europe is better highlight: about 60% of passengers travel on EU-AF routes, from 12 million in 2016 to almost 15 million in 2019.

[16] Southwest Pacific (at the bottom) and Latin America (under Europe column) differences have not been included due to the small numbers.

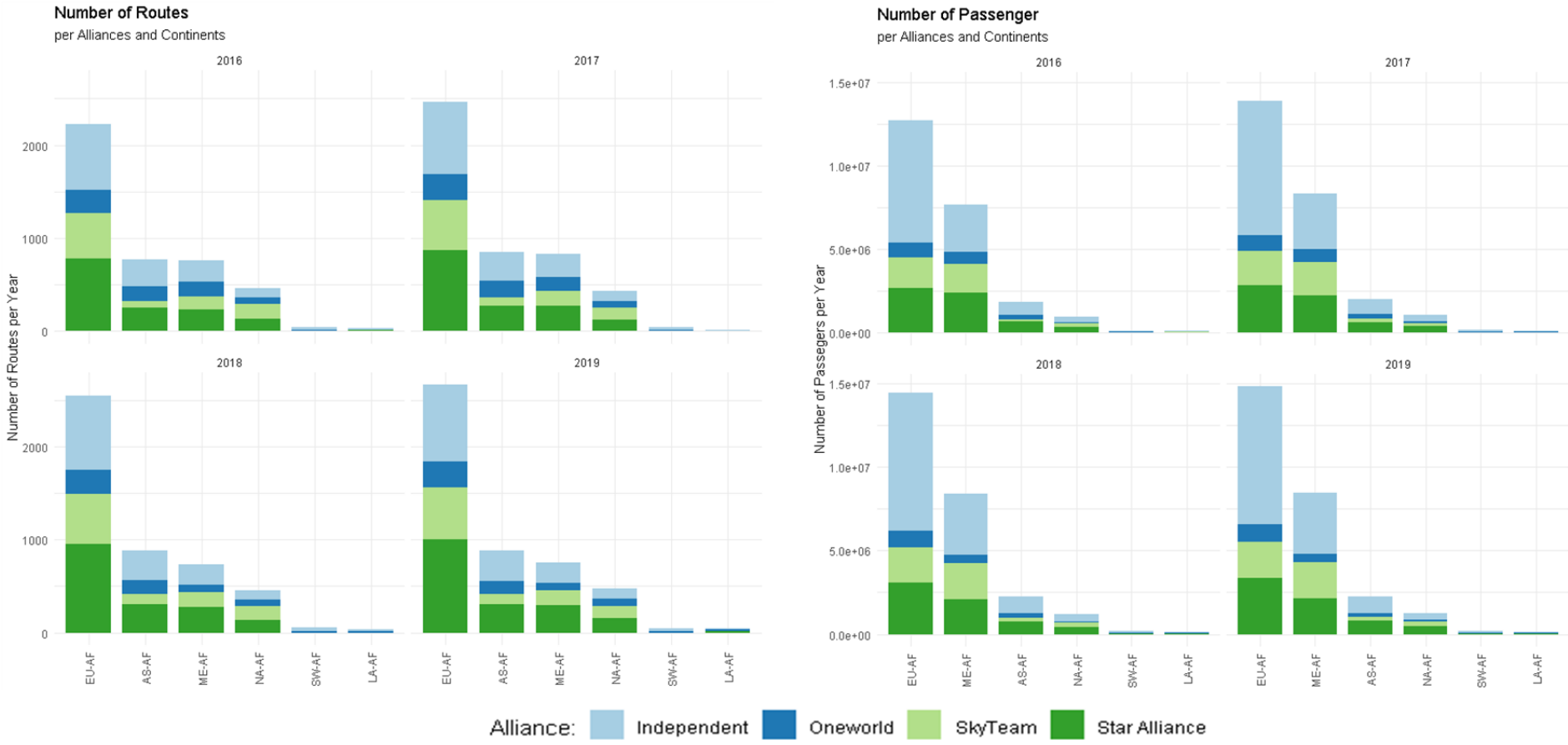

Figure 11- Global market share per Alliances (routes on the left, passengers on the right)

In this comparison, it could be noted that, despite the importance for alliances to take privileges over routes, the majority of passengers fly with independent carriers, namely Emirates, Air Algerie, Royal Air Moroc, Tunisi Air.

These graphs show also that Middle East and Asia are growing markets that should be considered more for further developments in the near future and that African governments should finalize more aviation agreements with these regions. However, the dominant position of Europe sets higher priorities to the strengthening of this synergy. For this reason, it could be interesting to give an additional look over Europe-Africa segment and see how this main sub-market works.

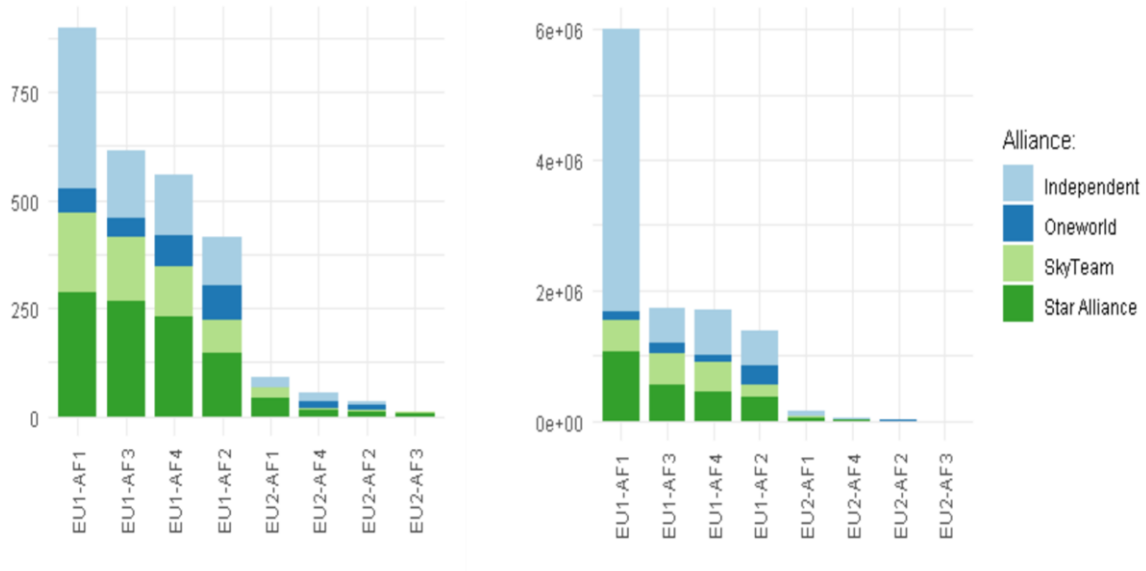

Figure 12 - Routes (left) and passengers (right) on Africa-Europe sub-market overview.

Within European market, the dataset distinguishes two different destinations: EU1, western Europe, and EU2, central/eastern Europe. Apparently, the most relevant sub-market in African aviation is, by far, the one connecting northern Africa and western Europe (AF1-EU1).

Differently from the other macro routes of the sector, AF1-EU1 is very similar to intra-European aviation market structure. The managerial influence consequent to market liberalisation, the enormous possibilities related to tourism and physical proximity to many important European hubs. All these aspects had played an important role into the "westernization" and liberalisation of aviation sector in all northern Africa and mostly in Egypt, Morocco and Algeria, which become the major hubs for connecting sub-Saharan region to the rest of the world. Moreover, many northern African carriers started adopting LCC business model to increase efficiency and to attract new customers.

As discussed before, there are similarities between intra-European's and northern Africa's markets: lot of competition, with the biggest slice of the market share concentrated in just few companies, following Pareto principle, as shown in the top-left corner of figure 13.

