Airline Regulation and Common Markets in Sub-Sahara Africa

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Abstract

We examine the effects of institutional reforms on both the demand and supply of air transportation in Sub-Sahara Africa. We specifically consider changes in air transportation regulations and the development of general Common Markets for trade in goods and services on African aviation. This is at a time when aviation is becoming more important in the development of tourism, the export of perishables such as flowers, and in linking emergent clusters of manufacturing and service industries. In examining the implications of economic changes affecting passenger airlines we also provides some weak-replication of previous studies of demand elasticities in the region.

Key Words: Sub-Saharan Africa, airline deregulation, Common markets, transportation policy, African airlines

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1. Introduction

March 2018 saw the signing by 44 members of the Africa Union of a provisional agreement establishing the African Continental Free Trade Area (AfCFTA). If ratified by the signees, and later by the eleven other members, then the United Nations Economic Commission for Africa estimates that by 2022, intra-African trade will be boosted by 52%. This signing followed the January agreement between 23 states to cooperate in a narrower Single African Air Transport Market (SAATM). These are the latest in a series of moves to free up international trade in Africa and various efforts to establish Common Markets.[1]

It is not easy to create economic unions in Africa. It has a population of about 1.2 billion, but is characterized by vast distances and, in general, has neither good road nor rail systems. The challenges are compounded by artificial political divisions of territories that often separate natural, economic trading partners. As a result, despite representing 15% of the world's population Africa's has just 2.1% of the commercial passenger and freighter aircraft, and its fleet's age average is 17 years versus 13 for the global fleet.

Forecasts for aviation activities in Africa are, however, by historic standards optimistic. Boeing Commercial Airplane (2017), for example predicts that traffic to, from, and within

[1] "Common Market" designated using upper case is used to distinguish general international agreements between countries to engage in free trade in goods. This is to avoid ambiguity involving specific multilateral open skies arrangement that are often called common markets.

Africa will grow an average of 5.9% a year between 2017 and 2036, with intra-African traffic increasing by 6.5%, and traffic involving Africa and the Middle East and Asia-Pacific growing by 7.6 and 6.7% respectively. Air cargo, which is often carried in the belly hold of passenger planes, is forecast to grow by 3.8% annually between Africa and Europe from 2015 to 2035, Africa–Asia trade by 6.5%, and Africa-North America trade by 5.3% (Boeing Commercial Airplanes, 2016).

We look at some of the underlying problems of developing passenger aviation markets in Sub-Saharan Africa.[2] We focus in particular on the public policies that have affected the supply of aviation services and macroeconomic strategies that have influenced the demand for such services. A "wider-replicability" exercise is conducted to assesses whether the core results are broadly consistent with previous studies. We then consider the roles of airline liberalization on the supply of air services and of the creation of Common Markets for goods and services on the demand-side[3]. To set matters in context, and to provide background for the control variables used in the later econometric analysis, we first discuss the nature of the mega-region and the institutional changes that are occurring.

2. Sub-Saharan Passenger Aviation Markets

While low incomes across most of Sub-Saharan Africa are the main explanation for the small size of its commercial air passenger sector, geography and political history are also important. Many African countries are artificial creations stemming from colonial days with limited internal political or economic cohesion (Button et al, 2015). The colonial powers often had limited interest in aviation, being more concerned with extracting raw materials and securing strategic locations which largely involved surface movements (McCormack, 1976).

Africa's geography is also not kind to aviation; it is an 'awkward shape' (Pirie, 2014). By contrast, the US is ideal for hub-and-spoke systems with its contiguous states forming

[2] The nations of the Sub-Sahara mega-region are: Angola, Benin. Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Democratic Republic of Congo, Cote D'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea-Bissau, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Swaziland, United Republic of Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

[3] Replicability has become an important topic in applied economics; Berry et al (2017) and Maniadis, et al (2017).

a virtual square embracing large populations at each corner and with major cities in the center acting as hubs. Equally, Europe is almost ideal for short-haul, non-connecting services emanating from bases, with economic activity in a densely populated area stretching from North West England to Northern Italy. Linear route configures, with aircraft moving along a line of airports, picking up and dropping passengers to maintain load factors, serve countries like Norway. Sub-Saharan Africa's human geography militates against the development of major hub-and-spoke networks with their potential economies of scope and density (Ssamula and Venter, 2013), or other common business models used in the airline sector (Button et al, 2017; Heinz and O'Connell, 2011).

Beginning in the 1980s, many Sub-Saharan cities started to globalize as their host nations liberalized their economies and adopted World Bank/International Monetary Fund Structural Adjustment Policies. At the same time, improved transportation and communication connections with the world, coupled with economic difficulties within individual African countries, caused many African nationals to emigrate to other parts of the Continent in search of better opportunities. These transnational émigrés, combined with expansions of many global corporations into a limited number of Africa locations, have contributed to the rapid globalization of a number of Sub-Saharan cities.

Set against this background, Otiso et al. (2011) find that while many African urban regions have poor airline interconnectivity, both among themselves and internationally, and rank low on global, transnational urban networks, a few, such as Johannesburg, Cape Town, Nairobi, and Lagos in the Sub-Sahara region, have developed relatively good international air connectivity and are at least partially integrated into global networks.

