Outlining the historical framework of the aviation sector in Turkey: A spatiotemporal approach

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The fast-growing, capital-intensive, and fragile structure of air transport makes the aviation sector crucial for national economic growth and regional development. Over a century old, Turkey's aviation sector has undergone a remarkable transition from a state-regulated market to a liberal, competitive one. This fundamental change has created an urgent need to quantitatively outline the historical and contextual framework of Turkey's air transport network in order to grasp its structural dynamics and thus obtain insights into the drivers of regional and air transport development. This paper uses time-series analysis to outline the historical framework of the aviation sector in Turkey based on air traffic and spatiotemporal data at the national and regional levels. The aim is to detect outlier changes in the historical air transport timeframe at both the national and regional levels and to define discrete periods in the history of Turkey's aviation sector. The results, discussed through the prism of transport policy and regional economies, provide structural insights into the dynamics of the Turkish aviation market. The findings reveal that the periods derived from the time-series analyses are consistent with the major changes discussed in the literature.

Keywords:

aviation development,
turkish airports,
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deregulation,
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Introduction

The aviation sector comprises an ecosystem of air transport-related service providers, such as airline companies, maintenance services, ground services, and airports. The evolution of the aviation sector in many countries has been driven by the power of neo-liberalisation, the transformation from state regulation to market-driven development (Palley 2005, Saad-Filho–Johnston 2005, Friedman 2009). The socioeconomic and political framework of this transformation has been the subject of many analyses focused on the United States (Button 1989), Europe (Button 1996, Barrett 2000), Australia, India (Hooper 1998), China (Wand et al. 2016), the UK, Spain (Lucio et al. 2001), Hungary (Béres et al. 2019), and Turkey (Cetin–Benk 2011). Neoliberal policies are driven by the forces of the free-market economy and privatisation (Polyani 1944). Under the policies, the state does not have a significant regulatory role but sometimes participates as an actor in the aviation market (Palley 2005, Friedman 2009).

In Turkey, aviation has become a dynamic, innovative, adaptive, and fast-growing sector, with an increasing share in both domestic and international air-transport demand and supply (Logothetis–Miyoshi 2018). Turkey's aviation market has been called 'successful' and part of the nation's 'soft power' (Selcuk 2013, Anaz–Akman 2017). Aviation activities in Turkey started in the 1900s with the construction of two hangars and a small runway in Istanbul. Today, Turkish Airlines (THY) is one of the fastest-growing airline companies in Europe, and Istanbul Airport is one of the biggest airports in the world (Erdem et al. 2019).

The deregulation of economy of Turkey and the privatisation of its state-owned enterprises (e.g. factories, refineries, roads, harbours) have accelerated the growth of the national economy and have helped restructure it according to liberalisation norms (Karaevli–Yurtoglu 2018).

According to the World Bank (2018), the Turkish economy is ranked 17th worldwide, with annual growth of about 6.7% on average. Since 2003, the Turkish aviation sector has grown at an annual rate of about 8.2% (Cetin–Benk 2011), and a growth of 10% is expected for 2020 (Georgieva et al. 2015). According to the International Civil Aviation Organization (ICAO 2017), Turkey is ranked 11th worldwide and 5th in Europe in the number of airline passengers. Moreover, the geopolitical location of Turkey is very important, because it is located at the meeting point of Europe and Asia.

Turkey's aviation sector is thus a unique case, and examining it can foster a better understanding of the forces underlying the 'market–state dichotomy' (Bruff 2011) and of their economic and political aspects (Boratav 2008, Pamuk 2014, Togan 2016). However, this sector has not been sufficiently studied. A large portion of the research – including Pamuk (2014), Togan (2016), Tekeli (2009), and Eraydın (2006) – have focused on the economic aspects of the transformation in Turkey, especially on the

restructuring of the market in accordance with neoliberal policies. Further research is needed into the political, geographical, and socioeconomic configuration of Turkey's aviation sector. Thus, this study quantitatively outlines the historical framework of the air transport network in Turkey (TAN) using air traffic time data at both the national and regional levels to detect outlier changes in the historical air transport timeframe and identify milestones in the sector's history. This assessment can help us to understand the discrete periods in the history of Turkish aviation and lead to a deeper understanding of the dynamics driving the national and regional aviation markets in the country.