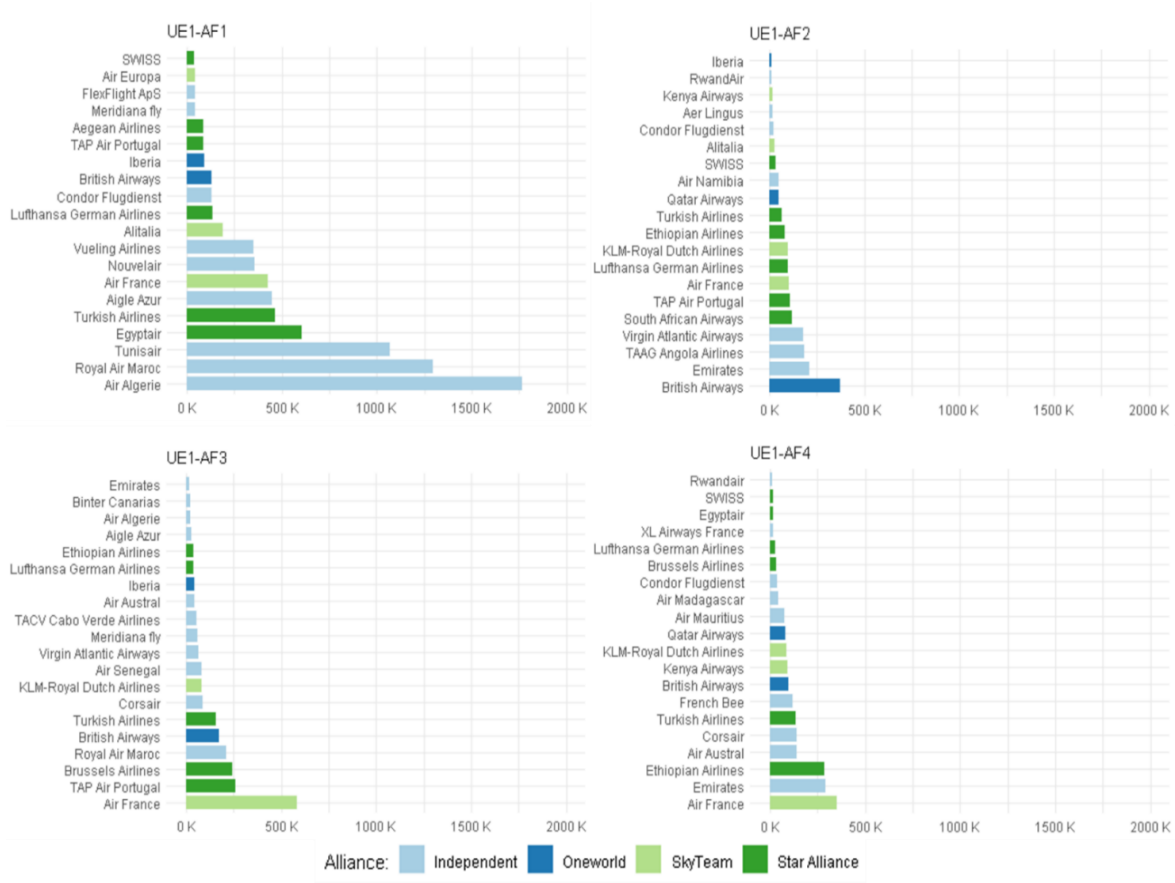

Figure 13 – Mean number of passengers in Western Europe to/from Africa segment (in thousands)

The evidence of independent carriers dominance in the market is undoubted, with carriers associated to alliances trying to keep up and expand their network, although with no significant improvement in these last four years. The following plot shows exactly this: despite the solid position in the market and the business continuity, there is still a huge gap in terms of passengers flows between allied and non-allied companies for what concerns AF1-EU1 routes.

Figure 14 - Total passengers by carriers on AF1-EU1 routes

4.3. Network Analysis

So far, it has been described the structure of the sector, how companies behaved in the past years, their growth and their share in the market. In the overall scenario, one other descriptive analysis is missing that is related to the network's design, i.e. how African cities are connected to the rest of the world. This passage is indeed important to further illustrate which are the most important hubs in the African continent and how they enable the connectivity with other countries. Four graphs will display the air network from each of African macro regions [17], starting from AF1.

The following provides the tools to read the maps that will be displayed.

<u>Legend</u>:

[17] See appendix 2.

Figure 15 – Northern Africa macro region connected to the world.

This first representation shows the dense network of routes connecting northern Africa to the world. However, here the map is cropped to Europe, since the majority of the connections is to the old continent. There are very few connections to the Americas and almost none to Asia and the Southwest pacific.

Most of the African hubs serve also as gateway airports, with Cairo as the most connected among northern Africa cities, followed by Casablanca (the level of connectivity is detected from the intensity of the line in between two airports).

A different scenario is presented for southern Africa (AF2), where a third of the total flights passing through Middle East region, specifically United Arab Emirates, Qatar and Saudi Arabia. Almost a tenth of the flights leans on Addis Ababa airport for the

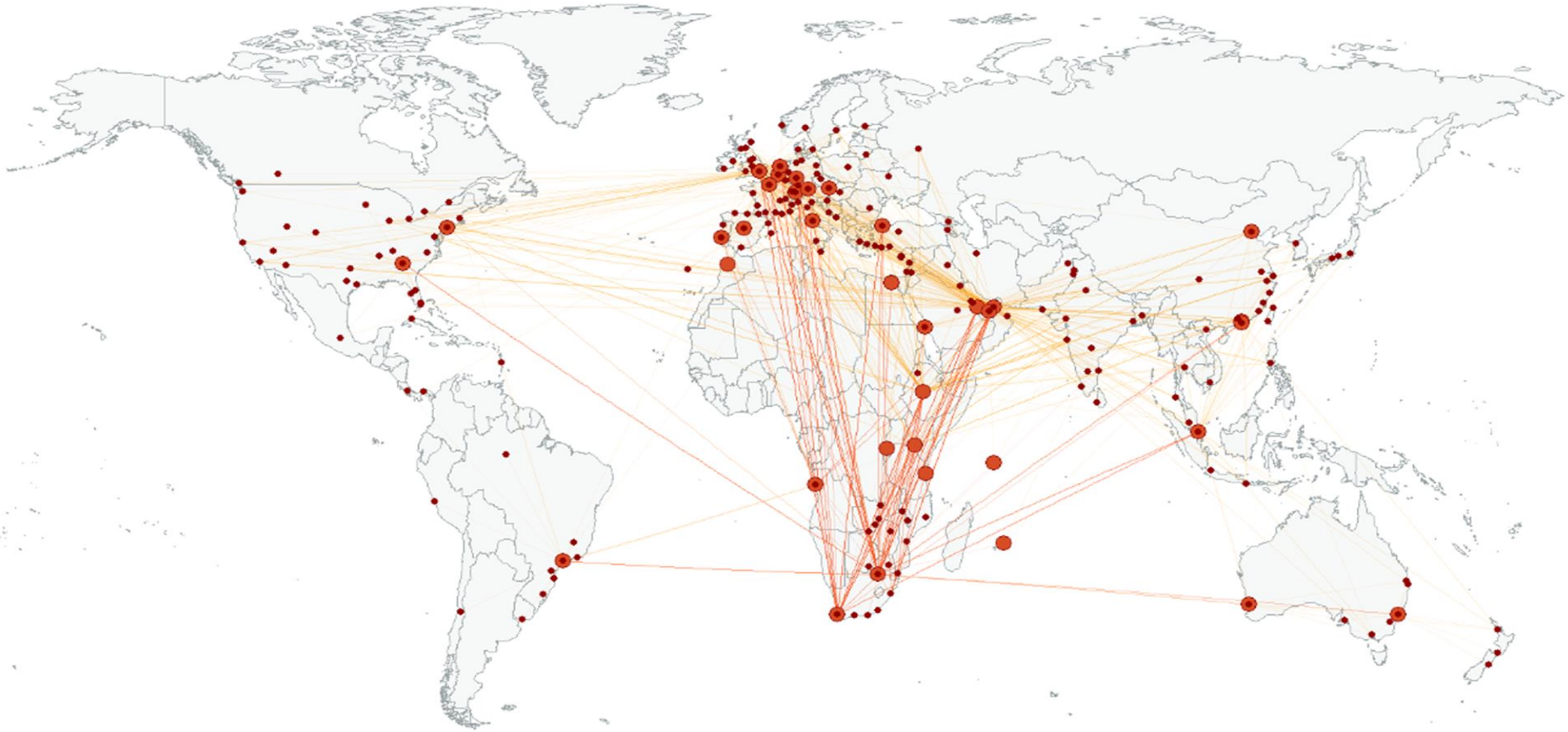

Figure 16 – Southern Africa macro region connected to the world.

lay over to go south. The remaining flights are distributed across Europe, with some exception of direct flights from other continents, like north and south America or Australia.