Public policies have historically added to Sub-Sahara Africa's aviation challenges. Partly because of its strategic importance in the colonial and immediate post-colonial periods, and partly because the necessary private institutional structure to finance and operate an air network is not well developed, the mega-region's air transportation has traditionally been heavily regulated (Button et al, 2015). However, following the experiences of aviation policy reforms in the US (Peoples, 2017) and Europe (Button, 2007), coupled with the manifest failure of many state-owned airlines in Africa, this attitude changed, and market liberalization began.

Despite deficiencies in its aviation infrastructure (Gwilliam, 2011), challengers in finding adequate investment sources (Gutman et al, 2015), questionable management of infrastructure (Stephens and Ukpere, 2011), and institutions that provided little support for the development of internal and external aviation markets in Africa (Schlumberger, 2010), changes are taking place and there is growth in aviation.. The policy challenge has become one of sustaining this and facilitating its geographical spread.

3. Aviation Policy

The 1944 Chicago Convention both set up the UN International Civil Aviation Organization (ICAO) as the international oversight body for the sector and set out the rights of nations to control the airspace over their territories. The outcome was that most nations limited internal air transportation to their national carriers and negotiated bilateral air service agreements (BASAs) with other sovereign states to provide international services.

For Sub-Saharan countries this resulted in nationalized airlines, often monopolies, serving their own markets, and flag carriers that flew heavily regulated international routes under BASAs that stipulated such things as the carriers involved, the fares charged, and the capacity offered. The results were high-fares, limited capacity, and low load factors in both domestic and international markets (Pirie, 2006; Lubbe and Shornikova, 2017).

In the years after independence, international air transportation focused primarily on European relationships and agreements (Guttery, 1998). Between 1960 and 1980 African countries signed only 78 BASAs among themselves but 172 with Europe countries. Schlumberger (2010) argues that instead of developing intra-African, or domestic networks, many Sub-Saharan countries aimed at building international networks to and from their former colonizers; e.g. the Economic Commission for Africa (2005) finds that it was not until the 1970s that importance was given to intra-African services.

Following US evidences on the high costs of regulation, other airline markets began to be liberalized. There have been, however, wide variations in policies and outcomes, and Sub-Saharan Africa has tended to lag in its reforms. There are reasons for this.

It was argued that airlines needed institutional protection to build up their networks and create the economies of density and scope that allow them to become competitive; the standard infant industry argument. International aviation is also often seen by developing countries as a source of foreign exchange, and they would rather forego short-term

economic efficiency in supplying aviation services for a such an immediate inflow of foreign currency (Button, 2010). Aviation, more generally, has the advantage for the authorities of being an efficient way of collecting tax revenues because it involves a single source and evasion is difficult. As a result, airline costs in Sub-Sahara Africa are generally high, with fuel taxes of 50% to 100% above than the global average.

More recently, many African nations in pursuing wider development economic goals have made efforts to liberalize their air transportation markets and invest in aviation infrastructure. While agencies like the World Bank and the African Development Bank have been active in putting resources into the sector, and there is increasing foreign direct investment by the likes of China, the outcomes have not always been as productive as hoped (Foster et al., 2009). In many cases, costs have exceeded those anticipated because of the challenges of operating in the Sub-Sahara's physical and political climate.

Having said this, flower exports from countries abutting Lake Victoria, (e.g. Kenya produces 11% of the world's cut flower) could hardly have been developed without air services (Bolo, 2006). The region's growing tourism sector also depends on air transportation (Naudé and Saayman, 2005) and forecasts by the Brooking Institution (Singé, 2018) suggest that consumer spending on it in Africa could reach $261.77 billion by 2030 with appropriate regulatory and infrastructure policies.

The 1988 Yamoussoukro Declaration offered a framework for reform with unification of African markets and governmental commitments to integrate their airlines within eight years. Implementation was, however, slow. In 1997, in frustration, as well with concerns over safety, the Banjul Accord for an Accelerated Implementation of the Declaration was adopted by Ghana, Sierra Leone and the Gambia, with Cape Verde, Guinea Bissau and Nigeria. This recognized the area embracing them as a single geographical air transportation operations zone. The action preempted the 1999 Yamoussoukro Decision whereby 44 countries committed themselves to liberalize air services and to open regional markets to transnational competition (Lubbe and Shornikova, 2017).

Using simulations, InterVistas's (2008) found that, if fully implemented, the Decision would increase the role of aviation in the mega-region. It was suggested that it would increase air services between 12 sample markets and generate an additional five million passengers per annum, $1.3 billion in annual GDP, and 155,000 jobs. The practice,

however, has been somewhat different. Implementation of the Decision has been slow and piecemeal (Bofinger, 2008). The reasons for the mixed picture include the continued protection of flag carriers (Amankwah-Amoah and Debrah, 2014) and the on-going use of national airlines as a means of obtaining foreign exchange.

