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Pricing effects of code sharing in Africa

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Abstract

We investigate whether cooperation in the form of code-sharing agreements results in lower fares in the African context. While there is extensive research on cooperative agreement in the airline industry, little is known on the effect of airline cooperation in developing contexts. We analyze the direct effect of code-sharing agreements on the fares of connecting flights that were previously offered as interline flights and switch to code-share as well as the indirect effect of having airlines that cooperate on the fares of those wo do not. To study these effects we exploit a rich dataset comprising the universe of international connecting routes in Africa, with information on operating and marketing carriers, and monthly fares, in the period 2017-2019. In addition to the inclusion of route-month and operating pair-route fixed effect, which account for shocks to the demand of the carriers in the specific market, we instrument the code-sharing decision exploiting the carriers' number of direct flights in code-sharing from the gateway. Our main results show that the activation of a CS agreement reduces airfares in African international routes by approximately 18%. This evidence is in line with the internalization of double marginalization and improvements in cost-efficiency found in the literature. When testing whether the pro-competitive effect of the introduction of code sharing percolates to interline, online, and direct airfares on the same route we find mixed evidence: in connecting flights with interline service we find that, all else equal, when code sharing is introduced on a route, other airlines operating interline itineraries react by reducing their price by about 10%. In flights with online or direct service, airlines do not react to the code sharing introduction. We interpret this as evidence of product differentiation as carriers providing direct or online itineraries are not likely to perceive the flight in code-sharing as threat. Our findings confirm that the African aviation market has a high potential growth coming from airlines' cooperation.

Keywords: code sharing, Africa, pricing effects

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1 Introduction

With a landmass of over 30 million square kilometers and a population of over 1.3 billion people, Africa's vast geography presents a challenge to its connectivity and integration. The airline industry has the potential to overcome these barriers by facilitating the movement of goods, people, and capital across the continent. Africa's natural resources, tourism potential, and rapidly growing economies have made it an attractive destination for foreign investment and tourism, but without a reliable and efficient airline industry, these opportunities cannot be fully realized (Button et al., 2017). Nevertheless, the sector is lagging behind: it accounts for only 2% of world passenger transport and 1.5% of freight transport, according to Button et al. (2017). Despite efforts to improve it through liberalization, progress has been slow due to antagonisms between nations, political instability, and ineffective negotiations, as noted by Njoya (2016).[1]

Contrary to the trend of airlines' consolidation that characterizes all other continents (Andreana et al., 2021), Africa is still plagued by a lack of cooperation among African airlines, as well as between African airlines and major worldwide carriers and alliances (Button et al., 2022). However, greater cooperation among airlines has the potential to drive network expansion, reduce costs, and increase efficiency, leading to the development and long-run sustainability of the air transport industry (see e.g., AFRAA, 2022). At the same time, theory suggests that cooperation agreements could act as coordination devices and result in reduced competition and higher prices. To determine whether increased cooperation would translate into lower airfares for passengers and drive an increase in passenger volumes, similar to what occurred in the United States and Europe, it is essential to study the relationship between airlines' cooperation and airfares in Africa. This paper aims to estimate the effect of airlines' cooperation on airfares in Africa, contributing to the ongoing debate on the role of cooperation in the development of the airline industry in Africa.

We focus on code-sharing (CS) as a form of airline cooperation. CS is the most widespread cooperation strategy globally and involves a marketing arrangement between two airlines where one airline's designator code is displayed on flights operated by its partner airline (Oum et al., 1996). This arrangement allows airlines to extend their network of routes and increase the load factor of their aircraft. While there are other forms of cooperation in the air transportation sector, such as global alliances, antitrust immunity, and joint ventures, CS is typically relatively light form of coordination compared to alliances and joint ventures. This is because code-sharing

[1] In 1999 the African countries signed the Yamoussoukro Decision, with the aim of liberalizing intra-African flights, and implementing uniform safety and security standards. Today, African states mutually grant themselves the right to exercise traffic rights, but retain the power to designate the airlines, and tariff freedom is limited to eligible airlines. Cabotage is not in place, as it is, for instance in the European Union.

agreements usually involve only the marketing of each other's flights, rather than the sharing of revenue, costs, and decision-making that typically occurs in alliances and joint ventures.[2] CS has a long history in the air transport industry, with the first international code-sharing agreement between American Airlines and Qantas dating back to 1985 (Dresner and Windle, 1996). Since then, CS has become increasingly prevalent, with about 75% of all direct and indirect flights between the US and Australia, as well as flights between Europe and the US, involving code sharing in 2018 (de Jong et al., 2022). This growth in CS has occurred in together with the liberalization of air transport.

This study aims to examine the impact of CS agreements on international flights within Africa using a rich panel dataset covering the period from 2017 to 2019. The analysis exploits the panel dimension of the data by incorporating route per time fixed effects and operating pairs per route fixed effect. To address potential endogeneity concerns, an instrumental variable (IV) approach is employed to instrument the codeshare decision. This IV strategy helps mitigate the issue of reverse causality and unobserved factors that may influence the decision to engage in codesharing. The identification strategy employed is akin to a difference-in-differences approach, leveraging the variation across airline pairs within the same route and month, as well as the variation across time for the same airline pairs within the same route before and after the CS decision. The main result of this study reveals a substantial and statistically significant reduction in airfares, amounting to approximately 18%. Remarkably, this magnitude of price reduction effect attributed to CS agreements surpasses any previous findings, suggesting a strong impact of double markup in Africa. The lack of cooperation among airlines in the region has contributed to excessively high prices, making the elimination of double markup through CS agreements particularly impactful. Additionally, this paper presents new empirical evidence on the potential spillover effects of CS agreements. Specifically, it explores the impact of CS agreements on the airfares of carriers not directly involved in the CS agreement but having strategic interactions with the participating airlines. This investigation focuses on three distinct types of flights to assess the spillover effects: (1) connecting flights where both carriers remain independent, constituting an interline itinerary, (2) flights operated by the carrier offering both legs of the journey, representing an online itinerary, and (3) direct flights operated by other airlines on the same itinerary as a connecting flight with CS. We find that, in connecting flights with interline service, airlines react to the introduction of CS agreements by reducing prices by approximately 10%. However, in flights with online or direct service, airlines do not exhibit

[2]On the contrary, a global alliance is a coordination among several alliances, granting benefits like a high network expansion to the allied carriers, and the possibility to collect advantages from frequent flyer programs to passengers while a joint venture typically involves airlines sharing revenue and costs on a specific set of routes or markets. In a joint venture, the participating airlines share profits and losses and make joint decisions about route planning, scheduling, pricing, and marketing.

any reaction to the introduction of CS agreements. These findings suggest that airlines do not perceive CS agreements as a threat to their market share when providing online or direct services.