The remainder of this paper is organised as follows. Section 2 describes the methodological framework and data used by the study. Section 3 presents the results of the analysis concerning the configuration of the time periods in the long-term history of the aviation sector in Turkey. These time periods are then discussed and evaluated in Section 4. Finally, Section 5 concludes the paper.

Methodology and Data

The methodological framework of the study is based on time-series analysis (TSA). A time-series dataset can be considered as a vector $\mathbf{x}$ of successive real (P) data $\mathbf{x} = (x_1, x_2, \dots, x_n)$, which is arranged into time order $t(x_1) < t(x_2) < \dots < t(x_n)$ and illustrates the temporal evolution of an attribute X expressed by the vector-variable $X = \mathbf{x}$ (Das 1994). The TSA generally includes methods and techniques for modelling the time distribution of attribute X and thus at extracting structural information from the available data $(x_1, x_2, \dots, x_n)$; Das 1994, Box et al. 2015).

In this study, TSA is used to extract the information required to classify the long-term history of the aviation sector into discrete periods. This is achieved by employing various TSA methods and techniques to produce outlier time points or cutting-points (thresholds) in the timeframe of the TAN's history. The discrete time periods are obtained by evaluating the frequencies and historical reference of these outlier values. The proposed methodological framework is the first to employ quantitative methods to classify historical events. As the flowchart shown in Figure 1 indicates, the overall approach is organised into two layers reflecting geographical scale (national and regional) and four computational steps: the *computations*, where the critical points (milestones) of the TAN's aviation history are estimated; the *literature evaluation* of the estimated critical points; the *verification* of the estimated time periods; and, finally, the *conclusion making*.

Figure 1

The TSA is based on annual passenger data, measured as the number of passengers transported in domestic and international flights from 1959 to 2018 (GDSAA 2018). The data are available at both the national (NS) scale (the aggregate domestic and international traffic in the country) and at the regional (RS) scale (for each of the 55 operating airports in the country), as shown in Figure 2. The data are obtained from the Turkish Statistical Service (TURKSTAT 2010) and the General Directorate of State Airports Authority (GDSAA 2018). Air passenger traffic is an effective proxy for air transport supply and can be used to examine the dynamics of the history of Turkey's aviation market and identify its main historical and contextual periods, as demand is heavily dependent on social, political, technological, and economic changes (Tsiotas–Polyzos 2015, Polyzos 2019).

Figure 2

**Time series of (left) the national (NS) and (right) regional (RS)
air-passenger traffic in Turkey for 1960–2018**

Source: GDSAA (2018).

Prior to the TSA, a stationarity assessment of the available time-series database is applied. Although an absence of stationarity is clearly observed in Figure 2, for the sake of completeness, an augmented Dickey–Fuller test (ADF) for a unit root (Shumway–Stoffer 2017) is applied to examine the hypothesis (H_0) that a unit root is present in the model's time-series data:

$$y_t = c + \delta t + \phi \cdot y_{t-1} + \beta_1 \cdot \Delta y_{t-1} + \dots + \beta_p \cdot \Delta y_{t-p} + \varepsilon_t \quad (1)$$

where Δ is the differencing operator ($\Delta y_t = y_t - y_{t-1}$), p is the (user-specified) number of lagged difference terms, c is a drift term, δ is a deterministic trend coefficient, ϕ is an autoregressive coefficient, β_i are regression coefficients of the lag differences, and ε_t is a mean zero innovation process.

According to the expression shown in equation (1), the unit root hypothesis testing is expressed as follows (Shumway–Stoffer 2017):

$$H_0 : \phi = 1 \text{ vs. } H_1 : \phi < 1 \quad (2)$$

and the (lag adjusted) test statistic DFt is given by the following formula (Shumway–Stoffer 2017):

$$DFt = \frac{N(\hat{\phi} - 1)}{(1 - \hat{\beta}_1 - \dots - \hat{\beta}_p)} \quad (3)$$

where the uppercase symbol “ $\hat{}$ ” expresses the estimator of the variables.

The first step of the TSA is a computation of the fundamental time-series measures. The first method is based on computations of the first-order differences according to the following formula (Das 1994, Box et al. 2015):

$$\Delta^{(1)} x_t = x_t - x_{t-1}, t = 2, \dots, n \quad (4)$$

where x_t is the value (score) of the time series at time t and x_{t-1} at time $t-1$. The first-order differences capture the changes of attribute X without removing the scale of the variable $\mathbf{x}$. These differences serve as a discrete analogy of the first derivative of

a function and thus provide information about the monotonicity of the time series (Das 1994, Box et al. 2015).