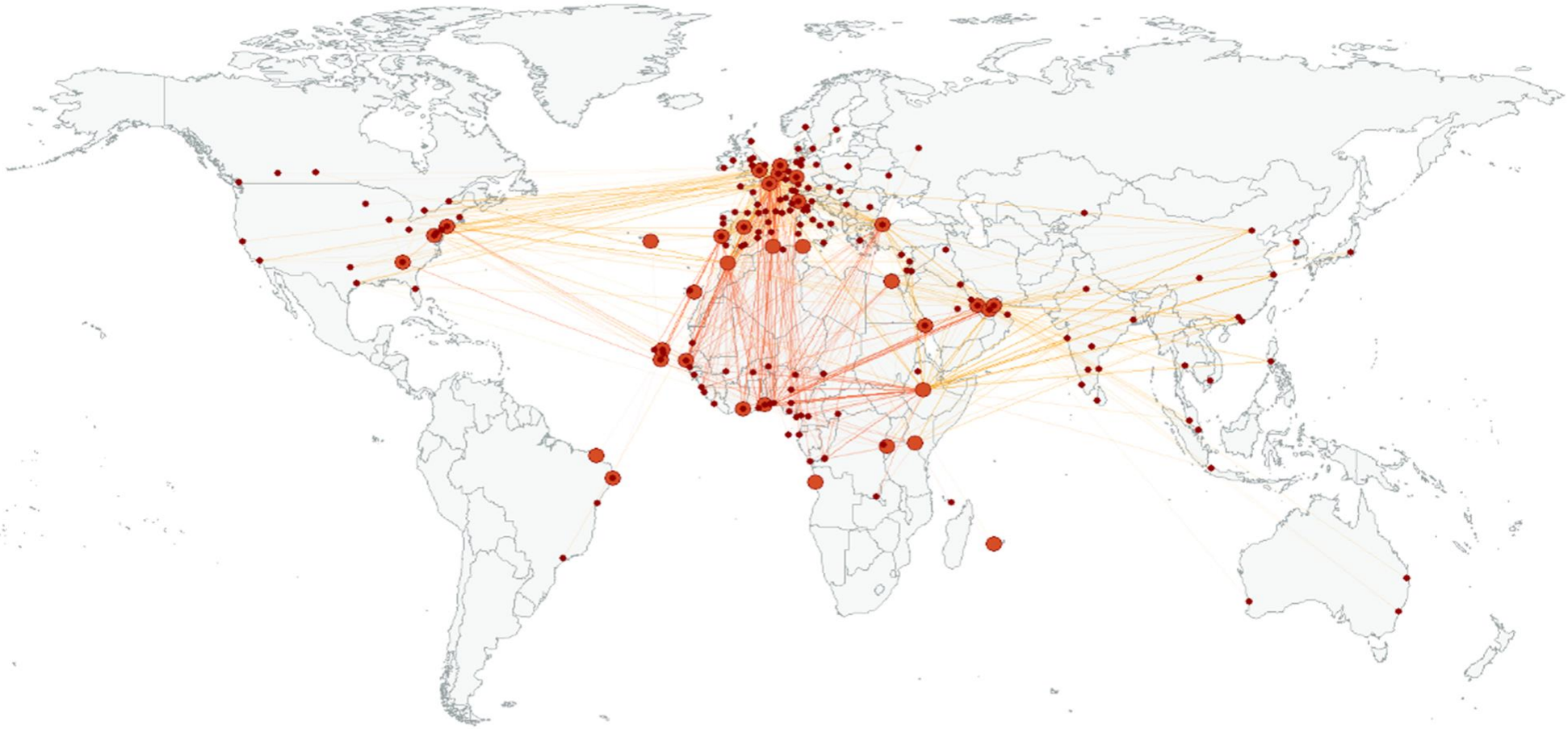

Figure 17 - Western Africa macro region connected to the world.

Western Africa (AF3) network is displayed above: this region is the less developed in terms of air connectivity with other destinations. There are fewer routes both in Asia and north America, Australia and South America provide a very limited set of possibilities. Still, Europe is the main hub

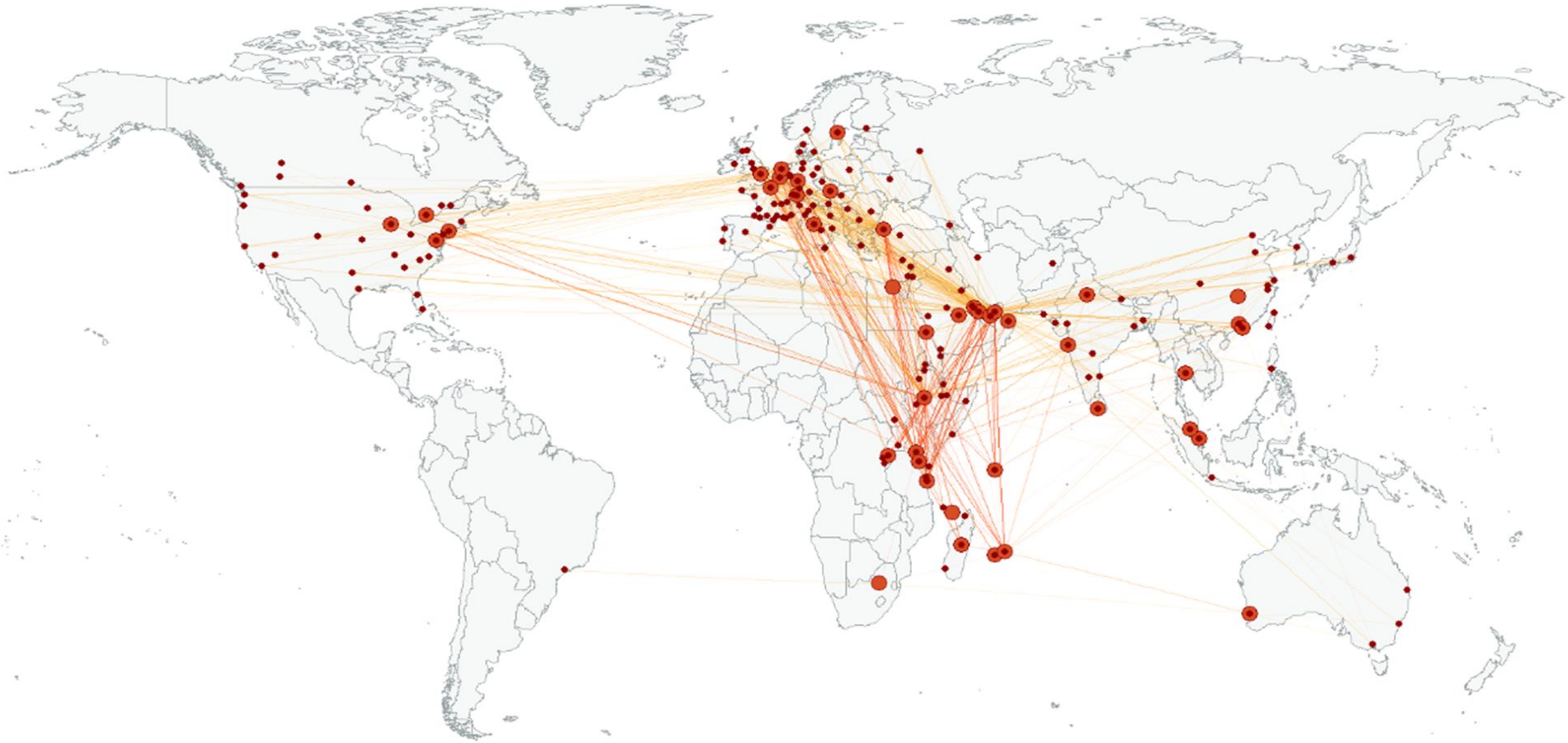

Figure 18 - Eastern Africa macro region connected to the world.

to connect Africa. Finally, it is shown how Eastern Africa (AF4) is connected to the world. Again, Middle East, due also to the nearness, is the center for the connecting flights. South America and Australia are lacking on routes to reach this area either directly or with one layover.

Many conclusions could be drawn from the connectivity maps above. It is confirmed once again the vital role of Europe in connecting Africa to the other markets. Second, Middle East region is becoming another crucial resource both in terms of total passengers originated and as a hub for the other regions. Eastern Africa (AF4) is extending its air network and gaining more and more importance in the continent's connectivity, mostly as a hub. In fact, from the following graph it could be noted a difference between the relatively high connectivity of the region and the very few passengers originating or ending up there.

Finishing with this section, it is presented African cities' weight in terms of passengers per year. Three methods are used to highlight those cities which satisfy a certain level of service:

- The first class represents those cities with a yearly passenger turnover higher than 5 million, namely Algiers, Cairo (by far superior with respect to the others with a yearly passenger flow of almost 24M compared to 8.6M the second best passing through Algiers), Casablanca, Johannesburg and Tunis.
- From 2M to 5M yearly passengers, there are only four cities (Cape Town, Khartoum, Marrakech and Oran)
- The last class of highlighted cities groups by the ones with at least 0.5 M of passengers a year up to 2M.

Even in the representation, northern Africa is the absolute protagonist in the sector. Southern Africa instead, the former most important destination, saw its solid position in the marker dropping to the second place in the last ten years, due to a non-optimal aviation freedoms management. The map also highlights the important issue of western/central African markets: both markets are still extremely underdeveloped and local governments should address new resources to the urgent need for adequate infrastructures.