Previous contributions on the effects of CS are mainly empirical, but there are also some theoretical papers (e.g., Hassin and Shy, 2004; Heimer and Shy, 2006; Chen and Gayle, 2007; Adler and Hanany, 2016) that have highlighted the possible existence of a trade-off between positive and negative effects of CS agreements.[3] The vast majority of studies is related to the US, since they exploit information available in the Department of Transportation origin and destination data bank 1B, which provides data on a 10% sample of passengers traveling both domestic and international flights extracted from reporting carriers.[4] A large number of these papers finds that CS decreases prices for connecting flights, while there is no effect on direct flights. The intuition is that through cooperation airlines realize that, in a one stop itinerary, if both independently set prices on the leg they operate, they do not take into account the external effect on the demand for the other leg–i.e., a typical double markup effect–and this leads to higher prices. Early cross-sectional studies estimated a price reduction of about 20% due to CS in connecting flights. However, more recent panel data studies have found smaller price reductions, ranging from -4% to -6%. For instance, Brueckner (2003) and Bilotkach (2007) estimate a 17% and 22% price reduction in one-stop flights respectively using a cross-sectional dataset. However, studies using panel data, such as Whalen (2007) and Brueckner et al. (2011), estimate a smaller price reduction of 4% due to CS in connecting flights. Armantier and Richard (2008) finds that CS agreements reduce prices by 6% in connecting flights but increase them by 10% in direct flights. Similarly, Calzaretta Jr et al. (2017) analyze international flights departing/arriving in the US between 1998 and 2015 and find that alliances involving CS agreements lead to a 4% price decrease on connecting fares. Using a more detailed dataset, Brueckner and Singer (2019) find a smaller price reduction of 1% due to CS in connecting flights for the period 1997-2016.

Interestingly, some papers do not find any effect, or a positive effect of CS on fares. Gayle (2008) examines US data for the $4th$ quarter of 2002 and of 2003, to test the effect of the announcement made in August 2002 of Delta Airlines, Continental Airlines, and Northwest Airlines to implement CS, and he does not find any effect. Gayle (2013) presents a structural model using US data for domestic flights covering the four quarters of 2006, and explores a counterfactual analysis where a CS between carriers is transformed as a complete integration, and

[3]Chen and Gayle (2007) study the effect of CS with a vertical product differentiation model in itineraries involving one stop, and show that it decreases prices by eliminating the double markup only if there is no CS partner offering online flights (i.e., the same airline operates both legs) in the same itinerary. Adler and Hanany (2016) present a game-theoretic model to study the impacts of CS in parallel networks, i.e., routes where airlines overlaps. They show that consumers are better off only if CS covers a small share of the flights offered in the parallel networks.

[4]Carriers are US-based (domestic) carriers, and reflect US airline and codeshare partner (foreign) airline routes.

finds that in this case prices would decrease by 20%, highlighting that CS does not reduce double marginalization. Other papers present a structural model, and find that CS is not facilitating collusion. Gayle and Brown (2014) using US data for the 4th quarter of 2002 and 2003 to study the effects of the alliance (involving also CS agreement) between Delta Airlines, Continental Airlines, and Northwest Airlines, show that data are better fitted by a model that assume Bertrand competition among the carriers, even if they cooperate, rather than collusion. On the contrary, Ciliberto et al. (2019) with US data for a long period, i.e., 1993-2016, finds that CS might be a factor facilitating price fixing, since airfare are more rigid in presence of CS. Ito and Lee (2007) makes an important contribution on the effect of CS, using the US data for domestic flights in the *3rd* quarter of 2003. They provide a classification of CS agreements, introducing the difference between traditional and virtual CS, that will be specified later, and show that CS may be implemented not only for expanding the network, increasing the flight frequency, and eliminating double marginalization, but also for market segmentation. The idea is that the CS flight is perceived a lower quality product by passengers, since when the itinerary is operated by a different carrier than the passenger's preferred one, luggage, check-in and boarding operations may be treated differently. They find that virtual CS reduces prices by 5%, while, as expected, traditional CS increases prices by 6%, in comparison to online flights.

Few studies have investigated the effects of CS outside the US, due to lack of data.[5] Alderighi et al. (2015) analyze 49 European routes from April 2003 to February 2004 by web-scrapping data from Opodo website with a focus on the dynamic pricing, i.e., the possible price differences among early and later buyers.[6] They show that CS increases prices by 10% on early bookers, due to the higher airfares charged by the marketing carrier, i.e., the airline that does not operate the flight. de Jong et al. (2022) use data from a survey involving Australian passengers flying on two routes: Australia-Chile, and Australia-North America. They show that CS increases passengers' willingness to pay for flights provided by non-Australian carrier, i.e., there is an evidence that passengers have a bias towards home airlines, and CS is a factor increasing the reputation of foreign carriers. Using data on El Al Israel Airlines flights from/to Israel for March 2008 and March 2010 and exploiting the 2009 decision of the Israeli antitrust authority to limit cooperative agreements between El Al and other international airlines Adler and Mantin (2015) find that for connecting flights where the Israeli antitrust authority decision removed CS, prices increase by

[5] A similar data set to the US Databank B1 is not available in other countries, where it is instead necessary to buy proprietary data from specialized companies, e.g., OAG–Official Aviation Guide, of from web scrapping, limited to some routes/airlines.

[6] Opodo is a online travel agency operating in Europe, developed by some European airlines, e.g., British Airways, Lufthansa, Air France, KLM, Iberia, etc.

4%.[7]

This paper contributes to the existing literature in several ways. Firstly, it presents empirical evidence regarding the price changes that occur when a CS agreement is implemented in a connecting flight where the two operating airlines previously had no cooperation. Similar to the approach taken by Adler and Mantin (2015) this study employs a difference-in-differences methodology. However, unlike in Adler's study, the implementation of the CS agreement in this paper is not a result of antitrust authority enforcement, which typically involves post-decision behavior monitoring. Instead, it represents an independent decision made by certain airlines. Consequently, it becomes possible to observe whether the potential benefits of lower prices arising from the elimination of double marginalization outweigh the potential losses of higher prices due to collusion. Secondly, using official data covering the universe of airlines and flights, the paper provides the first evidence of the effect of CS agreements on prices in Africa. By examining the African market, this study contributes valuable insights that can enhance our understanding of the implications and dynamics of CS agreements in a unique and understudied context. Lastly, this paper presents new empirical evidence on possible spillover effects of CS agreements. Specifically, it explores whether CS may have a indirect, general-equilibrium, effect on airfares of carriers not involved in the CS agreement. The spillover analysis aims to shed light on potential market segmentation resulting from CS agreements, similar to the findings inIto and Lee (2007).[8]

The plan of the paper is as follows. Section 2 introduces some definitions regarding the different types of air transportation services we analyze. Section 3 presents the African context, while Section 4 describes the empirical strategy. Section 5 provides information regarding data sources and variable definitions, while Section 6 show the econometric results. Section 7 offers some conclusions.

2 Definition of Air Transportation Services

Before examining the impact of codeshare (CS) agreements on fares in Africa, it is crucial to provide clear definitions of key terms pertaining to itineraries and CS types. Firstly, a distinction must be made between direct and connecting flights. A direct flight directly connects two airports without any intermediate stops. On the other hand, a connecting flight facilitates travel between an origin airport and a destination airport, but with at least one stop at an intermediate airport,

[7]They consider free sale CS. A free sale CS agreement implies that the marketing carrier can operate directly on the operating carrier's computer reservation system.