Next, the relative changes of the time series are computed according to the following formula (Polyzos 2019):

$$\Delta_R x_t = \frac{x_t - x_{t-1}}{x_{t-1}} = \frac{\Delta^{(1)} x_t}{x_{t-1}}, t = 2, \dots, n \quad (5)$$

where $\Delta^{(1)} x_t$ are the (previously defined) first-order differences. The relative changes $\Delta_R x_t$ express the first-order differences $\Delta^{(1)} x_t$ divided by the magnitude of the past-points x_{t-1} . In finance, the measure of relative changes is similar to the measure of logarithmic returns (Hudson–Gregoriou 2015), but the latter is defined for a certain time period between the initial and final (closing) values of a share. Therefore, the measure of relative changes is useful because it is scale-free (Tsiotas 2019): It does not include the magnitude of the x_t values since it expresses changes as percentages of the past-points x_{t-1} .

Next, the (simple) moving average statistic (Das 1994, Box et al. 2015) is computed as follows:

$$MA(t_n) = \frac{(n-1) \cdot MA(t_{n-1}) + x(t_n)}{n} \quad (6)$$

where $MA(t_2) = \frac{x(t_1) + x(t_2)}{2}$, and n is the number of time-series nodes considered in time t_n . The moving average is used to smooth the short-term fluctuations and highlight the long-term effects in the time series (Das 1994, Box et al. 2015), which is useful for defining the long-term historical framework of the aviation sector in Turkey.

Additionally, the sign (or signum) function (Yun–Petkovic 2009) is considered in the analysis using the following equation:

$$\text{sgn}(x) = \frac{d}{dx} |x_t| = \begin{cases} +, & \text{if } x > 0 \\ 0, & \text{if } x = 0 \\ -, & \text{if } x < 0 \end{cases} \quad (7)$$

where $\frac{d}{dx}$ is the derivative operant, and x_t is a time-series node at time t . When applied, the sign-function ‘binarises’ (in absolute terms) the time series, since it transforms the time-series data into a set of values belonging to a discrete set $\{-1, 0, 1\}$. This transformation is useful for grouping values of the same sign in order to define historical time periods based on the time-series data.

The final task in the first step is computing the outlier values extracted from percentiles P_k defined according to the following formula (Walpole et al. 2012):

$$P_k = \{x_i \in \mathbf{x} \mid x_i \leq p_k\} \quad (8)$$

where $\mathbf{x}$ is the time-series vector, k is the bound of the percentile, p_k is the score of the corresponding percentile belonging to the interval $p_k \in [\min(\mathbf{x}), \max(\mathbf{x})]$, and $|P_k| = \frac{k}{100} \cdot n$ is the cardinality of the set P_k . The outlier values are searched within 10% of the borderline cases, which are defined from the P_5 and P_{95} percentiles as follows:

$$x_{\text{outlier}} \in \{P_5 \cup \{P_{100} - P_{95}\}\} \quad (9)$$

The outliers, the outcome of the described procedure, are the candidate critical points (milestones) in the long-term history of the TAN. Based on their frequency in the overall analysis, the candidate milestones are further filtered to divide the long-term history of Turkish aviation into candidate time periods. In the second step of the methodological framework, these candidate time periods are submitted to a literature evaluation in order to determine whether they have real-world meaning for Turkish aviation history. To this end, a literature review is conducted to detect the historical events recorded simultaneously with the reference time of the candidate milestones, and correspondences are identified. In the third step, the two previous steps (TSA estimation of time periods and literature evaluation) are jointly considered to validate the historical time periods of the aviation sector in Turkey, which produces verified time periods in the long-term history of the TAN. Finally, in the fourth step, the overall approach is evaluated and discussed, and conclusions are drawn.

Results and Discussion

Time-series analysis at NS level

An ADF (Shumway–Stoffer 2017) for a lag of three periods (t_0 , t_1 , and t_2) is performed to examine whether the available data belong to a stationary time series. The results (see Table 1) indicate that this test fails to reject the null hypothesis of a unit root against the autoregressive alternative. Thus, the TAN time series is not a stationary verification of the initial visual evaluation of the raw time-series data.