Comparing regions where Yamoussoukro had been implemented with those where it had not, Njoya (2016) found frequencies grew faster, new privately funded airlines emerged, and services improved. Schlumberger (2010) found that after the Nairobi-Johannesburg route was fully opened-up in 2003, passenger volumes increased 69-fold, and on average fares on liberalized Southern African Development Community routes dropped by 18%. Supporting evidence on a number of South African based routes was also collected by Steyn and Mhlanga (2016), and Ismaila et al (2014) and Daramola and Jaja (2011) produce similar results regarding Nigeria. Additionally, partly stimulated by the Decision, there were movements towards airline integration through mergers, cross-shareholdings and the joining of airline alliances (Amankwah-Amoah, and Debrah, 2011). South African Airways (Star Alliance in 2006) and Kenya Airways (SkyTeam in 2007), for example, became global alliance members.

Despite these local successes, the gains suggested by InterVistas had not materialized two decades after the Decision had been signed. In particular, the piece-meal adoption of the Decision stymied the anticipated network economies.[4] Continued frustrations stemming led to renewed calls for full implementation of the Decision, and at the 2015 African Union Summit a commitment was made to the immediately implementation the Decision by 2017. But again, progress has been slow. By early 2018, only 23 Sub-Saharan African countries had signed on to the Single African Air Transport Market intended to allow airlines free access to airports. This compares to the 44 signatories for the Yamoussoukro Declaration 30 years earlier, and the signers tended to include the nations that had already partially introduced some form of liberalization under the old Decision.

4. The Market Structure

One objective of liberalization has been to inject more choice into airline markets. Choice of carriers has the potential not only of increasing price competition but also less easily

[4] Economides (1996) outlines the types of economies that well-structured networks can generate.

quantifiable service features including degrees of unbundling of services, greater variability in services, and more connections. This was also certainly one outcome of domestic deregulation in the US from 1978, with Morrison and Winston (1986) finding significant fare reductions as the ultimate outcome, as well as greater diversity in the services supplied. And a similar picture is found after reforms in Europe (Scharpensee, 2001; Button, 2007) which involved domestic as well as intra-EU international routes.

To examine for this in the Sub-Sahara case, Herfindahl–Hirschman Indices (HHI) are constructed at the route level.[5] To provide a reasonable degree of confidence in these calculations, routes with less than 50 passengers were excluded. The results depicted in Figure 1, are for routes where a non-Yamoussoukro member is involved, for routes where both origin and destination countries are Yamoussoukro members, and for domestic routes. The data are averaged over 2010 to 2016 to take out short-term volatility. The index is broken down into three trenches for presentation. These represent competitive routes (an index <0.4 in green), relatively competitive routes (between 0.4 and 0.8 in blue) and concentrated (>0.8 in red). There is obviously some degree of arbitrariness about this, but inspection of the data suggests these are quasi-natural beaks.

The generally thin nature of Sub-Saharan routes suggests that a large number will be highly concentrated, and this is what is found. A significant part of the Sub-Saharan network is either not competitive or only relatively so. This holds for both the liberalized, Yamoussoukro Decision group and those outside. Some 197 of the 623 international, origin-destination pairs emerged as either highly or relatively concentrated, with only 55 competitive. Regarding the Yamoussoukro group, of the 355 routes involving signatory countries, 152 remain highly or relatively concentrated with only 17 competitive. Overall, when comparing Yamoussoukro with non-Yamoussoukro signers just under 5% of the former's routes are competitive compared to around 10% outside of Yamoussoukro.[6]

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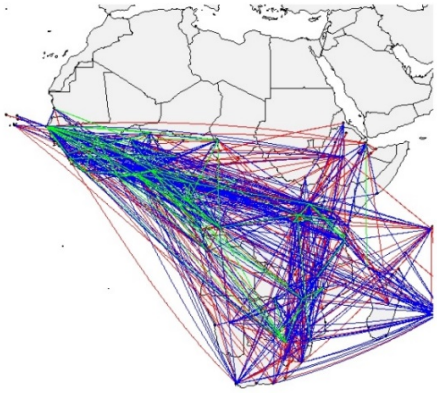
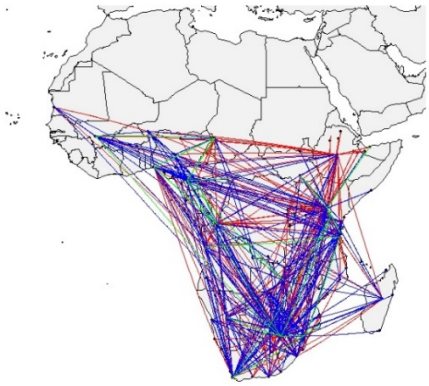
[5]The index involves squaring the market share of each airline serving an origin-destination pair and then summing the resulting numbers (i.e. $\sum_{i=1}^{N} s_1^2$, where s_i is the market share of firm i in the market with N the number of firms). It rises from zero to one as market concentration increases. The averaging over years is a simple arithmetic exercise to ease presentation, but separate annual results are little different.

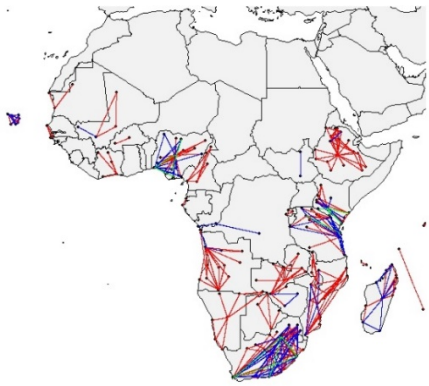
[6]A caveat involves the possibility of selection bias. Countries joining Yamoussoukro may have been those experiencing lower air travel demand and, thus, had more incentives to sign to boost their air transportation.