[8]For example, it may be possible to find no effect on direct flight because passengers consider this product completely different from a CS connecting flight even if the ticket is sold by the same company also operating the direct flight in that itinerary.

known as a gateway. It is common for many international itineraries to involve connecting flights, particularly due to the prevalent hub-and-spoke system adopted by full-service carriers (FSCs) in the aviation industry. A second A further crucial distinction pertains to connecting flights, where it becomes necessary to differentiate between self-connecting, interline, and online itineraries. Figure 1 illustrates the distinctions between these types: self-connecting (a), interline (b), and online (c). In the case of self-connecting itineraries, passengers purchase two separate tickets. The first ticket takes them from the origin airport (O) to the gateway airport (G), operated by airline A_1. The second ticket covers the journey from the gateway airport (G) to the destination airport (D), operated by either airline A_2 or airline A_1; the specific airline does not affect the distinction. Passengers are required to check-in, drop off their baggage, undergo security checks at both the origin airport (O) and the gateway airport (G), and claim their baggage at both the gateway airport (G) and the destination airport (D). In the event of a delay in the flight between O and G, if passengers miss their connecting flight from G to D, there is no protection or alternative flight arrangement provided. Furthermore, if passengers are enrolled in a frequent flyer program, their points are typically limited to the specific airline A_1 with which they are associated.

If the itinerary is interline (Figure 1b), the passenger purchases a single ticket, usually from a travel agency, in which the flight from O to G is operated by airline A_1, while the flight from G to D is operated by the other airline A_2. Check-in, baggage drop, and security controls are performed only at O, and baggage claim is only at D. In the event of a delay in the flight between O and G, if the passenger misses the subsequent flight, there is protection. However, points are treated in the same manner as in the self-connecting case. The characteristics of the online itinerary are described in Figure 1(c). Both legs, O-G and G-D, are operated by a single airline, for example, A_1. Passengers purchase a single ticket from either a travel agency or the airline's website. They go through check-in, baggage drop, and security checks only at O, and claim their baggage only at D. Protection in the case of delays is provided, and passengers can collect points for both legs. Clearly, in terms of service quality, the online itinerary offers the best experience, followed by interline, and lastly, self-connecting. In interline and self-connecting itineraries, airlines A_1 and A_2 determine the ticket prices to maximize their individual profits. Consequently, airline A_1 adds a markup to its marginal cost on the O-G leg, and airline A_2 applies a markup in the $G-D$ leg, resulting in a double marginalization effect.

The CS agreement introduces an important change and gives rise to a new type of itinerary. In connecting flights, if airlines A_1 and A_2 engage in code sharing, this implies a distinction between the carrier that operates and sells the ticket (referred to as the operating carrier) and the carrier that only sells the ticket (referred to as the marketing carrier). A CS agreement

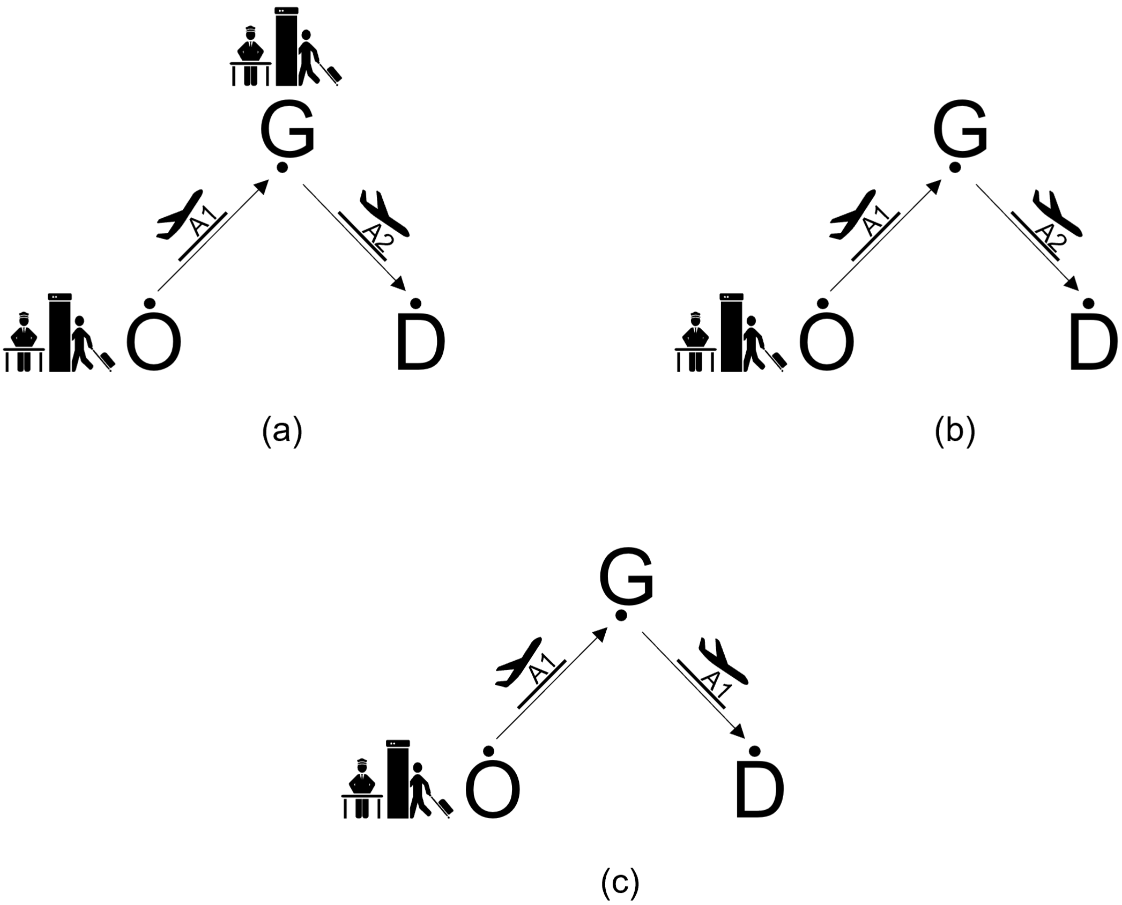

Figure 1: Different Types of Connecting Flights

allows the marketing carrier to sell tickets for the leg it does not operate.[9] In a CS itinerary, the passenger purchases a single ticket from the marketing carrier, which can be either the airline that operates the flight or the one involved in code sharing. They go through check-in, baggage drop, and security at the origin airport O, and claim baggage only at D. Protection is provided, and points can be collected for both legs. Hence, a CS itinerary shares similarities with an interline itinerary, albeit with some notable differences, as demonstrated by Ito and Lee (2007): since the passenger buys the ticket from the marketing carrier and then travels with a different airline, the check-in process, onboard experience, and other services may differ, and the points that can be collected may be lower. Additionally, the baggage handling may not be entirely seamless. These characteristics position the quality of a CS itinerary between that of an interline and online itinerary. Another distinction within CS agreements pertains to traditional and virtual arrangements: the former is implemented when, for instance, airline A_1 operates the O-G leg in Figure 1, and airline A_2 is the marketing carrier, while airline A_2 operates the G-D leg, with airline A_1 as the marketing carrier.[10] A virtual CS occurs when one airline does not operate any leg of the O-(G)-D itinerary but only markets some tickets. It is important to note that in the case of a direct flight, the only type of CS possible is virtual.