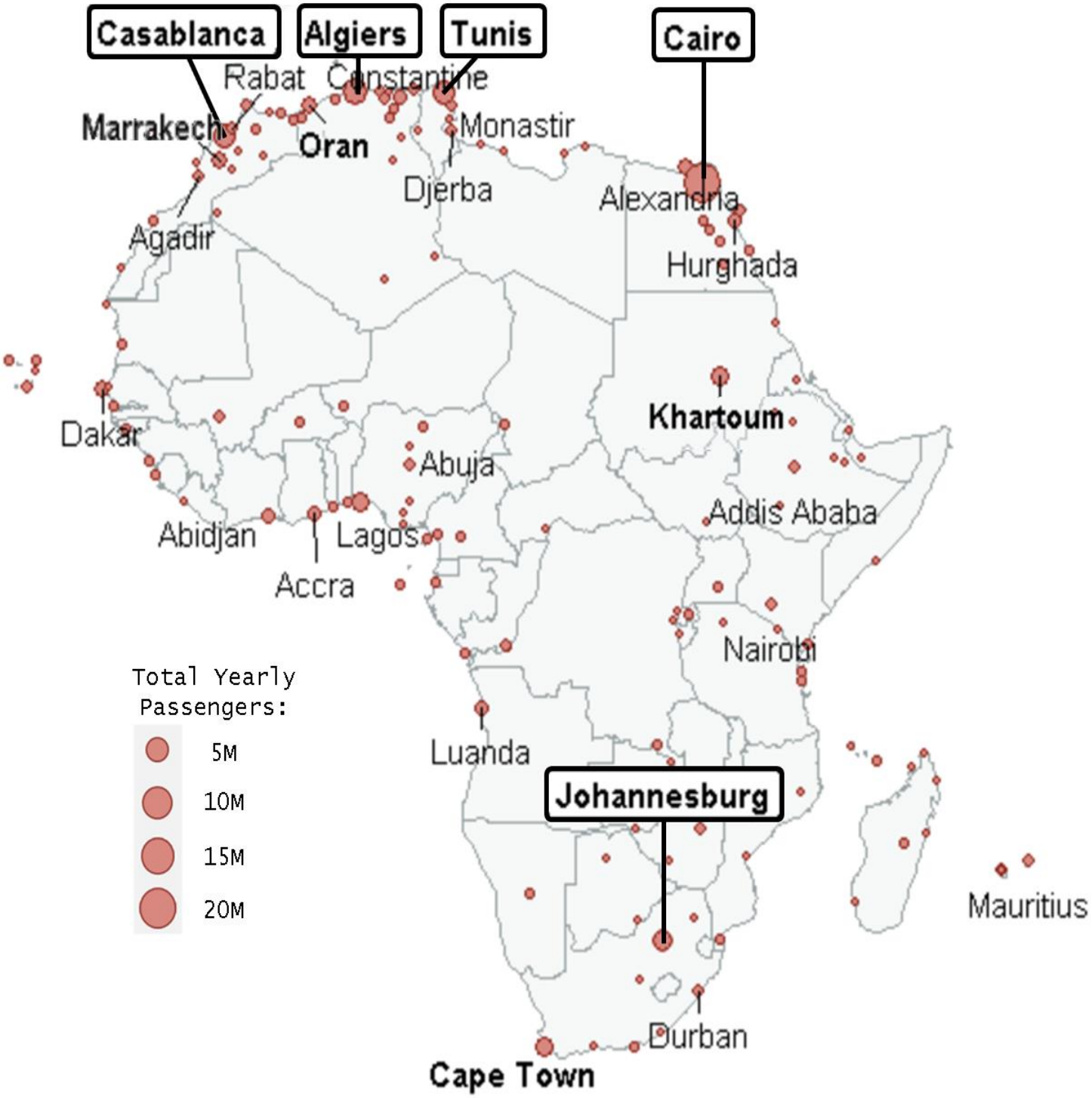

Figure 19 - African hubs and airports mapped by yearly average number of passengers.

5 Econometric Analysis

On one hand, the political background has been revised under theoretical but critical lens. Then the data needed to be processed, to find confirmations of what has been told in the literature, regarding African aviation market flourishing, carrier alliances and their presence in the market, and to provide new insights for further considerations and studies.

In this chapter, several econometric analyses will be performed to quantity either the positive or negative impact of alliances in the current state of things. The main question of the thesis starts from the average price for a flight. How is it influenced by the pressures alliances are exserting in the market? Before digging into that, it will be presented the general structure and the considerations around which the models will be shaped.

The datasets are distinguished between direct flights or gateway-to-gateway (denoted GTF from now on) and connecting flights. As a first step, separated analysis will study each of the two dataset types. Furthermore, data will be grouped on two additional levels. Each line will be characterised by a route, the dominant carrier (i.e., the carrier operating the longest segment in the route) and the time ID, a combination of the year and month in which the flight was performed.

5.1. Independent Variables

Even though the models will address different scenarios, there are several common variables used for the regressions.

Revenue passenger kilometres (RPK) could be used, by multiplying the number of paying passengers by the distance travelled. However, calculating the value in this way would mean to simplify the concept. For this reason, two separated measures, the number of passengers and the distance will be put in the models. Since in this paper both the effect on total average fares and discounted economy fares are tested, each model will have its own measure, evaluated on the respective number of paying passengers.

Acknowledged regressors for this kind of analysis are the origin's and destination's population and gross domestic product per capita. Population refers to the number of censused people in each city in the dataset, while GDP per capita considers the overall domestic production divided by the total population in each State. In order not to insert too many terms in the equations, new variables will be calculated following the geometric mean:

$$JointGDP = \sqrt{GDP\_capita_o * GDP\_capita_d}$$

$$JointPopulation = \sqrt{Population_o * Population_d}$$

With *o* indicating the origin in the route (the first city mentioned in the pair) and *d* representing the destination in the same couple of cities.

Moving on to non-econometric parameters, an interesting measure for the analysis could the number of carriers operating a certain city pair. This variable should provide a very raw, but effective idea of the level of competitiveness on each route, which leads to price changing as recognize universally in the general economic theory. However, there will be a difference between the variable for the GTG flights and the one used for the connecting flights. In the first case, the variable will indicate the number of carriers operating the said origin and destination cities. In the connecting flights dataset, instead, the variable captures the number of pairs of carriers operating the route.

Always referring to the number of carriers on a route, it could be interesting to see the quantitative effect that single carriers, operating both legs in a connecting flight, bring, i.e. to analyze the online flights. In addition, this variable should be used to confirm what many authors say about the impossibility to penetrate the African market. The problem is generally related to the monopolies established by bigger, international carriers which lead to higher fares and limitation in the offered services.

The dataset provides also a binary measure called "Low Cost", which can be included in the regressions to see how prices vary depending on this dummy. Even though low cost is not so popular in this context (see table 3, chapter 3.2), the analysis must consider this dummy to see the impact on fares.

Finally, it is introduced the variable connected to alliances and which will be used to capture the impact of such alliances on flight's prices. However, the models will present variants of the same concept:

- In the direct flight analysis, the regressors related to alliances simply detect whether an alliance is operating the route. In this way it could be checked the quantitative impact on fares.
- About the connecting flights instead, the variables will indicate, in the first place, the presence of an alliance like in GTG case, and then whether the two carriers operating the segments of the route are in the same alliance.

This difference enables to check in the first situation the impact of alliances per se, so to show that the presence of organizations of carriers is actually modifying market's fares. In the second case, it is studied whether the cooperation among carriers of the same alliance creates alternative and (possibly) better conditions for the market. For this reason, in the connecting flights, the lines presenting operating carriers belonging to different alliances are marked as no alliance is actually influencing the route.

The datasets used for the paper are panel data structured, meaning that each observation is cross sectional with respect to the cities pairs and repeated over time. Starting from this, the most suitable model could be selected to perform the coefficients evaluation. Even though fixed effect regression should be the first choice in these cases, it will be provided evidence that such model is not applicable here.

Before that, it should be run a correlation check to avoid variables to be excluded from the analysis. Based on what said in the last paragraph, the independent variables for the very first model will be:

- Distance
- Passengers
- Population geometric mean
- GDP per capita geometric mean
- Number of carriers on the city pair
- Dummy for the presence of low-cost carrier on the city pair
- Dummy for the presence of alliance agreement between operating carriers on the city pair (not included in the correlation plot since the variable is used as a factor)
- "Online" dummy to indicate whether a carrier operated both legs of the route (in the connecting flights model)

To do the correlation check, a simple command will be used on R and the results are presented in the following tabs (discounted economy's tables have not been included since the result is basically the same as the proposed one, with the average fare):

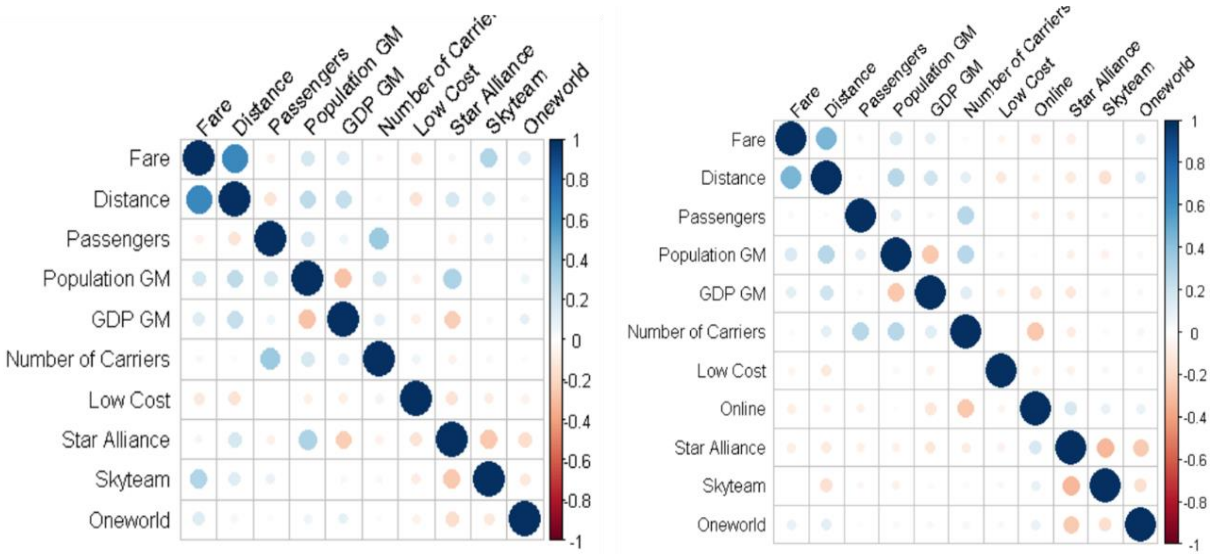

Figure 20- Correlation matrixes for mean fare: GTG flights(left), connecting flights (right)

These plots show clearly that there is no extreme correlation that would lead to a variable drop. In the case of fare and distance in the direct flights dataset, the correlation is not higher than 0.70, and it has been chosen (arbitrarily) to proceed with the value.

5.2. Results

The analysis starts with the simplest regression, to explore all possible outcomes. The first model tries to explain fare variations with the following multiple linear regression:

$$log(Fare_{pct}) = log(Distance_{pct}) + log(Passengers_{pct}) + log(GM\_POP_{pct}) + log(GM\_GDP_{pct}) + Carriers_{pct} + ALLY_{pct} + LCC_{pct} + Online_{pct}$$

Where *p* stands for the city pairs connected by the flight, *c* is the dominant carrier (i.e., the one operating the longest length of the route) and *t* is the combination of month and year when the flight took place. The model is applied to both direct and connecting flights, with the only difference in the Online dummy, since direct flight are by nature operated by a single carrier.