Table 1

Results of ADF test on TAN stationarity

	Lag (p)		
	t_0	t_1	t_2
h^a	0	0	0
p -value	0.9990	0.9990	0.9990
stat	3.1188	2.5907	2.2653
z -value	-3.4921	-3.4934	-3.4946

a) $h = 0$ indicates failure to reject the unit-root null (non-stationary). $h = 1$ indicates rejection of the unit-root null in favour of alternative model (stationary).

Observing the raw time-series data in Figure 3 reveals four reference periods based on a numerical scale. These periods are defined by the years 1969, 1991, and 2004. The diagram shows that, before 1969, the evolution of Turkey's air traffic appears almost stationary; after this year, an increasing trend begins. Starting in 1991, the slope of the increase grows and then rises steeply from 2004. Regarding scale, prior to 1969, air traffic averaged 1,012,217 passengers per year; then it averaged 6,079,715 passengers per year for [1969, 1990], almost six times greater than in the first period; 28,012,648 passengers per year for [1991, 2003], almost eight times greater than in the second period; and 120,317,704 passengers per year after 2004, almost four times greater than in the third period.

Figure 3

Note: based on numerical scale data.

The results derived from the TSA expressed in numerical values are shown in Figure 4 and those expressed in terms of signs are shown in Figure 5.

Figure 4

The results derived from the TSA expressed in numerical values

Notes: Outlier values exceeding the range $[P_5, P_{95}]$ between the 5th (P_5) and 95th percentiles (P_{95}) for the distribution of (a) first-order differences, (b) relative changes, (c) first-order differences of relative changes, and (d) first-order differences of the moving average (MA), all of which are computed using time-series data of NS air passenger traffic in Turkey. These outliers suggest candidate milestones in the long-term history of Turkey's aviation sector.

The outliers produced by the TSA are the candidate milestones in the history of the TAN. We can observe outliers due to first-order differences $\Delta^{(1)}x_t$ (see Figure 4a) in 1980, 1991, 1999, 2010, 2013, 2015, and 2016; due to relative changes $\Delta_R x_t$ (see Figure 4b) in 1970, 1978, 1980, 1991, 1992, 1999, 2004, and 2010; due to first-order differences of relative changes $\Delta^{(1)}(\Delta_R x_t)$ (see Figure 4c) in 1974, 1980, 1981, 1991, and 1992; and due to first-order differences of the moving average $\Delta^{(1)}(MA(t_n))$ (see Figure 4d) in 1963, 1980, 1981, 2011, 2014, and 2016. Next, the signum function analysis of the long-term history of TAN (see Figure 5) produces time periods composed of sequential years with the same sign. The signum function consideration of the first-order differences $\Delta^{(1)}x_t$ produces four discrete time periods with a positive sign: [1963, 1973], [1981, 1990], [1992, 1997], and [2002, 2014]. The signum function consideration of the relative changes $\Delta_R x_t$ also produces four discrete time periods with a positive sign: [1963, 1973], [1981, 1990], [1992, 1996], and [2003, 2015].

Figure 5

The results derived from the TSA expressed in terms of signs

Notes: Time periods defined by the sign functions of first-order differences (left) and of relative changes (right) computed using time-series data of NS air passenger traffic in Turkey.

Time-series analysis at RS level

As in the NS analysis above, we examine the raw time-series data at the RS level. Their numerical scale enables us to identify five reference periods in the cluster configured by the 55 RS time-series diagrams (see Figure 6). These periods are defined by the years 1966, 1989, 2001, and 2004. For the period prior to 1966, air traffic averaged 14,743 annual passengers per airport. Afterwards, air traffic averaged 88,550 passengers per airport per year for [1966, 1988], almost six times greater than in the first period; 432,788 passengers per airport per year for [1989, 2000], almost five times greater than in the second period; 584,623 passengers per airport per year for [2001, 2003], comparable to the third period; and 2,076,780 passengers per airport per year after 2004, almost four times greater than in the third and fourth periods. The decay observed for [2001, 2003] concerns only the maximum outlier cases (airports) and not the majority of airports, since the average number of passengers was not affected.

Figure 6

Note: based on the numerical scale.

We configure the time sequence (1959–2018) of the boxplots shown in Figure 7 to obtain a sharper picture of the time distribution of the regional data. In contrast to the previous consideration, we apply a log transformation to the vertical axis of the diagram. This approach allows us to configure the time periods in the history of regional TAN traffic based on the years wherein the whiskers of the boxplots exceed the P_5 and P_{95} borderlines. We can observe that three time periods exceed the percentile borderlines: [1959, 1968], [1976, 1984], and [1991, 2017].