	Obs	average HHI
Sample	623	0.68
HHI>0.8	197	0.92
0.4<HHI<0.8	371	0.59
HHI<0.4	55	0.35



	Obs	average HHI
Sample	355	0.73
HHI>0.8	152	0.93
0.4<HHI<0.8	186	0.60
HHI<0.4	17	0.35



	Obs	Average HHI
Sample	337	0.85
HHI>0.8	239	0.96
0.4<HHI<0.8	87	0.63
HHI<0.4	11	0.32

Key: Herfindahl–Hirschman Index on the scale 0 to 1.0 with green <0.4, blue = 0.4 to 0.8, and red >0.8

Figure 1 Herfindahl–Hirschman Indices for (top) non-liberalized intra-Sub-Sahara international routes, (middle) liberalized intra-Sub-Saharan international routes, and (bottom) domestic Sub-Saharan routes

At the long-haul international level, larger gauge aircraft are often more efficient. The lack of demand, however, associated with the low incomes in most of the mega-region, poses problems akin to the infant industry challenge alluded to earlier. Basically, entrant airlines have problems in achieving sufficient scale to match the costs of existing suppliers, especially if the route is not linked to their existing network (Sochor, 1988).[7] The paucity of genuine multilateral ASAs has added to this problem, and the piece-meal adoption of Yamoussoukro does not seem to have changed this

Regarding domestic routes (which fall outside of Yamoussoukro), the lack of aviation in the geographical core of the mega-region and of air services in most of the land-locked countries is striking. This is importance because domestic routes often provide feeder services for international and intercontinental markets. The evidence seen in the bottom element of Figure 1 is that outside of South Africa, and less so Kenya, there is an extremely high degree of market concentration; only about 4% of routes have an Index exceeding 0.8.[8] This lack of competition, may limit the development of efficient domestic hub-based operations, which in turn can restrict the economies of scope and density required for efficient, long-haul international services (Irandu and Rhoades, 2006).

The higher income levels in South Africa, together with its geography and the emergence of (LCCs) such as, FlySafair, kulula.com, and Mango, have led to a relative high degree of competition on the routes linking Durbin, Cape Town, and Johannesburg. Kenya, with the LCCs Jambojet and Fly540, has some competition on spokes serving Nairobi Airport. Elsewhere thinness of many domestic routes, lower incomes, and the embryonic nature LCCs markets have limited domestic competition. In many cases LCCs are legally prevented from competing with the local flag carrier.

There are inevitably limitations to these findings. These include the omission of very thin routes that likely means many concentrated markets being excluded, and there is no pre-Yamoussoukro data to provide a temporal counterfactual and historic picture. But the broad indications are that the Yamoussoukro agreement to create a multilateral, free-trade area in airline services has not produced significant airline choice at the route level. This is

[7]What the data does not allow is an analysis of the contribution of belly-hold air cargo to the viability of such routes. Ideally some form of weighted passenger/cargo HHI could insightful.
[8]In most markets simply because of lean demand there are often a large number of monopoly routes.

despite the availability of more variants of aircraft, and notably smaller ones with longer-range suited to thinner routes.

5. Demand for Passenger Air Services

Although widely used, market structure is an intermediate metrics for assessing the economic implications of deregulation. It also has limitations. Contestable forces rather than regulation may, for example, be restraining market entry.[9] Further, the US Airline Deregulation Act and the EU's Three Packages effectively breached a dam of high fares and limited services leading to significant increases in air traffic. Such demand levels do not exist, or at least seem unlikely to, in most Sub-Sahara market. Metrics directly including fare elasticities and traffic levels can provide additional indicators of the welfare implications of regulatory reform.

While studies have sought to estimate fare elasticities of demand in Sub-Saharan Africa, they have generally involved single equation models that do not reflect co-determination of fares and bookings, and often do not estimate regional elasticities directly but rather treat them as deviants from a global average. InterVistas (2008), for example, applying regional multipliers to globally, produced elasticities of -0.9 for short-haul and -0.8 for long-haul routes in Sub-Saharan Africa. Unusually using three-stage least squares to allow for the co-determination of fares and bookings and looking explicitly at Africa, Button *et al.* (2017) find fare elasticities of under -0.5 when specifically concerned with the substitutability of direct and indirect routings within the Sub-Sahara region.

Three linear, quasi-gravity models are used to describe Sub-Saharan air travel demand for a specific origin-destination routing (i) at a time (t) (Tinbergen, 1962).[10] The first specification models the possible impact of liberalization on passenger flows:

$$Bookings_{it} = \beta_0 + \beta_1 Fare_{it} + \beta_2 Domestic_{it} + \beta_3 Yamoussoukro_{it} + \beta_4 COMESA_{it} + \beta_5 Distance_{it} + \beta_6 GDP_{it} + \beta_7 POP_{it} + \beta_8 Language + \beta_8 DummyStop1_{it} + \beta_9 DummyStop2_{it} + \sum_{m=1}^{M-1} \sigma_m Month_m + \sum_{y=1}^{Y-1} \vartheta_m Year_y + \varepsilon_{it} \quad (1)$$

[9]Work in the US, however, suggests that potential competition has not the same power to restrain pricing as actual competition (Morrison and Winston, 1987; Moore, 1986). Even Baumol and Willig (1986), once two of the strongest supporters of contestability, agree on this.