Here is presented the first result. It is compared the linear regression performed on GTG flights (on the left) and the connecting flights (on the right). The most visible difference is in the R^2. The 0.603 R^2 for the direct flights is already a good approximation, with all the regressors being meaningful. On the other hand, connecting flights model seems to suffer a little bit and it does not explain well how fares change.

	log(Fare)			log(Fare)		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	-0.12	-0.22 – -0.03	**0.008**	0.18	0.12 – 0.24	**<0.001**
Distance [log]	0.59	0.59 – 0.60	**<0.001**	0.51	0.51 – 0.52	**<0.001**
Passengers [log]	-0.02	-0.02 – -0.01	**<0.001**	-0.03	-0.03 – -0.03	**<0.001**
Population GM [log]	0.04	0.04 – 0.04	**<0.001**	0.06	0.06 – 0.06	**<0.001**
GDP GM [log]	0.03	0.02 – 0.03	**<0.001**	0.05	0.05 – 0.05	**<0.001**
Number of Carriers	-0.03	-0.04 – -0.01	**<0.001**	-0.04	-0.04 – -0.03	**<0.001**
Alliance Name [Oneworld]	0.37	0.36 – 0.39	**<0.001**	0.12	0.11 – 0.13	**<0.001**
Alliance Name [SkyTeam]	0.45	0.44 – 0.46	**<0.001**	0.14	0.14 – 0.15	**<0.001**
Alliance Name [Star Alliance]	0.09	0.08 – 0.10	**<0.001**	-0.01	-0.01 – -0.00	**0.021**
Low Cost	0.07	0.05 – 0.08	**<0.001**	0.04	0.02 – 0.07	**<0.001**
Online				-0.19	-0.20 – -0.18	**<0.001**
Observations	62535			205783		
R^2 / R^2 adjusted	0.603 / 0.603			0.296 / 0.296		

Table 5 - Linear regression comparing direct (on the left) and connecting flights (on the right)

The step is repeated for discounted economy class, so that the dependent variable is the monthly average fare for discounted economy passengers and the relative number of discounted economy cabins will be considered. The results are not satisfactory for what concerns R^2. Nevertheless, the variables are all significant (see table 6 below). Another regression was launched on the joint dataset of direct and connecting flights, where each line was characterised by a number indicating the connection on that flight. The results in this scenario are not as expected and they will not be shown in the analysis.

	log(`Fare DE`)			log(`Fare DE`)		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
(Intercept)	1.95	1.87 – 2.03	**<0.001**	2.23	2.18 – 2.29	**<0.001**
Distance [log]	0.48	0.48 – 0.49	**<0.001**	0.43	0.43 – 0.43	**<0.001**
Passengers DE [log]	-0.04	-0.05 – -0.04	**<0.001**	-0.05	-0.05 – -0.04	**<0.001**
Population GM [log]	0.01	0.01 – 0.01	**<0.001**	0.02	0.02 – 0.02	**<0.001**
GDP GM [log]	-0.06	-0.06 – -0.05	**<0.001**	-0.04	-0.04 – -0.03	**<0.001**
Number of Carriers	0.03	0.02 – 0.04	**<0.001**	-0.05	-0.05 – -0.04	**<0.001**
Alliance Name [Oneworld]	0.22	0.21 – 0.24	**<0.001**	0.07	0.06 – 0.08	**<0.001**
Alliance Name [SkyTeam]	0.29	0.28 – 0.30	**<0.001**	0.10	0.09 – 0.10	**<0.001**
Alliance Name [Star Alliance]	0.03	0.03 – 0.04	**<0.001**	-0.02	-0.02 – -0.01	**<0.001**
Low Cost	0.08	0.07 – 0.09	**<0.001**	0.01	-0.01 – 0.03	0.525
Online				-0.20	-0.21 – -0.19	**<0.001**
Observations	62302			205783		
R^2 / R^2 adjusted	0.545 / 0.545			0.244 / 0.244		

Table 6 - Linear regression results for discounted economy first model; direct flights on the left, connecting on the right.

These tests were performed to check whether, to each alliance, was associated a meaningful coefficient, describing the alliance singular effect on fares. Bearing in mind the main point of the thesis, these models do not provide a realistic picture of how alliances impact fares in aviation market. Brueckner (2019), Calzaretta (2017), Lazzarini (2004), Wan (2009), among many others in the literature, found and explained why the existence of carrier alliances leads to higher prices in non-stop routes, while they provide sensitive fare discounts in connecting routes market. As shown in the previous tables, not only this behaviour is not followed, but there is no clear path that allows either to confirm or deny the other's conclusions.

Something that could explain this anomaly is related to both the size and the structure of African market. Abate (2013), Al kwifi (2019), Heinz (2013), Irandu (2008) argue in their studies that the heterogeneity in passengers load, flights frequencies and infrastructures makes it impossible to compare African market to any other aviation ecosystem. Beside the numbers per se, the main reason why linear regression models cannot be applied in this case is purely a statistics matter. Even though the R^2 is sufficiently high and the coefficients are significant, the fitted values do not provide a good approximation of the data.

The alternative to linear regression is panel data regression. Among the existing types of panel data regressions, many authors suggest the fixed effect model when it comes to aviation fare studying. The fixed effect model allows to isolate the time invariant part of a variable to better understand how the time variant part generates diversity in the observations. In our case, however, mainly two problems arise:

- The four years time span is not long enough for studying changings in population and GDP and the model would consider them as fixed, or not sufficiently changing over the analysed period. For this reason, population and GDP should be dropped. The same would happen to distance that, by definition, is fixed over time and so it should be dropped as well.
- Since the market did not grow as expected in these years, also the time variant measures would suffer if included into a fixed effect panel data regression.

Given these considerations, a random effect panel data will be applied in our case, starting from the model used before with the multiple linear regression.

Oneway (time) effect Random Effect Model

	Direct Flights				**Connecting Flights**			
Predictors	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*
(Intercept)	-0.44	-8.84	< 2.2E-16	0.10256	-0.05	-1.29	0.19855	0.745548
Distance [Log]	0.59	207.51	< 2.2E-16	< 2.2E-16	0.56	238.34	< 2.2E-16	< 2.2E-16
Passengers [Log]	-0.01	-2.98	0.002914	0.562186	-0.04	-14.87	< 2.2E-16	1.94E-05
Population GM [Log]	0.05	24.59	< 2.2E-16	6.054E-09	0.05	33.27	< 2.2E-16	1.42E-14
GDP GM [Log]	0.03	8.41	< 2.2E-16	0.121975	0.04	16.76	< 2.2E-16	3.46E-05
Number of Carriers	0.03	2.59	0.009581	0.456898	-0.03	-16.60	< 2.2E-16	9.60E-06
Low Cost	0.07	8.09	< 2.2E-16	0.044161	0.08	6.39	1.70E-10	0.005582
Online					-0.05	-6.70	2.15E-11	0.031098
Star Alliance	0.08	15.64	< 2.2E-16	0.0022560	0.01	3.20	4.24E-15	0.0136
Skyteam	0.49	76.46	< 2.2E-16	< 2.2E-16	0.19	43.93	< 2.2E-16	< 2.2E-16
Oneworld	0.32	39.48	< 2.2E-16	1.06E-14	0.11	18.02	< 2.2E-16	8.92E-09

Observations	50029	Observations	122045
R^2/ R^2 Adjusted	0.625/0.625	R^2/ R^2 Adjusted	0.389/0.389

Table 7 - Panel data regression. Direct flights on the left, connecting on the right

The first results show the comparison between direct and connecting flights. Both types of flights provided almost the same R^2 with respect to their linear regression counterpart, however, the new ones are not as robust as the previous.

Oneway (time) effect Random Effect Model

	Direct Flights DE				**Connecting Flights DE**			
Predictors	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*
(Intercept)	1.73	39.44	< 2.2E-16	4.57E-16	1.79	49.61	< 2.2E-16	< 2.2E-16
Distance [Log]	0.48	195.94	< 2.2E-16	< 2.2E-16	0.48	220.23	< 2.2E-16	< 2.2E-16
Passengers DE [Log]	-0.05	-24.67	< 2.2E-16	2.32E-08	-0.04	-18.30	< 2.2E-16	5.36E-08
Population GM [Log]	0.02	12.99	< 2.2E-16	0.002071	0.02	11.40	< 2.2E-16	6.28E-03
GDP GM [Log]	-0.06	-16.85	< 2.2E-16	0.001168	-0.04	-20.43	< 2.2E-16	3.51E-07
Number of Carriers	0.05	5.50	3.76E-08	0.049605	-0.06	-32.37	< 2.2E-16	2.50E-15
Low Cost	0.07	9.51	< 2.2E-16	0.021258	0.07	6.20	5.64E-10	0.00646
Online					-0.11	-15.57	< 2.2E-16	7.71E-07
Star Alliance	0.03	6.36	2.03E-10	0.1731060	0.01	3.40	0.00067	0.345438
Skyteam	0.32	57.46	< 2.2E-16	< 2.2E-16	0.16	38.64	< 2.2E-16	< 2.2E-16
Oneworld	0.24	33.80	< 2.2E-16	1.09E-13	0.10	17.60	< 2.2E-16	8.73E-09

Observations	50029	Observations	122045
R^2/ R^2 Adjusted	0.582/0.581	R^2/ R^2 Adjusted	0.338/0.337

Table 8 - Discounted economy first panel regression

Like in the linear regression, some coefficients are not what expected from the literature: the number of carriers in the direct flights shows that fares increase as the number of competitors increases and that the presence on low-cost carrier increase as well the route's fare. Most importantly, the presence of carrier alliances leads to higher fare in both non-stop and connecting flights, no matter the alliance a carrier belongs to and which is clearly in contrast to what most of the authors found by studying other aviation markets. The first point could be explained in a very simple way. The maximum number of carriers operating a route in the direct flights is three, so that the competition is reduced to an oligopoly. For this, price might be higher in those routes. The second issue is related to the way data was collected. OAG sets the dummy low cost =1 in the presence of, at least, one low-cost carrier operating a route, so that the interpretation of this coefficient might be tricky. Bearing in mind this market's singularity and all the environment this paper works in, it is still difficult to consider these results as acceptable.

