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The role of turboprops in China's growing aviation system ☆

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ABSTRACT

The Chinese aviation system is in a period of rapid growth, with significant growth in second tier and emerging cities. Lower density cities could be well served by regional aircraft, either regional jets or turboprops, which offer different qualities and a different future for Chinese aviation. Turboprops offer a high level of fuel efficiency compared with regional jets which may improve the cost economics for carriers and reduce the air quality and climate impacts of a growing aviation system in a region where air quality and greenhouse gas emissions are a serious concern. However, regional jets are known for their superior quality of service and faster travel speeds. We begin with a spatial analysis of existing Chinese short-haul aviation networks and find that turboprops are deployed in limited number and are dispersed throughout the country. Their limited use, however, is not because of their cost economics. For the existing regional jet network we estimate the trade space of fuel and time for the replacement of regional jets with turboprops and find that all regional jet routes in China would generate savings if replaced with turboprops. We next establish future short-haul aviation routes between new and emerging airports and estimate the likelihood that a turboprop will be used. The finding that the most viable turboprop markets are spatially dispersed through the country validates considering turboprop investment at the state-level as a component of the established Chinese aviation sustainability initiative.

1. Introduction

The Chinese aviation system is in a period of rapid growth. In the 30 year period from 1980 to 2009, China's civil aviation system grew at a rate of 17.6% per year, with the number of airports growing from 77 to 166 and annual traffic volume increasing from 3.43 million to 230 million (Lin, 2012). The Civil Aviation Administration of China (CAAC), the aviation authority in the Ministry for Transport, maintains a target of 244 airports across the country by 2020 with the goal of expanding aviation coverage in their National Aviation Network Plan (CAAC, 2007). The CAAC aims to enlarge the aviation network such that 80% of urban and suburban areas are within a 100 km (62 miles) of aviation service by 2020. As the eastern region of China is well covered with airports and aviation service, much of this growth will be in second tier and emerging western and southern cities. In growing the aviation services in these regions, the CAAC is looking to strengthen hub-and-spoke networks across the country to meet the dual goals of improving the competitiveness and efficiency of domestic and international aviation.

The aviation expansion into China's low-density areas follows years of reform in the Chinese Aviation System (CAS). In 2002, the state liberalized the CAS, a liberalization that was notably different compared with the free-market liberalization in the United States. Shaw et al. (2009) notes that the Chinese liberalization led to airline consolidation leading to three major carriers serving three major (northeastern) hubs, and a protectionist strategy to reduce route overlap for the three major carriers. The goal of the three carriers – to be competitive internationally or to serve the large domestic population – remains, however, a debate (Lei and O'Connell, 2011). Lin (2012) finds that that the state focus on major national hubs and alliance partners for international travel leads to an underdeveloped system of regional and sub-regional hubs to support regional traffic. While the three major airlines focus on boosting domestic coverage, many areas with insufficient air service remain. Shaw et al. (2009) discusses how regional commuter airlines could fill this gap by partnering with China's major carriers and serving the second-tier and emerging hubs that are not protected. This follows the practice of regional commuter carriers and major airlines partnering to serve low-density markets in the US.

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Wang and Jin (2007) note that the physical and socioeconomic traits of the more remote emerging airport regions include challenging terrains along with high poverty and percentages of minority populations. These regions are uniquely positioned for service by regional commuter airlines utilizing short-haul aircraft, either turboprops or regional jets. These aircraft are smaller than traditional narrow body jet aircraft which are widely used in China today (Shaw et al., 2009), offer lower ownership costs and operating costs per operation, and, because they necessitate shorter runways, are able to service some smaller and less developed airports. While aircraft in both of the short-haul aircraft categories share similarities, the adoption of short-haul aircraft in CAS expansion will have vast impacts on the economic and environmental impact of aviation. Firstly, turboprops necessitate shorter runways (1400 m compared with 2000 m for jets), offering the possibility of serving more challenging terrains; as a result, turboprops offer enhanced expansion opportunities. Secondly, turboprops are significantly more fuel efficient compared with regional jets; however, this fuel efficiency comes at the cost of passenger level of service (Ryerson and Hansen, 2010). Turboprops have a slower travel speed, and, in addition, are perceived as less comfortable compared with jets. In fact, Adler et al. (2005) find that the disutility of passenger travel on a turboprop can be up to $40/passenger-trip. In addition, turboprops have a shorter range of travel (900–1300 miles) compared with regional jets (1400–2000 miles) and have smaller cargo holds, limiting their versatility to serve a network.