[10]For a general overview of the use of gravity models in aviation work see Zhang, et al (2018).

where $Bookings_{it}$ is the number of bookings for a specific route i in time t and $Fare_{it}$ is the average ticket price. *Yamoussoukro* and *COMESA* are dummy variables describing separating routes connecting two countries participating in the Yamoussoukro Decision and in the Common Market for Eastern and Southern Africa (COMESA). The latter provides some indication of the extent that broad free trade areas can stimulate the aviation market. While highlighted earlier there are several regional free trade areas or customs unions in Africa, COMESA is one of the largest, with 20 members, and is well established having been formed in 1994.[11] Evidence on its overall economic impact is limited. Carmignani (2006) did concluded that to 2005 trade integration was low and there was limited evidence of convergence of per-capita incomes across countries. In contrast, Musila (2004) finds trade creation over at part of the Area. From the evidence we mildly, but no more, anticipate the *COMESA* effect will be positive, but have no real prior for the *Yamoussoukro* given the diversity of results found in earlier studies.

Also included are control variables reflecting the distances, an impedance, between origins and destinations ($Distance_{it}$), the product of the origin and destination country pairs' GDPs (GDP_{it}), and the product of their populations (POP_{it}), both reflecting potential generators of trade. A set of dummies is used to control for common first language (*Language*) which has been found in many studies, including Fidrmuc and Fidrmuc (2015), as important in fostering trade, whether there are 0, 1 or 2 changes (*Stops*) in a "flight" to reflect further impedances, and for the month and year of the flight, the later to capture seasonal cycles. Several other variables were examined that have been suggested as influencing trade, such as a corruption index (Majeed, 2014), but these either added nothing to the estimated equation or seriously disrupted it.

The second and third models estimate differences in elasticities by treaty. The argument being that events such as the Yamoussoukro interact with fares by affecting the quality of service – i.e., such things as numbers of flights, options of indirect services, and schedules that are being paid for. These are looked at separately to avoid any issues of collinearity.

$$Bookings_{it} = \beta_0 + \beta_1 Fare_{it} + \beta_2 (Fare_{it} * Domestic_{it}) + \beta_3 (Fare_{it} * Yamoussoukro_{it}) + \beta_4 Distance_{it} + \beta_5 GDP_{it} + \beta_6 POP_{it}$$

[11]While there is evidence that air transportation can stimulate economic activity, this effect tends to be local in nature. Here we are postulating that a significant integration of economies can increase trade, and with this, demand for airlines' services.

$$+ \beta_7 Language + \beta_8 DummyStop1_{it} + \beta_9 DummyStop2_{it} + \sum_{m=1}^{M-1} \sigma_m Month_m + \sum_{y=1}^{Y-1} \vartheta_m Year_y + \varepsilon_{it} \quad (2)$$

$$Bookings_{it} = \beta_0 + \beta_1 Fare_{it} + \beta_2 (Fare_{it} * Domestic_{it}) + \beta_3 (Fare_{it} * COMESA_{it}) + \beta_4 Distance_{it} + \beta_5 GDP_{it} + \beta_6 POP_{it} + \beta_7 Language + \beta_8 DummyStop1_{it} + \beta_9 DummyStop2_{it} + \sum_{m=1}^{M-1} \sigma_m Month_m + \sum_{y=1}^{Y-1} \vartheta_m Year_y + \varepsilon_{it} \quad (3)$$

Models 2 and 3 have similar specifications to model 1, the only difference being that $Fare_{it}$ is multiplied by a dummy separating flights ($Domestic_{it}$) when their origins and destinations are within the same country, and by a liberalization dummy when the flight is between two Yamoussoukro members (Equation 2) or COMESA members (Equation 3). This last variable is designed explicitly to separate the effects on aviation of the anticipated economic interactions that a Common Market should induce from those associated with multilateral open skies. This separation is of wider interest than just for the Sub-Sahara Africa case; there are, for example, other instances where an open skies structure does not coincide with the geography of a Common Market; e.g. the European Union and the European Common Aviation Area.

The simultaneity between supply and demand affects the relation between *Fare* and *Bookings* creating an endogeneity problem. To handle this, the models are estimated within a two-stage least squares instrumental variable framework. The first stages use the fares as dependent variables and includes as an instrument, the average fares in the US domestic market for origin-destinations with similar lengths in Africa. This type of instrument, sometimes called a Hausman-type price instrument (Hausman, et al, 1994), makes use of information on similar "brands" in other geographical markets to that of interest,

Defining instruments is difficult, and several alternatives were considered. These included cost-shifting instruments of the form used by Abate and Kincaid (2018) who adopted fuel prices as an instrument for fares when examining passenger numbers (essentially our *Bookings*) in the East African Community aviation market and Hsiao (2008) who also used jet fuel prices but in the context of U.S. aviation markets. We did not, however, use this approach, because fuel prices reflect supply-side effects that only get be passed on when there is demonstrable competitor price matching, and when fares

are not subjected to yield management practices. We could also have made use of our Herfindahl–Hirschman Indices measurement of competition and market power *à la* Granados et al (2012) work on airline books. In this case, while the index can provide a useful information of a general kind, many routes are monopolies, and thus the instrument provides limited sensitivity, and additionally it is largely a demand driven measure.