Figure 7

Notes: Boxplots computed using regional TAN data (airports). Periods with outlier values exceeding the interval $[P_5, P_{95}]$, computed using aggregate traffic data (for all available years), are shown within a coloured frame (vertical axis appears in log scale).

Figure 8

The TSA at RS

Notes: (a) Boxplots of first-order differences (log scale); (b) Boxplots of first-order differences (metric scale); (c) Barcharts of average first-order differences (metric scale); (d) Boxplots of first-order relative differences (log scale); (e) Boxplots of first-order relative differences (metric scale); (f) Barcharts of average first-order relative differences (metric scale), all of which are computed using annual TAN RS traffic data (airport traffic) for 1959–2018. Years exceeding the interval $[P_3, P_{95}]$, computed using aggregate traffic data (for all available years), are shown within a coloured frame.

The TSA at RS is shown in Figure 8. The first-order differences in log (Figure 8a) and metric scales (Figure 8b) and on average in metric scale (Figure 8c) are shown, along with the first-order relative differences in log scale (Figure 8d), in metric scale (Figure 8e), and their averages in metric scale (Figure 8f). Candidate milestones are detected in 1980, 1990, 2004, and 2008.

Configuration of time periods in TAN history

Estimation of candidate time periods

Based on the previous TSA at the NS and RS levels, we configure the diagram shown in Figure 9 summarising the potential milestones in the TAN's long-term history. The frequency with which a case appears in this aggregate diagram is considered a measure of importance (i.e. a potential milestone). To facilitate the literature review, we reduce the data resolution by focusing on cases appearing more than once in this aggregate diagram. The cases of greatest importance (≥ 4) are apparently more likely to suggest a historical TAN milestone.

Figure 9

The configuration of candidate time periods in long-term TAN history

Note: The frequency with which a case appears in this aggregate diagram is considered a measure of importance (i.e. a potential milestone).

The analysis shown in Figure 9 indicates that the potential milestones to be examined in the literature evaluation are in 1963, 1966, 1973, 1980, 1981, 1990, 1991, 1992, 1999, 2003, 2004, 2007, 2010, 2013, 2014, 2015, 2016, and 2018. The most important of these are 1980 (*freq.* = 5), 1981 (*freq.* = 5), 1990 (*freq.* = 4), 1991 (*freq.* = 6), 1992 (*freq.* = 4), and 2004 (*freq.* = 4). The literature on the history of Turkey's aviation sector is thus reviewed to investigate these potential milestone years.

Literature evaluation

The historical events concerning the TAN and their importance according to the TSA are summarised in Table 2. The historical periods that dominated the history of the TAN are summarised in Table 3. We see that aviation activities in Turkey began with the construction of two hangars and a short runway in 1912 in Sefakoy, Istanbul (Bakirci 2012), an area close to Ataturk Airport. Aviation activities then developed in accordance with the environment and the priorities driven by the Second World War. THY, Turkey's flagship carrier, was established as a state-owned enterprise in 1933, and Istanbul Ataturk Airport was selected as its operational centre (Sarilgan 2016). The first civil flights operated between Istanbul and Ankara airports in 1933, with a capacity of five aircraft and 28 seats (Bakirci 2012). This route connected the old imperial capital city of Istanbul to Ankara, the new capital city. Located in central Turkey, Ankara was new and modern, while Istanbul was regarded as un-modern. Izmir and Adana airports were completed in 1939 (THY 2018). The geography of Turkey's airports and its air routes were expanded to the western (Mediterranean) parts of the country. In 1943, Van airport was added to the network (Bakirci 2012). The growth and development of Turkey's aviation sector accelerated amid the political and technological environments of the Second World War. Airports were constructed in Sivas, Erzurum, Malatya in eastern Turkey; Diyarbakir, Gaziantep, and Urfa in south-eastern Turkey; Konya and Kayseri in central Turkey; Antalya and Iskenderun in southern Turkey; Samsun in northern Turkey; and Bursa in western Turkey from 1945 to 1947 (THY 2018). These airports expanded the geography of the aviation sector beyond major cities (e.g. Istanbul, Ankara, Izmir) to include secondary regional hubs (Tasligil 2014).