Turboprops offer significant benefits at a cost, namely a cost to passengers in the form of reduced service quality and to airlines in the form of reduced flexibility. In the 1980s and 1990s, the relatively loud, uncomfortable turboprop with a limited operational range fell out of favor with the introduction of regional jets (Johnston, 1995; Mozdzanowska and Hansman, 2004). Recent improvements to passenger level of service and operating range, coupled with fuel price increases are leading a surge of interest in new turboprop models. New turboprops are currently in service for North American carriers such as Alaska Airlines/Horizon Air, Canada's Porter Airlines, along with other carriers worldwide. In 2008, turboprops were 4% of the domestic seat capacity provided by US carriers. While this is a small percent, it is very robust; in fact, turboprops saw a reduction in total seat capacity offered in 2008 of 6% compared with 2007, a minimal decline compared with the 11% seat capacity reduction from 2007 to 2008 seen by narrow body aircraft. Because turboprops consume fuel at a relatively low rate, the Government Accountability Office (GAO, 2009) concludes that the market for turboprops is small but stable compared with other jet aircraft, a finding empirically confirmed by Ryerson and Hansen (2010). Aircraft manufacturer plans also signal a renewed interest in turboprops. As of 2013, five aircraft manufacturers in as many different countries – China, India, Korea, Canada, and Italy – maintain serious plans to develop and market 90-seat turboprops; such a move will boost turboprop seat capacity and also increase the competitiveness of turboprops with regional jets (Perrett, 2013). Also signaling a growing market for turboprops is the increased competition in the engine market, with General Electric designing a turboprop engine to contend with the established Pratt & Whitney model (Morris, 2013).

While turboprops may be close to shedding their perception as aircraft with low quality of service and flexibility, their perception as unsafe aircraft lingers, particularly in China. Two crashes of the Xian MA-60 turboprop, the model favored in China and manufactured by Chinese manufacturer Xi'an Aircraft Industrial Corporation, occurred on the same day in the summer of 2013. In the immediate aftermath, the civil aviation authorities of Indonesia and Myanmar grounded their fleets of the MA-60 (Dennis, 2013). There are instances of turboprop crashes worldwide, including a crash in Buffalo, New York in 2009. Turboprops are not necessarily unsafe aircraft, however, they are generally operated by inexperienced crew and pilot error is a frequency cause for such crashes (Ryerson and Hansen, 2010).

Turboprops present challenges compared with regional jets: institutional challenges such that the operating crew are well-trained, and passenger preference challenges because of their perceived discomfort. However, the significantly lower cost of operation reduces the break-even point for which such services are cost effective. This lower cost allows airlines to serve more destinations and complete their hub networks, increasing their market dominance and allowing them to charge higher fares (Morrison and Winston, 1990). Much of this savings comes in the form of reduced fuel costs. In addition to financial health, turboprops present an opportunity for the CAS because of their potential to reduce aviation fuel consumption, a major initiative of both public and private entities worldwide. The consumption of fuel has significant economic and environmental implications. The cost of fuel plays a large role in the economic health of the airline industry worldwide. Because of the skyrocketing cost of fuel, in 2012 fuel was 33% of operating cost for US-based carriers compared with 9% in 2004 (BTS, 2013). This percentage is likely larger in China, as fuel costs are greater in China compared with the US. Fig. 1 shows US and Chinese jet fuel prices (IndexMundi, 2013; National Development and Reform Commission, 2013). Currently, Chinese jet fuel prices are set by the National Development and Reform Commission. While both follow the same trend, Chinese prices are higher, making fuel consumption an even greater cost concern for airlines in China.

There is significant uncertainty, however, regarding fuel prices going forward. Ma and Oxley (2010) address tentative moves by the Chinese government towards energy market deregulation, which may bring down energy prices. Deregulation faces significant barriers and challenges, however, surrounding the future of energy regulation and resulting prices in China with uncertainty (Ma et al., 2009). Despite the uncertainty, Ma et al. (2009) emphasize the need for energy pricing reform in China, particularly in the response of prices to demand, because of the need to manage transportation system congestion and environmental emissions.

The consumption of fuel leads to environmental externalities in the form of local and global pollutants, both of which have reached large levels in China. Regarding global Greenhouse Gas (GHG) emissions, China surpassed the US in 2007 and ranked first on the Carbon Dioxide (CO_2) emissions country list. Emissions of CO_2 have not slowed, as CO_2 emissions in China grew from 6.8 billion metric tons in 2007 to 8.3 billion metric tons in 2010, accounting for 26.4% of global 2010 CO_2 emissions (United Nations Statistics Division, 2013). Emissions from aircraft are particularly significant, as GHG emissions at altitude can be particularly harmful in terms of an increased warming effect (Williams et al., 2002). Aircraft also emit local pollutants such as CO, NO_x, and PM during their ground taxi procedures, which have a strong impact on human health (Chester and Horvath, 2009). Local pollutants are a significant concern in China, as many major Chinese cities suffer from PM2.5 concentration much higher above World Health Organization standards (Tan, 2013). The small particles generated from burning fossil fuels contribute to significant number of fatal respiratory diseases and premature deaths (Winter, 2013).

While the aviation industry continually seeks improvements in fuel efficiency, this share is expected to increase as other transport modes shift away from carbon-based fuels. Such an action will further increase the pressure on the aviation sector to reduce GHG emissions (Yang et al., 2009). Additionally, aviation in the European Union is now included in emissions trading, effectively increasing the cost of fuel; as environmental concern intensifies, so does the threat of fuel price increases from a mix of market forces and environmental charges (Scheelhaase et al., 2010).