Our Hausman style approach avoids all these difficulties, takes account of both sides of the market in fare setting, has a pedigree in the aviation literature (e.g. Mumbower et al; 2014; Gayle 2004), and is supported by standard goodness tests.[12] ,

The equations estimated in the second stage are similar to models 1 to 3 with the difference of $Fare_{it}$ substituted by the first stage estimated variable ($\widehat{Fare}_{it}$). All equations are estimated in log-linear form allowing the coefficients to be read as elasticities, and within a robust framework to correct for possible heteroscedasticity. Thought was given to the use of a fixed-effect specification but there was no intuitive reason for adopting this. Additionally, the standard Hausman specification test (Hausman, 1978), accepting its limitations, indicates that a random effects framework is the most appropriate.[13]

The data are composed of the fare and bookings for direct and indirect (one or two stops) flights operated within Sub-Saharan Africa between February 2010 and December 2016. Data are monthly, with *Bookings* as the sum of the bookings and the fare as the monthly average.[14] Observations are collected with respect to the operating airline with bookings allocated accordingly. The data are cleaned by deleting observations with fare lower than $50 or 50 passengers in the case of the bookings, and distance less than 200 kilometers. The resultant unbalanced data set comprises nearly 150 thousand observations

[12] For each month/year the average fare in the US market is computed based on 250 km distance groups (i.e. 0-250; 251-500; etc.) and matched with African fares belonging to the same distance category. The standard tests applied in subsequent estimations confirmed the goodness of the instrumental variable adopted. Because the Hansen J test cannot be performed, the equation being exactly identified, the validity of the instruments relies on satisfying the Kleibergen-Paap Wald validity test. The Kleibergen -Paap rk Wald F statistic is 534.9 for Equation 1, 139.4 for Equation 2, and 147.1 for Equation 3 - i.e. the tests show valid and not weakly identified instruments being above their critical values.

[13] Fixed effects were also not found appropriate in Abate's (2016) and Abate and Kincaid's (2018) work on African airlines using somewhat similar forms of analysis to us albeit using different data and addressing somewhat different issues.

[14] The data source is Official Airline Guide traffic analyser. See; data http://www.oag.com. Ideally, actual fares or some breakdown of fares by class would have been ideal but this was not available.

(origin destinations) over 83 months (t), embracing around 1300 origin-destination markets served by about 70 airlines.[15]

Figures 2a and 2b graph the evolution of the average fares and bookings when routes connect Yamoussoukro members' destinations (Yamoussoukro), COMESA members (COMESA), domestic destinations (Domestic), and other destinations.

Figure 2a shows a decreasing trend in all the fares, with average domestic fares being the lowest, a reflection of the shorter average distances involved. With respect to the international fares, the average fare connecting COMESA members is the lowest for the first period analyzed while converging to Yamoussoukro and other destination in the last two years of the dataset. When analyzing the bookings' levels (Figure 2b), domestic bookings present the highest values and greatest temporal volatility, with the various types of international bookings all following similar paths.

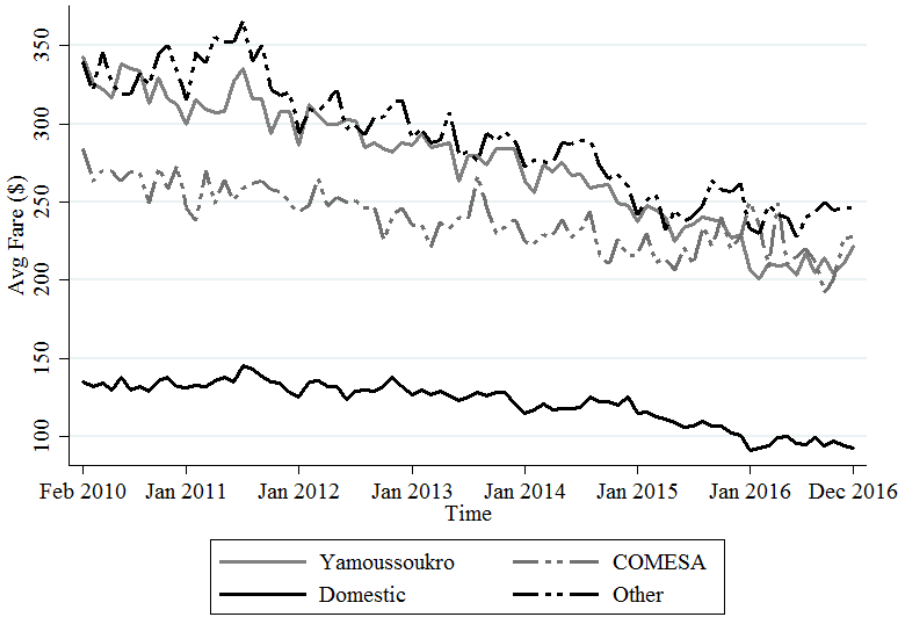


Figure 2a. Evolution of average fares

[15] What is missing from the data is any indicator of service quality and, in particular, of reliability. From gray data sources, this seems to vary considerably by route, and often due to the quality of air traffic control. For example, see https://www.thisdaylive.com/index.php/2019/03/31/trends-in-africas-business-travel/. But as Einstein supposedly said, "Not everything that can be counted counts, and not everything that counts can be counted."