After 1947, the capacity of the aviation sector increased in terms of both aircraft and seats, and Turkey's aviation activities expanded to the international level. In line with the Westernisation of the nation, Turkey's first international flight took place in 1947, between Ankara and Athens with a connection at Istanbul. In 1951, the TAN's international destinations increased to four (Athens, Rome, Frankfurt, and Vienna), the number of aircraft to 33, and the number of seats to 1,120 (THY 2018). The growth of the aviation sector continued in parallel with technological developments, decreasing oil prices, and increasing capital investments, leading to the emergence of new lines from Turkey to the Middle East and Europe (THY 2018). In 1963, flights from Turkey to the United States began, and new European destinations were

included in the TAN (Orhan–Gerede 2013). Until the 1980s, Turkey's aviation sector was state-regulated and developed mainly through public investments. Several public-owned enterprises providing ground handling, catering services, and mechanical services were established in this period. The THY, airports, and supplementary services (e.g. ground handling, catering services, and mechanical services) were maintained as strict monopolies (Orhan–Gerede 2013).

After 1980, the Turkish economy was exposed to rapid and uncontrolled liberalisation (Pamuk 2014). These liberalisation policies meant that the state was no longer the sole regulator of the economy; rather, regulation occurs in accordance with the priorities of capital groups and the market (Boratav 2008). The Civil Aviation Law was issued in 1983, and many airline companies started operating in the aviation market without entry restrictions. With the help of free market-oriented deregulation and an increased number of TAN airports, 16 private airline companies were established between 1980 and 1990 (Battal–Kiraci 2015). However, six of these companies soon ceased operations (Cetin–Benk 2011, Kiraci 2018). In line with the increasing domestic and international demand, the number of airports in Turkey increased to 38 in this period (Bakirci 2012). The market liberalisation fostered demand for airlines, and the aviation sector developed rapidly. Domestic air ridership more than quadrupled between 1980 and 1990 (TUIK 2010, GDSAA 2018). However, the overwhelming majority of the flights were between the major airports in western Turkey. Flights to airports in northern, eastern, and southern Turkey were limited and seasonal. To overcome this problem, several regulations aimed at balancing the flight differential between the regional airports were implemented (Orhan–Gerede 2013). Any aviation company entering the Turkish market had to operate at least one flight to secondary airports.

After the 1990s, the TAN's liberalisation was interrupted by the protectionist measures taken in response to the national economic crises in 1988–1989, 1994, and 2001; the Gulf War in 1990, and the Asian Crisis in 1997 (Pamuk 2014, Battal–Kiraci 2015). Privatisation policies were applied to state aviation institutions in the late 1990s (Togan 2016). In this period, 18 new airline companies entered the market to meet both domestic and international demand. The total number of airline companies increased to 28. However, 19 of these companies exited the market between 1990 and 2000; high competition, poor market strategies, lack of experience, and high taxes led to their bankruptcy. Additionally, regulations were implemented by state aviation authorities in order to protect THY's market share. The 'THY Is First' strategy included provisions requiring new companies to operate only on lines that THY was not operating on or that THY could not service. These measures reduced the competitive power of emerging aviation companies (Orhan–Gerede 2013).

In 1989, Sun-Express joined in partnership with THY and Lufthansa to operate as a leisure airline providing charter flights between Turkey and Germany (Bakirci 2012). The main hub of the company was in Antalya, a major tourism destination in Turkey. In 1998, Antalya airport was expanded with a terminal constructed for

international flights via public–private cooperation on a build-operate-transfer (BOT) model (Acar–Karabulak 2015). This was the first use of the BOT model for infrastructure investments in the aviation sector. Konya and Istanbul Sabiha Gokcen airports began operating in 2000 and 2001, respectively, and the total number of airports in Turkey had increased to 40 by 2003. Sabiha Gokcen Airport, completed in 2001, was Turkey’s first privately operated airport (Bakirci 2012).

The privatisation of public Turkish aviation enterprises began in the 1990s. In this period, the nation’s economy and its domestic and international aviation activities were affected by the 1988–1989 economic crisis and the Gulf War (Battal–Kiraci 2015). Ucak Servisi Anonim Sirketi (USAS), the public supplier for ground handling services and catering, became the first privatised public aviation company in Turkey. Togan (2016) stresses that 70% of the catering services were privatized in 1989, and the remaining 30% were privatized in 1993, additionally, 60% of the ground handling services were privatized in 1995 and the remaining 40% were privatized in 1998. Turkey’s economy also experienced several major milestones just before the 2000s; the Asian Crisis affected international flight demand in 1997, and catastrophic earthquakes and economic crises occurred in 1999 and 2001, respectively.