Analysing the alliances alone, a coefficient has been assigned to each of them. Even though it was not as predicted for what regards the coefficients' signs, both direct and

connecting, as well as both DE passengers and total passengers regressions agree that flying within SkyTeam network leads to higher fares. The second issue with alliances is that Star Alliance has always a non-significant or a low significance coefficient and the causes should be further investigated.

To solve the robustness problem, first the variable "Low Cost" is dropped, since it is clearly misleading and its impact on the result could be significant. Another corrective action was found while performing test regressions. It seems that merging both direct and connecting flights, the coefficients' significance increases. For this reason, a new combined dataset will be processed, and a variable indicating the number of legs (called Connections) will be introduced to characterise each line. Another point in favour of the merging is that alliances' coefficients have the same positive sign, so that no alteration should be created by combining the two starting datasets. Nevertheless, the alliances' dummies and their values are the main outputs for the paper, so that they will be monitored to see whether their significance increase.

Oneway (time) effect Random Effect Model

	Direct Flights + Connecting Flights					**Direct Flights + Connecting Flights DE**			
Predictors	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*	*Predictors*	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*
(Intercept)	0.02	0.65	0.516500	0.88254	(Intercept)	1.89	61.88	< 2.2E-16	< 2.2E-16
Distance [Log]	0.55	283.96	< 2.2E-16	< 2.2E-16	Distance [Log]	0.46	265.99	< 2.2E-16	< 2.2E-16
Passengers [Log]	-0.02	-9.92	< 2.2E-16	0.0112418	Passengers [Log]	-0.03	-22.05	< 2.2E-16	3.63E-10
Population GM [Log]	0.07	49.33	< 2.2E-16	< 2.2E-16	Population GM [Log]	0.03	26.76	< 2.2E-16	9.68E-11
GDP GM [Log]	0.04	19.78	< 2.2E-16	5.46E-06	GDP GM [Log]	0.04	-21.52	< 2.2E-16	5.08E-07
Number of Carriers	-0.03	-13.50	< 2.2E-16	0.0004031	Number of Carriers	-0.06	-32.47	< 2.2E-16	5.51E-15
Online	-0.04	-4.77	1.87E-06	0.1230468	Online	-0.12	-15.80	< 2.2E-16	3.76E-07
Connections	-0.15	-39.31	< 2.2E-16	< 2.2E-16	Connections	-0.12	-35.01	< 2.2E-16	< 2.2E-16
Star Alliance	0.02	5.56	2.78E-08	0.0151814	Star Alliance	0.01	3.79	1.53E-04	0.3255000
Skyteam	0.22	55.83	< 2.2E-16	< 2.2E-16	Skyteam	0.18	48.28	< 2.2E-16	< 2.2E-16
Oneworld	0.12	22.87	< 2.2E-16	5.18E-11	Oneworld	0.12	24.15	< 2.2E-16	1.52E-12
Observations	150617				Observations	150617			
R^2/ R^2 Adjusted	0.465/0.465				R^2/ R^2 Adjusted	0.435/0.435			

Table 9 - Panel results (GTG plus Connecting). Total passengers table on the left, DE on the right

Looking at table 9 it could be seen a substantial change from the previous results: The presence of connections, with the consequent cost splitting for the two operating carriers, allow companies to charge a lower fare (at least in the aviation market in general). Though, online variable's negative coefficient leads to the opposite

conclusion and it seems that one carrier, operating the entire route, generates positive effect on fares. If this sounds anomalous in the overall aviation context, it could be considered normal within African borders. As discussed in chapter 1.1, several factors make it complex to connect African countries to the world, mostly because of an incomplete air deregulation, and for this, fares might increase when more than one carrier operates a route. Second, a higher number of carriers on a route decreases fares as the economic theory suggests for competitive markets. Even before the connecting flights-based regressions provided the same result, while the GTG did not and it is basically due to the higher proportion of connecting flights with respect to GTG ones, which is almost 3:1.

Coming to Alliances' coefficients, SkyTeam is confirmed to be the most expensive of the three main competitors in the aviation market, followed by Oneworld and Star alliance. However, this last one is still to be questioned for its significance.

Even though the study refers to Africa and its aviation sector, none of the models include variables that are connected to the data's origin. Two types of regressors will be introduced in the next run, in addition to the existing set. The first, called "African" is a dummy variable indicating whether the route is operated by at least one African carrier. Then, geographical dummies will be inserted in the equation with the aim of capturing any African sub-market related effect and they will be called with the name of the region they refer to (AF1, AF2, AF4. AF3 is used a base case and will not be included). Each dummy is equal to one when a flight originated or ended in a city belonging to that region. In this way, the model should be enabled to look at a more direct relation between the market and the continent.

The results are shown below, in table 10. All new variables have a positive impact on the result. "African" dummy indicates that the presence of an African carrier on a route leads to a lower fare of approximately 8% less for the avarage fare and 3% on the discounted economy fare (remembering the regressions are evaluated with the logarithm, so that the results indicate how sensitive the dependent variable is with

Oneway (time) effect Random Effect Model

	Direct Flights + Connecting Flights					Direct Flights + Connecting Flights DE			
Predictors	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*	*Predictors*	*Estimates*	*z-values*	*Pr(>|z|)*	*Robust Pr(>|z|)*
(Intercept)	0.54	15.39	< 2.2E-16	3.58E-04	(Intercept)	1.85	57.78	< 2.2E-16	< 2.2E-16
Distance [Log]	0.49	201.18	< 2.2E-16	< 2.2E-16	Distance [Log]	0.47	206.83	< 2.2E-16	< 2.2E-16
Passengers [Log]	-0.01	-6.62	3.49E-11	7.06E-03	Passengers [Log]	-0.03	-21.30	< 2.2E-16	1.02E-09
Population GM [Log]	0.07	50.19	< 2.2E-16	< 2.2E-16	Population GM [Log]	0.04	28.98	< 2.2E-16	2.26E-12
GDP GM [Log]	0.04	21.95	< 2.2E-16	6.65E-07	GDP GM [Log]	0.03	-14.42	< 2.2E-16	8.44E-04
Number of Carriers	-0.04	-19.10	< 2.2E-16	7.74E-07	Number of Carriers	-0.06	-34.81	< 2.2E-16	< 2.2E-16
Online	-0.10	-12.09	< 2.2E-16	1.01E-04	Online	-0.14	-19.36	< 2.2E-16	8.66E-10
Connections	-0.14	-36.53	< 2.2E-16	< 2.2E-16	Connections	-0.12	-35.46	< 2.2E-16	< 2.2E-16
Star Alliance	0.02	6.47	9.49E-11	4.74E-02	Star Alliance	-0.001	-0.23	8.19E-11	9.51E-03
Skyteam	0.19	48.85	< 2.2E-16	< 2.2E-16	Skyteam	0.15	41.97	< 2.2E-16	< 2.2E-16
Oneworld	0.11	20.32	< 2.2E-16	1.10E-08	Oneworld	0.12	24.75	< 2.2E-16	1.22E-12
African	-0.08	-30.09	< 2.2E-16	5.69E-16	African	-0.03	-13.00	< 2.2E-16	5.16E-04
AF1	-0.18	-50.26	< 2.2E-16	< 2.2E-16	AF1	-0.10	-29.81	< 2.2E-16	2.14E-11
AF2	-0.05	-12.65	< 2.2E-16	1.66E-02	AF2	-0.15	-42.77	< 2.2E-16	< 2.2E-16
AF4	-0.15	-44.40	< 2.2E-16	< 2.2E-16	AF4	-0.12	-38.21	< 2.2E-16	< 2.2E-16
Observations	150617				Observations	150617			
R^2/ R^2 Adjusted	0.48/0.48				R^2/ R^2 Adjusted	0.435/0.435			

Table 10 - Second panel data results. Average fares on the left, discounted economy fares on the right

respect to a unitary change of each of the regressors). For what concerns the geographic dummies, as well as for the alliances coefficients, it should be kept in mind that they refer to the respective base case and they should not be read as single values. The firsts show that flying from/to all Africa but AF3 (which was selected as the base case) is cheaper. This was expected since AF3 is the less developed region among the four with regards to infrastructures and volumes. It is not a surprise either that flying from/to Northern Africa is the cheapest solution, both for the incredible number of flights connecting Africa to Europe and for the presence of important hubs in Morocco and Egypt thanks to which economies of scale can be adopted with the resulting fare reductions.

Alliances' coefficients have been evaluated on the base case of independent carriers i.e., all the ones not associated to an alliance. Remembering this consideration, they all provide higher fares with respect to the non-allied carriers. Like the previous regressions, SkyTeam is the most expensive with a 15% in DE fares and 19% increase for the average fares. oneworld follows up with 12% and 11% increase respectively for DE and average fares. Star Alliance is again the cheapest, however its coefficient is

very almost equal to the independent cases and it is close to the non-significance (at least at the 5% level).