This paper focuses on connecting flights, therefore it is focused on the traditional type of codeshare. As shown by Adler and Mantin (2015); Adler and Hanany (2016), there are several factors that may induce airlines to sign a CS agreement, ranging from network expansion, increasing perceived flight frequency, the stimulus to demand through the elimination of double marginalization, price discrimination through market segmentation (Ito and Lee, 2007), cost reductions through economies of density and scope (the airline can open new connections without operating an aircraft and grasp benefits from higher passengers in the hub airport), higher load factor through better listing in the reservation systems. A further incentive may be increasing prices through cooperation. The paper aims to identify if CS is a factor decreasing prices in African aviation, that implies that it limits double marginalization and/or generates cost reductions. Furthermore, by analyzing the CS spillover effects on interline, online, and direct itineraries, the paper provides some evidence on whether CS may be implemented for market segmentation: for instance, if airlines involved in online itineraries react to the introduction of CS by reducing the price it means that the CS itinerary is a strong substitute of the online one.

[9] The right to sell tickets on the flight operated by the other CS member can vary under different specifications. In a free-sale CS, seats on the aircraft that operates the leg are not allocated to the marketing carrier, which can directly access the operating carrier's reservation system and sell tickets. In a hard-block CS agreement, the marketing carrier purchases some seats from the operating carrier and sells them independently.

[10] In a traditional CS, it is sufficient for at least one leg to involve an operating and different marketing carrier.

3 Air Transportation in Africa

Africa holds immense potential for the development of air services, owing to its demographic characteristics (representing approximately 15% of the global population, spread across more than 50 countries) and geographical factors (vast distances and growing urban concentrations). Moreover, the underdevelopment of alternative transportation modes further enhances the prospects for aviation growth in Africa (Button et al., 2015; Abate, 2016; Lubbe and Shornikova, 2017). However, despite these favorable conditions, African continental airline markets remain relatively underdeveloped, accounting for only about 2% of global air traffic. Moreover, the market is concentrated in a few countries, with many airlines exhibiting a local focus and inefficiency. This is particularly evident among Sub-Saharan African carriers. Consequently, African airlines face challenges in realizing the benefits of economies of scope and density. Additionally, they often encounter significant political interference, further impeding their efficiency (Button et al., 2022). Various factors contribute to the high costs and operational challenges faced by African airlines. These include the high finance costs associated with aircraft acquisitions, limited connectivity and liberalization, expensive jet fuel, and high aviation fees and charges. As a result, airfares in Africa are considerably higher compared to more developed regions such as Europe and the United States. When factoring in the average income of a country, the "real cost" of air travel in Africa becomes even more burdensome. It is estimated that an average middle-class African citizen can afford only one air trip per year, whereas their European and North American counterparts can afford approximately 26 and 33 air trips per year, respectively (Logistic, 2022).

The financial struggles and inability of African airlines to offer competitive fares pose significant obstacles to the development of the aviation industry in many African countries. To overcome these challenges, a crucial step is to prioritize the liberalization of the African skies. Over the past three decades, various efforts have been made to enhance connectivity and eliminate the rigid bilateral constraints that hamper the industry. The Yamoussoukro Decision (YD) of 1999 stands as a significant agreement in this regard (Scotti et al., 2017). Despite these efforts, progress in liberalizing African aviation has been insufficient thus far (Button et al., 2022). However, the establishment of the Single African Air Transport Market (SAATM) in 2018 represents a clear and committed step towards the full implementation of the Yamoussoukro Decision. The African Airlines Association (AFRAA) emphasizes that liberalization is crucial not only to improve connectivity but also to create a favorable environment for airlines to engage in cooperative agreements, providing the necessary commercial and operational flexibility. The global aviation industry has witnessed remarkable benefits from commercial cooperation, particularly through strategic alliance memberships and code-sharing agreements. However, such cooperation is currently lacking among African airlines (Button et al., 2022). Njoya (2016) attributes part of the failure in past liberalization efforts to the lack of cooperation between African carriers and airlines from other regions. Therefore, fostering commercial cooperation is viewed as a key strategy to make travel within Africa more convenient and affordable. It can lead to fare reductions and increased revenue for African carriers, ultimately making intra-Africa travel more accessible and viable.

4 The Empirical Strategy

This section presents the econometric model used to investigate the impact of CS agreements on airfares in Africa. The analysis aims to address two main objectives: (1) to examine the price changes following the adoption of CS on specific routes, and (2) to investigate the spillover effects of CS adoption on the same set of routes under different circumstances (e.g., nonstop, connecting with a single player for both legs, etc.). To achieve these goals, two distinct empirical approaches are employed.

For the first objective, the panel dimension of the dataset is leveraged, and a fixed effect econometric model is implemented as follows:

$$\log FARE_{prt} = \gamma CS_{prt} + \alpha_{pr} + \alpha_{rt} + \epsilon_{prt} \tag{1}$$

where $FARE_{prt}$ is the average fare charged by the operating carriers pair p (i.e., the pair A_1-A_2 or A_1-A_1 in Figure 1), on the O&D market r (the connecting itinerary *O-(G)-D* in Figure 1) during period t (month-year), expressed in logarithm. CS_{prt} is a dummy variable equal to 1 if the two operating carriers are in a CS agreement on market r in period t, and 0 otherwise. α_{pr} is the carrier pair×market fixed effect, α_{rt} is the market×period fixed effect, and ϵ_{prt} is the error term, which is assumed to be normally distributed.

The model is applied to connecting itineraries where there are at least two pairs of operating carriers covering the two different legs, with at least six observations, of which at least in the first three periods the itinerary is interline, and then one carrier pair adopts the CS agreement and keeps it until the end of the observed time interval. Table 1 offers a clear view of our definition of a CS agreement.

Table 1: Example of the Activation of Code Sharing

t	OC1	MC1	OC2	MC2	CS
1	A1	A1	A2	A2	0
2	A1	A1	A2	A2	0
...	...	...	...	...	...
23	A1	A1	A2	A2	0
24	A1	A1	A2	A1	1
...	...	...	...	...	...
T	A1	A1	A2	A1	1

The inclusion of a rich set of fixed effects allows us to parsimoniously control for many sources of unobserved heterogeneity. Specifically, the carrier pair×market fixed effect captures time-invariant factors associated with the interaction between two airlines in a given market. It controls for any persistent characteristics or differences between airline pairs operating on the same market that could affect ticket prices. On the other hand, the market×period fixed effect accounts for time-varying factors that might influence ticket prices in a specific market during a particular period. This includes factors like seasonal variations, unique characteristics of country pairs, and competition dynamics on the route. The dummy variable CS captures the switch from interline to codeshare. The coefficient, γ, is identified only using fare variation in the same market and period between pairs that are in CS and those who are not, as well as variation within pairs and market before and after the switch to CS. It is therefore possible to interpret γ as a difference in difference effect: the difference in fares charged in market r between airline pairs operating in CS and those operating interline, before and after code sharing is introduced.[11]

The potential endogeneity of the CS dummy variable in the model (1) is an important concern, as airlines may strategically select routes to adopt codeshare agreements based on unobserved factors that are correlated with the error term ϵ. This correlation can pose challenges in identifying the causal effect of codeshare adoption on ticket prices. To address this endogeneity issue, we employ an instrumental variable approach. We use the "gateway characteristics" as an instrument, specifically focusing on the number of direct connections that the two airlines have in codeshare with any airline from the gateway to destinations other than the origin and destination of the considered market. We refer to this instrument as $CS_{PROPENSITY}$, as it captures the propensity of an airline pair to engage in codeshare agreements for flights that

[11] The inclusion of market × period and market pair fixed effects implies that to identify gamma we are using only those itineraries where that are at least two pairs of operating carriers covering different legs in which at least one of the two switches.

depart from gateway G at a given period t.