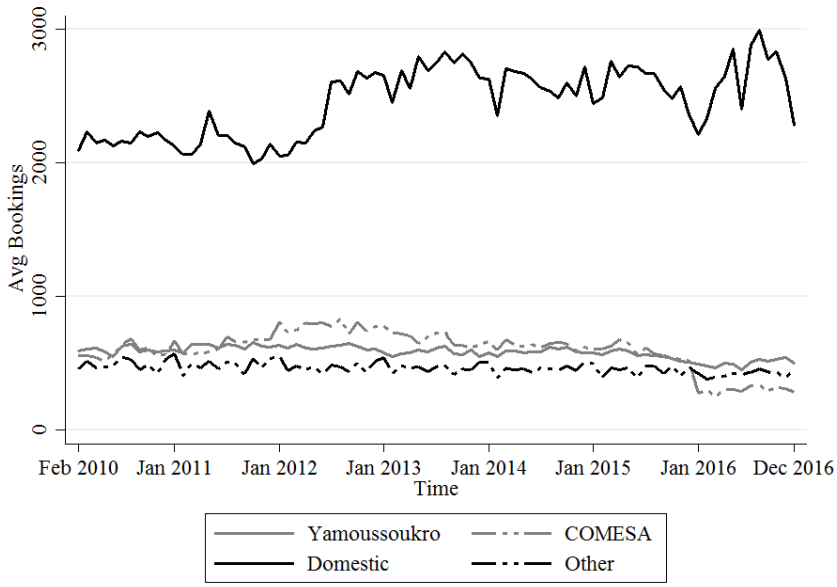


Figure 2b. Evolution of average bookings

The results of our estimations are seen in Table 1. Most of the key control variables' coefficients take anticipated signs, are highly significant, and overall the specifications meet test criteria for over and under identification. The year coefficients contain no major surprises and are consistent across model specifications.

Table 1. Coefficient estimates

ln(Bookings)	Equation 1 Coefficient	Equation 2 Coefficient	Equation 3 Coefficient
ln(Fare)	-0.619 ***	-0.533 ***	-0.667 ***
ln(Fare*Domestic)		0.053 ***	0.056 ***
ln(Fare*Yamoussoukro)		-0.008***	
ln(Fare*COMESA)			0.035 ***
Domestic	0.253 ***		
COMESA	0.182 ***		
Yamoussoukro	-0.071 ***		
ln(Distance)	0.185 ***	0.131 ***	0.202***
ln(GDP)	0.186 ***	0.182 ***	0.181***
ln(Population)	-0.091 ***	-0.086 ***	-0.091***

Language		0.178 ***	0.186 ***	0.176***
stop1		-1.649 ***	-1.650 ***	-1.649***
stop2		-1.564 ***	-1.571 ***	-1.544***
Year				
	2011	-0.018 ***	-0.018 ***	-0.017***
	2012	-0.051 ***	-0.047 ***	-0.051***
	2013	-0.058 ***	-0.049 ***	-0.058 ***
	2014	-0.105 ***	-0.090 ***	-0.106 ***
	2015	-0.128 ***	-0.100 ***	-0.135***
	2016	-0.257 ***	-0.226 ***	-0.263***
Constant		2.266 ***	2.243 ***	2.605***

Notes: *** represents significant at the 1% level, ** 5%, and *10%.

The coefficients for direct versus one- or two-stop flights indicate lower bookings if there are interruptions to people's travel, although the difference between one and multiple stops is similar, perhaps indicating an unexpected degree of stoicism. Journeys involving countries with a common language consistently show higher numbers of bookings, as do the effects of distance, and GDP. The language effect corresponds to an extensive body of work looking at culture and international trade more generally (Melitz, 2008).

The positive sign for distance is not unique to the study. Grosche et al (2007) had a similar result when looking at the European aviation market. They explained it in terms of correlations of distance with other variables and because, as in this study, forecasting was not an objective simple accepted this. We would argue, however, that in addition to multicollinearity, the positive effects of distance fits with a pattern of transportation whereby aviation has a comparative advantage over longer distances where effective competition is least. It may also reflect the fact that the main air corridors within Sub-Sahara Africa involve the major business centers of Johannesburg, Lagos, Nairobi (Scottie *et al*, 2017); all involve long-haul routes between 1,800 and 2,800 miles. Additionally, the geography between them is generally sparsely populated with few fights serving intermediate points; in modeling terms there are few intervening opportunities (Stouffer, 1940). The overriding strength of demand for the trunk services may thus lead to a positive

coefficient for distance if the relative attractions of destinations is not being fully picked up in the population and GDP variables.