R^2 is improved from the first joint case of GTG plus connecting flights even if by a small percentage. 48% in the average fares and 43% in the discounted economy could be considered acceptable since all coefficients are valuable. For sure other suitable regressors could be found outside this domain, perhaps like Brueckner (2019) and Calzaretta (2017) or Whalen (2005) introducing a more detailed division on the agreement's levels and types i.e., codeshare, antitrust immunity and joint venture. However, the point of this thesis is to focus on the alliance and its impact on the market. Moreover, they applied this structure to US aviation market datasets which is a much more complete and consolidated set of data.

A final regression could be run, by creating a dummy variable equal to one in the case a carrier is both African and associated to an alliance. The result could be interesting for the sake of providing a guideline to the other African carriers, to answer a critical question raised in this paper (and in many other regarding African aviation): is it convenient for smaller African carriers to join an international alliance? However, the actual data is not sufficient to generate this dummy. In the first place for the reduced number of carriers actually involved in alliances, for which the results might be too small to be seen. Second there are too few African carriers holding significant shares of the market. Third, the majority of the remaining carriers (small and mainly used for local and short routes) would need an extremely high quantity of resources for improving their infrastructures before actually try to enter an alliance.

Conclusions

Both descriptive data analysis and quantitative analysis have been performed to study, on different levels, the current set of data. For what concerns the first part, it was detected the depth of aviation alliance's penetration into the African market. Up to now, the main three carrier alliances have not been able to penetrate this market and to produce revolutionary changes in the way aviation is managed. Above all, figure 11 perfectly show the difficulties and the slowness African market is facing in the four years that have been analysed. The evident reliance (if not dependence) African aviation puts on European routes and carriers is the most important factor for the continent's development as a whole, but at the same time, it represents the curse for local carriers that are struggling to establish themselves in the market. What is clear from the graphs is that carriers associated to alliances are in dominant positions in African market: both passenger flow and number of operated routes make believe that the synergies emerging from alliance agreements lead to increases in performances and market share. AF1-EU1 segment is the only exception to this consolidated rule. In these four years, and for many in the future, the big three local carriers will continue to dictate the pace [18]. If northern African's governments and carriers' high management will be able to manage the covid-19 situation, the area will blossom even at a higher speed than before. Still considering segments to be developed, a lot of attention must be put on both Middle East area and Asia, China in specific. By changing how international air privileges are granted, both macro areas will enjoy a mutual boost in aviation sector.

Analysing the network's structure, each of the four Africa macro regions should adopt new directives to improve in quantity and passenger volumes the existing connections. Starting from the less developed area, which is AF3. Considering the variety of countries, carriers and business opportunities that could be found in this region (especially in the Gulf of Guinea area), some solutions might help the region opening up to the world. Almost ten years ago, Air Afrique [19] was dismissed and the

[18] The carriers in question are: Air Algeri, Tunisiair, Royal Air Moroc. Considering that Royal Air Moroc is a new joiner of oneworld, the remaining are still characterising a very important slice of the segment.
[19] The first attempt of a Pan-African carrier, managed by several African countries, that went bankrupt a year after the events at the twin towers in 2001.

dream of a pan-African airline disappeared. However, times have changed, management has changed, the market has changed and 09-11 is just a bad memory that people (and aviation sector) are trying to get over. The point is, Western Africa Nations could rebuild Air Afrique from its ashes, but with a new awareness and new directions to aim at. With the proper managerial knowledge and a joint effort to create an efficient infrastructure, the aviation sector in the region might have a chance to enter in the market's upper positions. Continuing with the analysis, AF4 is a very promising region, with lot of possibilities for connecting Africa to the East of the world. As said previously in the chapter, attention should be put by strengthening this relation. The role of Khartoum and Addis Ababa airports will be vital in the process. Moving on to AF2, the region has already the competencies, tourism and mineral extraction opportunities to leverage on in order to increase its passenger flow. Though, the more effective solution proposed in northern Africa indicates that a lot of work is to be done if the region wants its first position back. If not going north to increase the connectivity to Europe, agreements should be stipulated with south America's countries on one side and Middle East, India and Australia on the other. Finally, no remarks will be said on AF1 area, since it provided already a clear example of effectiveness and efficiency (at least within the African context). The only note regards Royal Air Moroc entering oneworld: it will be interesting to see how the market balance is shifted after this and what will be the effect on other African carriers in the near future.

At last, the regressions' results will be commented. The key point on the empirical analysis was to provide a quantitative value indicating how the three main carrier alliances affect fares in the African market.

The final regression provides a very interesting insight; however, these results are not going to explain African situation by only looking at the coefficients themselves. Carriers associated to alliances tend to set higher fares with respect to non-allied carriers, both in GTG and one stop connecting flights. This evidence is clearly in contrast with the literature, though the result is significant.

Concerning the coefficients, the reason why Star Alliance is the cheapest in African market is certainly related to the strategic agreements made with local key carriers (Ethiopian in the first place, Egyptair and South African Airways), suggesting that entering an alliance does lead to benefits for both parties in terms of passenger volume, number of routes operated and cost reduction. A further supporting evidence is the

timing African carriers joined Star alliance. At the time Ethiopian Airlines entered the alliance (2011), South African Airways was one of the most powerful carriers in the continent, while now it has a secondary role in this market's scene and Ethiopian is in the top 5 of African's carriers. This also means that the membership alone cannot guarantee for short term success and it has to be supported by managerial skills from the inside of the company and regulation flexibility from a political point of view. Another extremely critical aspect is how an alliance value the presence of an African carrier in their ranks. As already explained earlier in the paper, there is a long list of requirements that alliances need to check before accepting a new joiner. If the candidate cannot provide strategic advantages to the group, either in terms of stable passenger flow or resources or even know-how, there are very few possibilities that African carriers will enter an alliance. This is exactly the main challenge for the future of local carriers.

On the other hand, there is Skyteam, the most expensive of the three carrier alliances analysed in this paper. Currently it has made an agreement with only Kenya Airways. According to figure 5, this carrier is not even in the top 20 for what concerns the yearly passenger volume. Either the alliance has no interest in entering the market with a big share, or it has not come to better arrangements with more powerful carriers in the market, remembering that Tunisiair and Air Algeri are currently not associated to an alliance and they provide most of the AF1-EU1 services. In both cases, the motive why Skyteam is the most expensive alliance hold and is reasonable since it relies on non-African carriers, in the first place, which necessarily leads to higher fares. In addition to it, Skyteam has not sufficient passenger volume and flight frequency to set lower fares and be sustainable at the same time.

In the comparative overview of alliances' impact and penetration into African market, oneworld has the lowest values (see table 4, reproposed below).

	2016			2017			2018			2019			
	Total Passengers	Routes	African Countries	Total Passengers	Routes	African Countries	Total Passengers	Routes	African Countries	Total Passengers	Routes	African Countries	African Carriers in Alliances (DEC 2019)
Oneworld	1,595,717	696	22	1,612,303	743	21	1,428,537	600	21	1,430,755	647	21	/
SkyTeam	1,970,068	941	42	2,331,403	965	40	2,665,965	1,004	40	2,594,713	1,012	42	Kenya Airways
Star Alliance	3,609,231	1,508	48	4,000,690	1,680	49	4,421,885	1,803	49	4,723,521	1,941	49	Ethiopian Airlines; Egyptair; South African Airways.
Grand Total	**7,175,016**	**3,145**		**7,944,396**	**3,388**		**8,516,387**	**3,407**		**8,748,989**	**3,600**		

Among the three alliances, oneworld is the only one not showing an increase in yearly passengers, it has the lowest number of routes and operates in half of the countries the other alliances do. Actually, it is quite surprising that it is not the most expensive alliance on the market. Nevertheless, it could be said that this alliance has and will have the least impact in African aviation market, so that African carriers willing to enter an alliance should not be looking for oneworld.

In conclusion, both qualitative and empirical analysis over African aviation market come to the same point: even though there is a significant increase in performances when carriers enter an alliance, fares necessarily increase as well. If in the wider scheme of the global aviation market this is not true and alliance's presence lowers fares, it becomes an option when referring to a smaller and less developed market like the African one.

Possible Extensions

After having analysed African aviation sector with the datasets provided, several questions and peculiarities might be the basis for other studies, perhaps more centred around each of the topics listed below. The impossibility to include them within the terms of this thesis lies in their very niche theme that makes them either too specific for the purpose of the paper or too time consuming. In reality, embodying the necessary information would require not so many extra datasets, but still a considerable amount of data that is missing in the current situation. While investigating the impact of alliances over fares within African market, the following issues emerged:

1. Here in this paper, it has been deepened the relationship between carrier alliances and fares. However, African carriers are not well integrated within these international organizations as just few carriers belong to one of the major alliances in the market. It could be interesting to study how minor African carriers interact with each other at a local level first and then in the wider international context, how these connections enhance changings in fares or if there are other cooperation schemes to gain market share. Beside alliance agreements, there are other ways in which companies could interact, obtaining mutual benefits and still compete in the same market, as explained in chapter 2.
2. Regarding one of the main assumptions for this paper, it was decided not to include 2020 data into the analysis. Introducing information that are clearly affected by an endogenous factor such as the global pandemic might have altered drastically the overall result. In the following years, it could be studied whether and how aviation companies (either African or international) survived the pandemic and how they were able to create stability and continuity for their business. Nowadays, the literature is overcrowded with cases related to the concept of resilience, even in the aviation sector. But, have African carriers been carrying on (correct) policies to face this anomalous situation?
3. Many authors start from a single city or sub-region within African borders to frame their studies. While in this paper the focus was put on macro regions and mostly on northern Africa-to-Europe connection. Instead of considering just a

small region, many cases of different carriers and airports which present common business features should be taken into account, to compare them and to find patterns to explain their outstanding results. It could be not only interesting, but also important for local aviation development to understand why and how those four hubs in northern Africa (Algiers, Cairo, Casablanca and Tunis) succeeded in becoming the pillars for African aviation sector. The point could be useful both for them to grow further and for other African carriers which are willing to expand their influence over the territory by emulating successful business models.