This measure allows us to exploit some variation at the airline pair (p) - market (r) - time (t) level. The assumption we make is that if we observe an interline connection A1/A1 $\rightarrow$ A2/A2 on the itinerary Origin-Gateway-Destination $O_0 - (G_0) - D_0$ at time t, the likelihood of observing a codeshare agreement (i.e., A1/A1 $\rightarrow$ A2/A1*) at period t is positively associated with the number of segments in codeshare that the two operating carriers (A1 and A2) have with any partner connecting the specific gateway G_0 to airports other than the origin and destination of the route. This number serves as an indicator of the propensity for codeshare agreements at gateway G_0 but does not directly impact the fare of the itinerary $O_0 - (G_0) - D_0$ as it pertains to other origin-destination markets.[12] To illustrate this concept, Figure 2 and Figure 3 provide graphical representations.

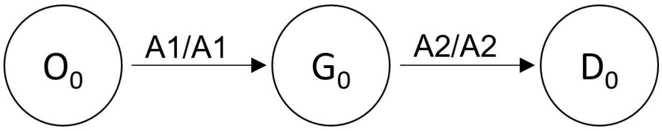

Figure 2: An Interline Itinerary operated by A_1 and A_2

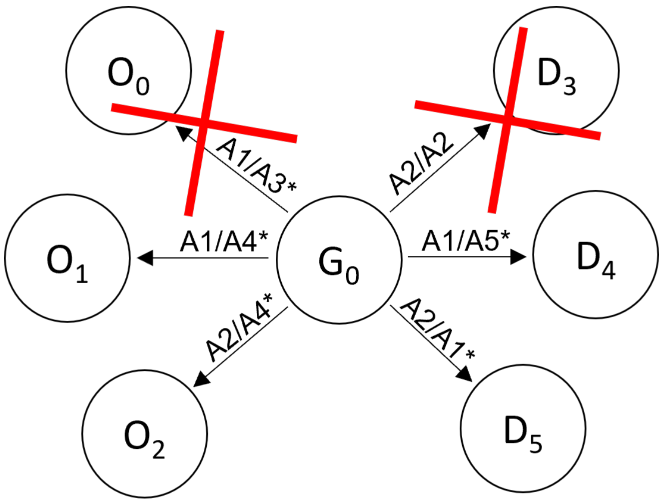

Figure 3: A Gateway and All Its Outbound Direct Codeshare Flights That We Count to Build Our IV

Our second goal is to investigate whether CS adoption by a carrier pair in a particular market has spillover effects on the prices of the same route when served under different circumstances: by

[12]In cases where an airline pair A1/A2 operates the same interline itinerary through different gateways, this number is computed as the average across the gateways.

airline pairs that never switch to codeshare (the interline case), by airlines offering the two legs on their own (the online scenario), and when the O&D market is served without any intermediate stop (the direct case). To this purpose we use three different subsamples and estimate the following econometric model:

$$\log FARE_{prt} = \theta CS_{rt} + \alpha_{pt} + \alpha_{rs} + \alpha_{ct} + \psi_{prt} \tag{2}$$

where $FARE_{prt}$ is, in the interline subsample, the fares charged by the airline pair p that never adopt CS in market r (t identifies the period, as before); in the online subsample, the price charged in the connecting route r by the single carrier i that operates both legs; on the direct itinerary subsample, the price charged by airline p that serves market r without stops (i.e., a direct flight from origin O to destination D). CS_ROUTE_{rt} is specified as a dummy variable equal to one if on route r at least a carrier pair operating a connecting flight switches from interline to codeshare; hence, the coefficient θ identifies the spillover effect, i.e., how the other airlines, offering a different product, react to the introduction of CS by some competitors on the same route. The set of fixed effects is now different than the one we exploited to estimate the double difference in the main model (1). α_{pt} is the airline pair×period (or the single airline×period in the online and direct subsamples) fixed effect, α_{rs} the market×semester fixed effect, α_{ct} the country pair×period fixed effect capturing all the time varying characteristics of the route at the country pair level (e.g., all the sociodemographic attributes that we could have included at the country level are taken into account).[13]

5 Data and Variables

This Section presents the data sets used in the empirical application to identify the impact of code sharing on airfares in Africa. The main dataset covers a period of 36 months from 2017 to 2019 and includes connecting flights in the intra-African international market. It excludes itineraries with gateways located outside of Africa. To investigating spillover effects, non-stop (direct) flights are also included in the sample.

The data for airfares, such as prices and passengers information, are sourced from the OAG Traffic Analyzer, which provides monthly averages traffic data on ticket sales at the airline and market level. The datasets also includes the codes for operating and marketing carriers.

Standard data cleansing actions have been implemented to ensure the inclusion of the most credible and relevant records. Firstly, observations not reporting airfares have been excluded as

[13]Market and period fixed effects cannot be included since they are collinear with CS_{rt}. α_{rs} should capture most of the airline competition at the $r-t$ as the entry/exit decision is rarely something changing within the season, but rather decided months in advance and stable along the semester. Birolini et al. (2021)

they clearly are not informative and are likely the result of misreporting or missing data. The remaining observations show a minimum airfare of 10$[14] Ex-ante we have not implemented any trimming action on the minimum level of ticket prices to avoid the risk of losing information; instead we have run robustness checks, and tested different thresholds for airfares. In fact, very low fares may be associated with frequent flyer programs or discounted fares for cabin crew. Secondly, observations that appear fewer than six times (consecutively or not) in our sample have been excluded, as it becomes challenging to accurately assess actual changes in code sharing agreements for such infrequent occurrences. Similarly, to obtain a clearer pattern for the application of our models, pairs that switch on and off code sharing have been excluded from the sample. Consequently, this second cutoff results in an additional 20% reduction in the sample size.[15]

The basic unit of observation in the analysis is an airline pair in a market that is defined as the combination of airlines operating the first and second legs of the itinerary. This differentiation is particularly relevant in the case of codesharing. A market is defined as a directional flight between two airports, regardless of the intermediate connecting point (gateway). Taking directionality into account, where O–D and D–O are treated as separate routes, is a common practice in the literature that relies on the same data source. (e.g., Dresner et al., 2021).