Starting in the 2000s, neo-liberalisation policies came to the fore, a process fostered by the neoliberal agenda being pursued across the world (Togan 2016). These processes have been particularly brutal in developing countries. The liberalisation program of the government led to crucial privatisation and deregulation measures like the privatisation of national refineries, industrial areas, and factories (Togan 2016). The government’s motto has been ‘Every Turkish citizen will board at least once’ since the 2000s began. This period consists of three sub-periods (see Figures 5 and 6). The first sub-period covers 2000 to 2004; this can be considered a period of transition to a liberal market driven by the deregulation policies known as ‘Dervis Policies’, after the Minister of Economic Affairs who initiated the IMF liberalisation program. After 2002, this liberalisation program was fostered by the new government, which is still ruling Turkey (Türkan–Ozel 2019). In 2003, the aviation market was deregulated.

In this period, several old airports were restored to service, and new airports were constructed. The geography of the aviation sector was expanded to include all parts of the country, increasing demand for domestic flights between the peripheral small cities and the major airports (Orhan–Gerede 2013). The market deregulation accompanied by the increasing domestic demand attracted the attention of private companies. After 2003, several low-cost carriers servicing both domestic and international destinations entered the market with varying strategies. Legislation deregulating the market and eliminating the price advantages and privileges of THY were the main impetus for this process (Tasligil 2014).

Table 2

Summary of historical TAN events and their importance according to TSA

Year	TSA Importance	Related historical events	References
1912	–	Construction of two hangars and a short runway in Sefakoy, Istanbul and then in Esenboga, Ankara.	Bakirci (2012)
1933	–	Establishment of THY; THY starts operating from Istanbul Ataturk to Ankara Esenboga airport	Bakirci (2012) Sarilgan (2016)
1939	–	Construction of Izmir and Adana airports	THY (2018)
1943	–	Construction of Van airport	Bakirci (2012)
1945–1947	–	Construction of new airports in all regions (LTAR, LTCE, LTAO, LTCC, LTAJ, Urfa, LTAN, LTAM, LTAI, Iskenderun, LTFH, LTBE)	THY (2018)
1951	–	Increase of international destinations (Athens, Roma, Frankfurt, and Vienna)	THY (2018)
1963	3	First flights from Turkey to the U.S.; New European destinations started	Orhan–Gerede (2013)
1973	2	Establishment of the aircraft industry in Kayseri, Turkey	Eriksson (2016)
1980	5	Military coup	Pamuk (2014)
1981	5	Trade liberalisation program	Pamuk (2014)
1983	–	Issue of Civil Aviation Law	Togan (2016)
1989	–	Sun-Express partners with THY	Bakirci (2012)
1990	4	Gulf War, global economic crises	Pamuk (2014); Battal–Kiraci (2015);
1991	6	Privatisation of the state-based institutions	THY (2018)
1992	4	End of Gulf War	Korul–Kucukonal (2003)
1999	3	National economic crises	Pamuk (2014)
2003	2	Major barriers for market entry were eliminated; total number of airports increased to 40	Bakirci (2012); den Hartigh–Kucukonal (2012)
2004	4	Deregulation of aviation market	Orhan–Gerede (2013)
2006	–	New international terminal at Izmir's Adnan Menderes Airport opened; many airports reopened	THY (2018)
2007	2	New airports (LTAS, LTCS, LTAK, LTAO) entered TAN, many airports reopened	THY (2018)
2008	–	THY joined Star Alliance; new airports (LTAP) entered TAN	THY (2018)
2010	3	New airports (LTFG, LTFK) entered TAN; major improvements to Balikesir Koca Seyit Airport	THY (2018)
2011	1	New airports (LTBQ) entered TAN	THY (2018)
2012	–	New airports (LTBZ, LTCT) entered TAN	THY (2018)
2013	3	New airports (LTCV) entered TAN; major improvements to Kastamonu Airport	THY (2018)
2014	3	New domestic terminal at Izmir's Adnan Menderes Airport opened	THY (2018)
2015	2	Subsidies for promoting lines between secondary and major airports	DGCA (2014)
2016	3	Holiday bans from Russian government in response to the war aircraft crisis	Ersen (2017)
2018	3	Istanbul Grand Airport	THY (2018)