4. Alongside with EU-AF routes, Mideast and Asian markets are gaining ground in the battle of connecting Africa to the world. Still, there are not the numbers to compare the European impact over African aviation development to those of the other two macro regions. However, China has shown interest in Africa by financing the continent and in these last ten years or so. Financial aids have been granted to African countries, mainly for infrastructures investments and they are often part of larger commercial agreements which include several importing/exporting benefits. How will this impact over Africa-to-China connectivity? And to the market in general?

Appendix

Appendix 1: Aviation Freedoms[20]

- First Freedom of the Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State or States to fly across its territory without landing (also known as a First Freedom Right).
- Second Freedom of the Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State or States to land in its territory for non-traffic.
- Third Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State to put down, in the territory of the first State, traffic coming from the home State of the carrier.
- Fourth Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State to take on, in the territory of the first State, traffic destined for the home State of the carrier.
- Fifth Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State to put down and to take on, in the territory of the first State, traffic coming from or destined to a third State.
- Sixth Freedom of The Air - the right or privilege, in respect of scheduled international air services, of transporting, via the home State of the carrier, traffic moving between two other States.
- Seventh Freedom of The Air - the right or privilege, in respect of scheduled international air services, granted by one State to another State, of transporting traffic between the territory of the granting State and any third State with no requirement to include on such operation any point in the territory of the recipient State, i.e the service need not connect to or be an extension of any service to/from the home State of the carrier.

[20] International Civil Aviation Organization, 2016, *Manual on the Regulation of International Air Transport (Doc 9626, Part 4)*

- Eighth Freedom of The Air - the right or privilege, in respect of scheduled international air services, of transporting cabotage traffic between two points in the territory of the granting State on a service which originates or terminates in the home country of the foreign carrier or outside the territory of the granting State.
- Ninth Freedom of The Air - the right or privilege of transporting cabotage traffic of the granting State on a service performed entirely within the territory of the granting State.

Appendix 2: Macro-Regions Acronyms

AF1 Africa: North Africa
AF2 Africa: Southern Africa
AF3 Africa: Central/Western Africa
AF4 Africa: Eastern Africa
AS1 Asia: South Asia
AS3 Asia: South East Asia
AS4 Asia: North East Asia
EU1 Europe: Western Europe
EU2 Europe: Eastern/Central Europe
LA4 Latin America: Lower South America
ME1 Middle East
NA1 North America
SW1 Southwest Pacific

Summary of Tables & Figures

Econometric Analysis:

References

1. Abate, M., (2013). *Economic Effects of Air Transport Market Liberalization in Africa*.
2. Adler, N., Njoya, E.T., Volta, N., (2018). *The multi-airline p-hub median problem applied to the African aviation market.*
3. Al-Kwifi, O., Frankwick, G.L., Ahmed, Z.U., (2019). *Achieving rapid internationalization of sub-Saharan African firms: Ethiopian Airlines' operations under challenging conditions.*
4. Ahmed, A.H., Ochieng, M.D., (2014). *The Effects of Privatization on the Financial Performance of Kenya Airways*.
5. Amankwah-Amoah, J., Debrah, Y.A., (2011). *Competing for scarce talent in a liberalised environment: evidence from the aviation industry in Africa*.
6. Amankwah-Amoah, J., Debrah, Y.A., (2011). *The Evolution of Alliances in the Global Airline Industry: A Review of the African Experience*.
7. Bassens, D., Derudder, B. Otiso, K., Storme, T. & Witlox, F., (2012). *African Gateways: Measuring airline connectivity change for Africa's global urban networks in the 2003-2009 period.*
8. Brueckner, J.K., Whalen, W.T., (2000). *The Price Effects of International Airline Alliances.*
9. Brueckner, J.K., (2003). *International Airfares in the Age of Alliances: The Effects of Codesharing and Antitrust Immunity*.
10. Brueckner, J.K., Singer, E., (2019). *Pricing by International Airline Alliances: A Retrospective Study Using Supplementary Foreign-Carrier Fare Data.*
11. Button, K., Drexler, J., (2006). *The Implications on Economic Performance in Europe of Further Liberalization of the Transatlantic Air Market*.
12. Button, K., Martini, G., Scotti, D., (2014). *Economic Efficiency of European Air Traffic Control Systems.*
13. Button, K., Martini, G., Scotti, D., Volta, N., (2019). *Airline regulation and common markets in Sub-Saharan Africa*.

14. Calzaretta, R.J., Eilat Y., Israel M.A., (2017). *Airline Cooperation and International Travel: Analyses of the Impact of Antitrust Immunity and Joint Ventures on Fares and Traffic.*

15. Chingosho, E., (2005). *African Airlines in the Era of Liberalization; Surviving the Competitive Jungle*.

16. Dunn, G., (2012). *Ethiopian sees encouraging progress on long-term goals.*

17. Gillespie, W., Richard, O.M., (2012). *Antitrust Immunity Grants to Joint Venture Agreements: Evidence from International Airline Alliances.*

18. Goetz, A., R., Vowles, T., M., (2009). *The good, the bad, and the ugly: 30 years of US airline deregulation.*

19. Goldstein, A., (2001). *Infrastructure Development and Regulatory Reform in Sub-Saharan Africa: The Case of Air Transport*.

20. Gomes-Casseres, B., (2006). *How Alliances Reshape Competition*.

21. *Head, K., Mayer, T., Ries, J., (2011). The erosion of colonial trade linkages after independence*.

22. Heinz, S., O'Connell, J.F., (2013). *Air Transport in Africa: Toward Sustainable Business Models for African Airlines*.

23. IATA, (2019), *World Air Transport Statistics.*

24. Irandu, E.M., Rhoades, D.L., (2006). *Challenges of sustaining growth in African aviation: the case of Jomo Kenyatta international airport*.

25. Irandu, E.M., (2008). *Opening African Skies: The Case of Airline Industry Liberalization in East Africa*.

26. Ismaila, D., A., Warnock-Smith, D., Hubbard, N., (2014). *The impact of Air Service Agreement liberalisation: The case of Nigeria*.

27. Lazzarini, S.G., (2004). *The Impact of Membership in Competing Alliance Constellations: Evidence on the Operational Performance of Global Airlines*.

28. Luo, Y., (2007). *A coopetition perspective of global competition*.

29. Meichsner, N., O'Connell, J.F., Warnock-Smith, D., (2018). *The Future for African Air Transport: Learning from EthiopianAirlines.*

30. Mhlanga, O., Steyn, J.N., (2014). *The aviation industry in South Africa: A historical overview*.

31. Mhlanga, O., Steyn, J.N., (2016). *The impact of International Air Transport Agreements on Airline Operations in Southern Africa.*

32. Myburgh, A., Sheik, F., Fiandeiro, F., Hodge, J., (2006). *Clear Skies over Southern Africa. The importance of air transport liberalisation for shared economic growth.*

33. Njoya, E.T., (2013). *Air Transport and Destination Performance - A case study of three African countries (Ethiopia, Kenya and South Africa)*.

34. Njoya, E.T., (2016). *Africa's Single Aviation Market: The Progress so Far.*

35. Njoya, E.T., Christidis, P., (2016). *Recent developments in EU-Africa aviation relations and their impact on African airports.*

36. Organisation of African Unity, (1994). *Treaty Establishing the African Economic Community.*

37. Oyieke, S., (2002). *Kenya Airways: A Case Study of Privatization.*

38. Park, J.H, Zhang, A., (2000). *An empirical analysis of global airline alliances: cases in North Atlantic markets.*

39. Rhoades, D.L., (2004). *Sustainable Development in African Civil Aviation: Problems and Policies.*

40. Schlumberger, C.E., (2010). *Open Skies for Africa, Implementing the Yamoussoukro Decision*.

41. Ssamula, M., (2009). *Sustainable Business Models for the State-Owned African Airlines.*

42. Ssamula, B., Venter, C., (2012). *Application of Hub-and-spoke Networks in Sparse Markets: The case of Africa.*

43. Surovitskikh, S., Lubbe, B., (2015). *The Air Liberalisation Index as a tool in measuring the impact of South Africa's aviation policy in Africa on air passenger traffic flows.*

44. Tesfay, Y.Y., (2016). *Modified panel data regression model and its applications to the airline industry: Modelling the load factor of Europe North and Europe Mid Atlantic flights.*

45. United Nations Economic and Social Council, Economic Commission for Africa, (1999). *Relating the Implementation of the Yamoussoukro Declaration Concerning the Liberalisation of Access to Air Transport Markets in Africa*.

46. Whalen, W.T., (2005). *A Panel Data Analysis of Code Sharing, Antitrust Immunity and Open Skies Treaties in International Aviation Markets*.

47. Wan, X., Zou, L., Dresner, M., (2009). *Assessing the Price Effects of Airline Alliances on Parallel Routes.*