Although we do not employ a traditional Difference in Differences framework, we adopt its terminology to identify the Treatment Group (TG) and Control Group (CG) in our analysis. The TG consists of observations that operate as interline for (at least) the first three periods and subsequently switch to code sharing for the remaining periods in the sample. The CG comprises observations that remain interline throughout the entire sample period. In our dataset, there are a few cases of virtual CS, which we categorize as interline. However, these instances account for less than 0.8% of the total number of records and do not significantly affect the estimates when treated differently.

After applying the data cleansing actions, our dataset consists of 1,008 unidirectional markets involving 83 carriers, including 6 Low-Cost carriers (e.g., FA [Safair], JE [Mango]), as well as several European and Gulf carriers (e.g., AF [Air France], BA [British Airways], EK [Emirates]).[16] The top 10 airlines and airline pairs in our main sample are presented in Tables 2 and 3.

[14]Airfares are reported in US dollars and do not include fees for seat allocation, baggage, priority boarding, on-board food and drinks, taxes, airport fees, and surcharges (Dresner et al., 2021).

[15]Robustness checks have been conducted using different thresholds, but no significant changes have been observed in the final estimates.

[16]Prior to applying the cutoffs, we had 6,580 markets and 128 carriers. The distribution in terms of carrier identity was similar.

Table 2: Top 10 Operating Carriers in *Panel A*

Airline Code	Airline Name	Business Model
SA	South African Airways	Mainline
KQ	Kenya Airways	Mainline
ET	Ethiopian Airlines	Mainline
BA	British Airways	Mainline
FA	Safair	Low Cost
MN	Comair	Mainline
BP	Air Botswana	Mainline
WB	Rwandair Express	Mainline
KP	ASKY Airlines	Mainline
HF	Air Cote d'Ivoire	Mainline

Table 3: Top 10 Operating Pairs in *Panel A*

Airline Pair Code	Airline Pair Name
BA-SA	British Airways-South African Airways
FA-SA	Safair-South African Airways
MN-SA	Comair-South African Airways
BP-SA	Air Botswana-South African Airways
KQ-SA	Kenya Airways-South African Airways
WB-KQ	Rwandair Express-Kenya Airways
ET-SA	Ethiopian Airlines-South African Airways
5H-KQ	Five Forty Aviation-Kenya Airways
KQ-ET	Kenya Airways-Ethiopian Airlines
MS-ET	Egyptair-Ethiopian Airlines

Our final dataset consists of 2,061 unique airline pair-market combinations for which we have observed ticket prices over time. Table 4 provides summary statistics for the variables utilized in our empirical models. *Panel A* presents the characteristics of the main sample, while panels B, C, and D display the summary statistics for the subsets used in the spillover analyses. *Panel B* comprises interline observations that never transition to codeshare. In this subset, we explore the potential indirect effects of code sharing activation by certain airline pairs on airfares offered by those carriers that never engage in code sharing within the same market. *Panels C* and *D* represent the online observations (where the same carrier operates both legs of the journey) and the direct (nonstop) observations, respectively. The direct subset is expected to represent the highest quality product or, at the very least, the highest level of integration by definition.

Table 4: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Panel A: main sample					
FARE	31,085	215.26	127.11	10	1,892
CS	31,085	0.04	0.20	0	1
CS_PROPENSITY	31,085	1.520	5.311	0	56
DOM_LEG	31,085	0.50	0.50	0	1
KEY_GTW	31,085	0.66	0.36	0	1
Panel B: interline sample					
FARE	27,959	210.15	122.55	10	1,892
CS_ROUTE	27,959	0.03	0.48	0	1
DOM_LEG	27,959	0.52	0.50	0	1
KEY_GTW	27,959	0.636	0.362	0	1
DIST	27,959	2,863	1,503	283	9,149
Panel C: online sample					
FARE	19,729	194.25	118.18	10	1,523
CS_ROUTE	19,729	0.07	0.26	0	1
DOM_LEG	19,729	0.27	0.44	0	1
KEY_GTW	19,729	0.88	0.17	0	0.99
DIST	19,729	3,415	2,002	294	11,374
Panel D: direct sample					
FARE	9,299	176.48	104.85	14	1,319
CS_ROUTE	9,299	0.05	0.22	0	1
DIST	9,299	2,156	1,360	278	6,711

Panel A includes all the observations that either belong to the control or to the treatment group. In this case, the effect of the adoption of code sharing has a direct impact, which is assessed on the *i*-*j*-*t* level. Differently, for the spillover analyses the level of detail is the *j*-*t* level. After excluding the observations according to the criteria described above we are left with 31,085 interline observations where a change in CS takes place (*Panel A*), and 27,959 records with airline pairs never activating CS (*Panel B*). Within the online itineraries (*Panel C*), 19,729 observations are identified, while direct flights (*Panel D*) represent the smallest group, and account for 9,299 observations. In *Panel A* are included 1,008 markets and 2,061 products, *Panel B* has 886 markets and 1,862 products, *Panel C* has 878 routes and 1,686 products, while *Panel D* includes 455 markets and 616 products.

Our key variable of interest is CS, which is a dummy variable describing whether the two airlines operating the interline itinerary are cooperating through a code sharing agreement.

From *Panel A* it is evident that the average level of fare is the highest among the four panels, maybe reflecting that airlines codeshare in the most profitable markets. Code sharing is typical of about 4% of the sample. On average, about 20% of the routes (i.e., 198) are characterized by the adoption of code sharing during the observed time window. $CS\_PROPENSITY$ is the instrumental variable used to tackle the CS endogeneity problem. As described in Section 4, it represents the airline pair's propensity to codeshare from each specific gateway as it counts the number of segments in CS that the two carriers (A1 and A2) have with any partner connecting that specific gateway to airports different from the origin and destination of the itinerary. On average, about 25% of the direct flights from the gateway are operated under a codeshare agreement (i.e., about 2 routes per carrier pair). Among the interline routes, more that 70% of them are connected through a gateway from which airlines codeshare to other destinations. DOM_LEG is a binary variable taking one if at least one of the two segments is domestic (links two points within the same country). In *Panel A*, half of the observations involve a connection of this kind. Lastly, KEY_GTW is a continuous variable ranging between 0 and 1, and describing the importance of the gateway for the airline pair by the percentage of flights of the two airlines having the gateway as origin for other destinations with respect to the total number of destinations operated by the two players. This is a proxy measure of the hub nature of a gateway, which we believe to be important to control for.[17] In the main sample, on average, the gateway is often key for the airline pair.

Moving to Panels B, C, and D, when studying the spillovers, we define CS_ROUTE to take one if at least an airline pair activates codeshare on that particular market. On average, in our samples, this is typical of 3-7% of the observations, with the online sample the one with the highest percentage of observations on routes where codeshare is activated by some other airline pairs.

In addition to the variables already described for *Panel A*, to capture the disutility of the travel, and a cost term for the airlines, the average distance connecting origin and destination ($DIST$) has been included in the spillover models. As expected, the average distance is higher for connecting itineraries than for non-stop flights. $FARE$, and $DIST$ variables have been logged when included in the regression models.