Another coefficient that takes a seemingly perverse, negative sign is that associated with population. Despite being significant, the coefficient is small, but it does need to be thought about. A probable explanation for the result is that while the population of most of the major African cities have grown considerably over the years considered, much of this is due to inflows of low income, young rural workers and refugees from various conflicts who are unlikely to fly (Awumbila, 2017). Hence, while aggregate urban populations have risen, the potential airline booking proportion of this has likely fallen, and, important for this analysis, by differential amounts across cities.

Equation 1 estimates indicate that being a COMESA member has a positive impact on bookings. This conforms with our hypothesis that because the costs of doing business, and especially custom are lower, this will stimulate trade in air services. Conversely, being a Yamoussoukro member shows a negative but negligible impact. In terms of fares differentiating international from domestic traffic, the positive coefficients exhibited for domestic fares in Equations 2 and 3 indicate these markets are stronger for airlines because demand is less elastic. This is broadly consistent with what was seen in Figure 2.

Equation 2 tells us that fare sensitivity is generally higher when Yamoussoukro fares are involved irrespective of whether the countries are part of COMESA or not. This may reflect the greater competition and openness noted in the earlier general discussion of Yamoussoukro impact on some individual routes. The small size of the coefficient probably reflecting the averaging across all Yamoussoukro routes. Elasticities are lower, however, when considering fares involving countries in COMESA (Equation 3) irrespective of whether they are part of Yamoussoukro or not.

Turning to the importance of fares, the base elasticities for international flights in Equation 2 is -0.53, between Yamoussoukro members' origin-destinations, it is –0.54, while between domestic origin-destinations it is -0.48. These parameters are higher than those found by InterVistas (2008) and Button et al (2017) for Africa but less elastic than those found in Brons et al's (2002) meta-analysis that produce a global average fare elasticity -1.15 for markets excluding Africa. The low African elasticities confirm the

impression given by Figure 2. The much higher global average for non-African countries is almost certainly a reflection of higher and more even incomes.

The very small negative coefficient for Yamoussoukro-fares in Equation 2, while indicating a sensitivity to fares that may be seen as an enhanced competitive effect, hardly supports the idea of the Decision bringing about radical change.[16] The "COMESA fare effect" in Equation 3 is positive and significant offering some support for the Musila's (2004) findings that higher bookings are generally associated with greater levels of trade.

What the results show is that the overall demand for passenger air transportation in the Sub-Sahara mega-region is highly inelastic. This seems to be the result of a relatively small and embryonic middle, professional class that makes up a large proportion of traffic in the markets of Europe and North America and increasing so in Asia. The highest income business travelers are traditionally much less fare sensitive (Gillen *et al*, 2003; Heinz, et al, 2013). This gives something of a short-term advantage to the full-service carriers and adds weight to the relatively slow emergence of low-cost carriers in Sub-Sahara Africa because they mainly compete on fares (Amankwah-Amoah and Debrah, 2009; Schlumberger, and Weisskopf, 2014). Whether this pattern will continue as several of the major economies of the mega-region develop is questionable. If the dynamics seen in many western economies is replicated, then the demands of lower-level professionals, to whom fares are important, will stimulate the growth of lower-cost carriers (Mason, 2005).

6. Conclusions

Liberalization of air transportation in most higher income nations has produced demonstrable benefits for those involved. In the Sub-Sahara Africa case, however, where long distances and difficult terrain makes air transportation an obvious mode for many individuals and firms, it is not so clear from this study that efforts at deregulation, which has admittedly lagged behind many parts of the World, has so far had anything like the same success. Declarations are signed enthusiastically, but actions have not been pursued with the same energy or urgency.

[16] The low, significant income coefficient indicates a lack of sensitivity of bookings to GDP. This is likely due to the generally high income of user of air transportation in the mega-region. One reason for this is the general impediments the average African faces when traveling internationally (e.g. visa requirements) even within the continent (Kimeria, 2016). Ideally, some indicator showing the ease of obtaining necessary documentation on each route would have been included, but suitable data is not available.

Shortage of trained personnel, the pressures from other priorities, and inadequate infrastructure on the scale highlighted by Gwilliam have been part of the problem, but there have also been difficulties posed by regulatory policies of governments seeking to control and protect their own air carriers. The evidence presented here is that lip-service to multilateral liberalization under the Yamoussoukro Decision has, in general, neither been successful in really opening markets to effective competition nor creating the positive externalities associated with most networks industries. And this is true whether using the metric of market concentration, or the more direct measure of airline bookings. As a result, given that transportation is an intermediate input, almost inevitably aviation has not fulfilled its full potential as a facilitation of economic development in Sub-Sahara Africa.

There is also some evidence that air transportation may have been more sensitive to the demand stimuli for its services stemming from the creation of Common Markets than to specific measures of airline deregulation. This is important because if AfCFTA becomes a reality it will be the biggest free trade agreement since the establishment of the World Trade Organization. The UN Economic Commission for Africa estimates that an agreement could, by 2022, increase intra-African trade by 52%. The role of air transportation in this will, of course, depend on the details of the Common Market arrangements arrived at, and the willingness and ability of countries to carry through effectively concomitant liberalizations of aviation markets. And especially their ability to reap the network economies inherent in efficient air transportation activities. The old adage, "The Devil is in the detail", needs invoking in both cases. Past experience of policy making should perhaps not lead to optimism.

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