[17] We considered the maximum percentage of direct flights from the gateway between A1 and A2. A value equal to one would mean that the airline pair (or at least one of the two airlines) serves all its direct routes from that particular gateway.

6 Results

6.1 The Effect of Code Sharing Agreements on Fares

This section estimates model 1 to determine a direct causal relationship between code sharing and fare levels. Table 5 collects the results. Column (1) reports the correlation between the activation of a codeshare agreement and the logarithm of fare, conditional on carriers pair×market and market×period fixed effects. The coefficient on CS indicates the change in fares charged by a pair of carriers on a specific market j after they start operating in code sharing, compared to the fares of pairs that remain interline on the same route. The conditional correlation is small, positive and statistically insignificant, suggesting that, on average, in a market, prices charged by carriers operating interline and in code sharing are comparable.

As discussed in Section 4, we expect carriers to choose which markets to operate in CS and who to stipulate the agreement with in order to maximize their expected profits. This makes the CS variable endogenous and the effect we estimate with a simple OLS regression biased. Therefore, to estimate the causal effect of the introduction of CS on fares, we employ an instrumental variable approach. Column (3) reports the results of the 2SLS estimate of model 1, where $CS\_PROPENSITY$ is used as an instrument for CS. The first stage coefficient in Column (2) suggests that the instrument is strong (*0.011 (0.003)*), and positively correlated with CS, implying that the higher the number of segments that the two carriers operate in (virtual) CS from the gateway (other than those connecting the gateway to the origin and the destination of the specific route) the higher the likelihood that they will have a CS agreement also on that route. The 2SLS estimates of γ is now negative and statistically significant, and implies that airline pairs that switch to CS lower their fares by approximately 18% on a route, compared to fares charged by carriers that continue to operate interline. The comparison of the OLS and the 2SLS estimate suggests that carriers typically enter in CS agreements in markets where fares are higher (either because they have higher margins or because they have higher costs to serve that market). The magnitude of the effect is sizable and slightly larger than what the literature finds when analyzing code sharing on intercontinental or US domestic routes.[18] This could be due to the underdevelopment of the African air service sector.

To assess the robustness of our findings, we conducted a sensitivity analysis, the results of which are summarized in Table 8. First, we introduced two additional control variables that could explain both the propensity to engage in CS and lower fares. The variable DOM_LEG serves as

[18] Among others, Brueckner (2003) finds a reduction of fares of 8%-17%, Ito and Lee (2007) compares the CS case to the online case but the direction and the magnitude of the coefficient is comparable. In Brueckner et al. (2011) the effect is estimated in about a 4% reduction of fares with respect to the interline case.

an indicator, taking a value of one if the gateway is either in the origin or destination country. This control helps us account for any effects related to domestic legs of the journey.Additionally, we included the variable KEY_GTW, which measures the proportion of flights departing from or arriving at the gateway that are operated by one of the carriers in the pair. This variable serves as a proxy for the importance of the gateway in the network of the carrier pair, helping us mitigate any confounding factors associated with the presence of a hub. We do not find any significant difference when including this additional controls (row 1).

Second, we conducted additional analyses to address potential concerns related to the composition of the sample and to examine the impact of specific choices of criterion made during the construction of the dataset. Given the unique characteristics of the African air transportation market, where the North-African region tends to be more developed, integrated, and dominated by European players, it is reasonable to assume that the effect of CS on fares may differ between North Africa and the rest of the continent. To explore this possibility, we excluded routes with origins and destinations in North-African Mediterranean countries and focused our analysis exclusively on Sub-Saharan Africa (row 2). Similarly, driven by the same concern, we conducted the analysis by narrowing our focus to African airline pairs only (row 3). In both cases, we observed a significant increase in the magnitude of the 2SLS coefficient. These findings provide further evidence that, compared to their interline counterparts, airline pairs that transition to code sharing experience a substantial reduction in fares on the route, estimated to be approximately 30%. Furthermore, when excluding Low-Cost Carriers (LCCs) from the sample, which operate with a distinct business model, the results remained consistent with those obtained in the baseline analysis, indicating that the presence of LCCs does not significantly affect the observed effect (row 4). In rows (4) and (5) we conducted sensitivity analyses by varying the cutoff thresholds for acceptable fare levels. With different cutoff values, we observed a slightly stronger effect, resulting in estimated fare reductions ranging from -20.5% to -23.2%. In rows (6) and (7), we modified the sample composition by excluding carrier pairs-routes that were present for less than 3 months or less than a year, respectively. Compared to the baseline cutoff of six months, both modifications resulted in slightly lower coefficients, indicating fare reductions of approximately -15%. Finally, we examined the impact of clustering the standard errors using three different methods to account for potential correlation in the error term. In row 8, we employed double clustering at the operating pair and route level. In row 9, we clustered at the operating pair-time and route level, while in row 10, we clustered at the operating pair, route-time level. Despite these variations in clustering, we found no change in the significance of our results.
Overall, the findings in this section provide robust evidence that the transition to code sharing results in lower fares for airline pairs. These results align with previous studies on cooperative

pricing (see Brueckner, 2003, Ito and Lee, 2007, among others), which have consistently shown that code sharing leads to reduced fares compared to the interline case. It is worth noting that the observed effect of code sharing in the African air transport market appears to be stronger than in other more developed and efficient markets, which is in line with our expectations.

Table 5: Fare Estimates from the Main Model

	(1)	(2)	(3)
Dependent Variable	*LFARE*	*CS*	*LFARE*
CS	0.038		-0.202***
	(0.041)		(0.074)
CS_PROPENSITY		0.011***	
		(0.003)	
Observations	19,800	19,800	19,800
Model	OLS	FS	2SLS
Adj. R-Squared	0.84	0.50	-
OPERATING PAIR×ROUTE FEs	✓	✓	✓
ROUTE×TIME FEs	✓	✓	✓

Standard errors, clustered at the route level, in parentheses.
*** p<0.01, ** p<0.01, * p<0.01

Table 6: Robustness of the Fare Estimates from the Main Model

Dependent Variable: *LFARE*		
	CS (2SLS)	Observations
Specification		
(1) Additional Controls	-0.192***	19,800
	(0.074)	
Sample		
(2) Sub-Saharan Africa	-0.333***	18,656
	(0.089)	
(3) African pairs only	-0.328***	19,772
	(0.074)	
(3) Excluding LCC	-0.201***	13,298
	(0.074)	
(4) *FARE>=25*	-0.229***	19,730
	(0.072)	
(5) *FARE>=50*	-0.264***	19,204
	(0.068)	
(6) *T >=3*	-0.157**	22,903
	(0.070)	
(7) *T >=12*	-0.160**	14,551
	(0.074)	
SE correction		
(8) *Operating pair and Route*	-0.202***	19,800
	(0.074)	
(9) *Operating pair × Time and Route*	-0.202***	19,800
	(0.074)	
(10) *Operating pair and Route × Time*	-0.202***	19,800
	(0.077)	
OPERATING PAIR×ROUTE FEs	✓	✓
ROUTE×TIME FEs	✓	✓

Standard errors, clustered at the route level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

6.2 Spillover Effects

We now shift our focus to examining the spillover effects of CS. In the previous section we find that interline flights operated under CS arrangements tend to have lower fares compared to interline flights without CS on the same route. Therefore, we investigate whether code sharing generates pro-competitive effects on fares charged by airlines that do not participate in code sharing.

To investigate this, we analyze various categories of flights that may be influenced by the introduction of code sharing on a specific route. We begin by analyzing the impact of code sharing on interline flights. To do this, we restrict the sample to carrier pairs that operate as interline on connecting routes (O-(G)-D). We compare the fares of these carrier pairs on routes where code sharing is introduced by rival carrier pairs to those routes where there is no code sharing at all. Consequently, the main explanatory variable, CS_ROUTE, is an indicator that takes a value of 1 if some carrier pairs (other than those included in the sample) operate in code sharing on that route in that period. In this analysis, the variable CS_ROUTE varies at the route-time level. To account for time-varying factors that may influence each airline pair, such as changes in governance, political pressure, or company restructuring, we include carrier pair×time fixed effects. Additionally, market×semester fixed effects absorb route-specific confounding factors that vary every six months, such as competition on the route. The country pair×period fixed effects account for oThe country pair × period fixed effects account for non-observable characteristics of the origin and destination, such as population characteristics, trade, and occupation. These fixed effects allow us to capture changes in demand for the itinerary without explicitly including market-level time-varying controls.

The interpretation of the codeshare coefficient is akin to a difference-in-differences estimator. We compare fares within routes before and after the introduction of code sharing and within company pairs between routes with code sharing and markets without. Table 7 collects the results of this exercise. The results of Column 1 suggest that, all else equal, when code sharing is introduced on a route, interline prices drop on average by approximately 10% (Column 1).

We are also interested in examining whether the pro-competitive effect of the introduction of CS extends to online and direct itineraries serving the same route. There are two perspectives to consider. On one hand, online and direct flights are often perceived as distinct products from interline flights and may not experience the same impact from increased competition in the interline market. On the other hand, even though they are differentiated products, a higher competitive pressure on the route could still have some effect, such as increased service frequencies by interline carriers. The results in Columns (2) and (3) of table 7 do not indicate any pro-competitive spillover effect on online and direct itineraries. The presence of at least one pair operating in code sharing on the same market-period is not sufficient to drive down the prices of online and direct competitors.

Table 7: Spillover Fare Estimates on the Interline, Online, and Direct Samples

Dependent Variable: *LFARE*			
	(1) INTERLINE	(2) ONLINE	(3) DIRECT
CS_ROUTE	-0.107**	-0.028	0.024
	(0.051)	(0.069)	(0.051)
Observations	15,617	14,899	4,730
Model	OLS	OLS	OLS
Adj. R-squared	0.74	0.60	0.86
OPERATING PAIR×TIME FEs	✓	✓	✓
ROUTE×SEMESTER FEs	✓	✓	✓
COUNTRY PAIR×TIME FEs	✓	✓	✓

Standard errors, clustered at the route level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

As for the main results, we propose some robustness checks on the spillover results as well. With a similar setting, Table 8 below collects these results.

Table 8: Robustness of the Spillover Fare Estimates on the Interline Sample

Dependent Variable: *LFARE*			
	CS_ROUTE	Obs.	Adj. *R*-Squared
Specification			
Add. Controls	-0.105** (0.050)	15,617	0.745
Sample			
Sub-Saharan Africa	-0.107** (0.051)	15,364	0.745
African pairs	-0.161** (0.068)	10,587	0.749
w/o LCC	-0.107** (0.051)	15,617	0.744
FARE>=25	-0.131*** (0.037)	15,514	0.745
FARE>=50	-0.124*** (0.036)	14,898	0.726
T >=3	-0.107** (0.051)	15,617	0.744
T >=12	-0.124*** (0.044)	11,804	0.760
Clustering			
Route and Time	-0.107** (0.041)	15,617	0.734
Operating pair × Route and Time	-0.107** (0.040)	15,617	0.734
Operating pair and Route × Time	-0.107* (0.060)	15,617	0.758
OPERATING PAIR×TIME FEs	✓	✓	✓
ROUTE×SEMESTER FEs	✓	✓	✓
COUNTRY PAIR×TIME FEs	✓	✓	✓

Standard errors, clustered at the route level, in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

7 Conclusions

This study contributes to the existing literature on cooperation agreements in the airline industry, by examining their applicabilityin underdeveloped markets, specifically focusing on the

African aviation market. We aimed tout most of the studies were applied to higom previous dies conducted in highly developed markets also hold true for regions that athe literature apply also to those markets that are still developing and trying to fill the gap. Moreover, we were intere still in the pss of development. Our analysis focused on internaed in understanding whether the pro-competitive effect line, and direct airfares ion Africa. By employing two simple models with aa rich set of fixed effects, we to estimated the effeimpacts of CS on different types of airfares, including interline, online, and directcodeshare on airfares in the African aviaing flights to investigate whether cooperation actually helps to internalize doube marginalization and results in lower fares. s a potential catalyststims for air transportation demand in Africa. When introduced by a carrier pair thatviously operated under interline service, CS leads to a significant reduction in air18%. The magnitude of the price reduction effect of CS is larger than what has been observed inany previous studies, highlighting the strong influenceresults, implying that the impact of double markup in Africa's aviation market and the high potential for cost efficiencies. The introduction of CS helps alleviate the issue of high prices resulting from limited cooperation among airlines. Furthermore, our analysis revealed significant spillover effects on interline fares when CSs strong in Africa where the lack of cooperation among the airlines generates too high prices. The direct effect is not the only one, since our second set of results highlight the presence of significant spillover effects on airfares of interline products. Indeed, all else equals, when code sharing is introduced on a route by at least onea pair of operating carrier. On averages, interline prices experience a decrease of approximately 10%. However, we did not find any significantdrop on average by approximately 10%. With this respect, the fact that no pro-competitive significant spillover effects on is found on neither the online andnor the direct fares. This suggestsample means that the CS itineraries arey is not a strong substitutes for of online or direct flightitineraries connecting the same origin and destinationO&D market, and they do not experience the same level offeel the effect of increased competition ason the interline market. Our findingestimates aremain robust across variousto all the alternative specifications, allowing us to differentiate; yet we are able to distinguish the effects of cooperation in the most developed regions of Africa from those ine one we find for the Sub-Saharan countries. Moreover, we can, and to distinguish the impaeffect of increased cooperation and efficiency when this happens between African airline pairs collaborate withand partners from outside telsewhe region.

In light of our findings, it becomes evident that the African aviation market holds substantial growth potential through enhanced cooperation among airlines. The results of our study align with the recommendations put forth by the African Airlines Association (AFRAA, 2022) emphasizing the importance of fostering collaboration within the industry to drive positive outcomes. The observed strong reduction in airfares when CS is introduced signifies the potential for increased air transportation demand in Africa. By addressing the issue of double markup. Among the possible future developments of our work, perhaps, one i as a catalyst for making air travel more affordable and accessible to passengers.

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