The second sub-period covers 2004 to 2008. These were the golden years for the growth of the aviation sector in Turkey in terms of both domestic and international passengers. THY increased its capacity substantially and started to focus on international operations through a strategy of expanding to all continents with the help of technological and political changes in the global aviation sector (Orhan–Gerede 2013). The company managed to meet the high share of domestic demand until the 2008 creation of Anadolujet (Sarilgan 2016), a low-cost carrier and THY subsidiary established to help meet domestic demand (THY 2018). THY entered into partnership with the Star Alliance in 2008 in order to service new destinations in the global market. This was perhaps the most significant development in the sector. The passenger volume of domestic flights almost quintupled between 2003 and 2010 (see Figure 3).

The third sub-period ranges from 2008 to the present. As Figure 3 shows, the growth rates in the number of both domestic and international passengers were interrupted by the increases in oil prices and the economic and political environments created by the 2008 global crises (Togan 2016). After 2010, the growth of Turkey's aviation market boomed due to new developments in the sector, in line with the growth of the Turkish economy (Duran–Erdem 2017, Shinnar–Zamantili 2019). The aviation sector was supported by budgetary allocations as well as the BOT model of public–private partnerships. Two subsidies were provided by the government to increase and enhance the connections between secondary and major airports in 2013 and 2015 (DGCA 2014). This growth pattern was interrupted by the Syrian war and the political tensions between Turkey and Russia in 2016, which affected the tourism sector and international flights (see Figure 3). Nevertheless, the volume of domestic passengers continued to grow significantly.

Domestic flights had departed from seven centre hubs (Ataturk, Sabiha Gokcen, Izmir, Adana, Trabzon, and Antalya) to 49 airports and from two centre hubs (Ataturk and Ankara) to 26 airports. The BOT model was used frequently for the renovation, construction, and expansion of the airports. Zonguldak, Gazipasa, and Aydin airports were constructed via the BOT model, and are to be operated for 20 years by the private sector. The terminal buildings of Ataturk, Izmir, Antalya, Milas-Bodrum, and Dalaman airports are being rented for varying durations, from 15 years to 26 years. Under the BOT model, airport terminal construction and operations were transferred to the private sector (Acar–Karakulak 2015, Tasligil 2014).

Subsidies were used to increase connections between smaller and major airports, promoting new flight lines in 2013 and 2015. Accordingly, the number of domestic lines from the seven centre hubs increased to 52 by 2013 (DGCA 2014). Five regulations were established in 2013. The first stipulated the minimum number of flights that must be provided by companies assigned to new lines: The number of weekly flights cannot be fewer than three during the summer and two during the winter for each line. The second requirement concerns the date on which flights

begin: Flights had to start in the summer of 2013. The third requirement concerns the duration of the allocation of the lines: If a company was assigned a line, no other company was allowed to fly on it for two years. The fourth requirement was designed to promote new domestic lines through international lines: If a company had started adequate flights in new domestic lines, priority would be given to servicing international lines. If a domestic line was cancelled, the allocated international line would also be cancelled. The last requirement regulated the rights of passengers on new lines: Any company found to be using its current position against passengers or charging excessive prices would be taken off its line (DGCA 2014).

Table 3

Summary of historical TAN periods

Denomination	Pre-1980	1980–1991	1991–2004	After 2004
Period name	State-dominated period	Liberalising transition period	'State-regulation revisited' period	Liberalised market period
Contextual	Import-substitution industrialisation based closed economy	Liberalisation; Opening up to international trade, uncontrolled trade liberalisation	Liberalisation; Opening up to international trade, uncontrolled trade liberalisation	Fast liberalisation, Privatisation of the public-owned enterprises, integration with European Union
Socio-economic	Market monopoly of THY, state dominance	Uncontrolled deregulation of aviation market, THY-first privileges, institutions have strong regulation power	Uncontrolled deregulation of aviation market, new regulations for saving the position of THY in the market	Deregulation of the market, emergence of new low-cost-carrier firms in the market
Market players	THY	THY and 27 new companies entered market; 19 of these declared bankruptcy	THY, 8 of the companies declared bankruptcy	THY, Pegasus, Sunexpress, AnadoluJet, Borajet, Izair
Regulations	Strong regulation/control of state and state-owned institutions, airports operated by state-owned institutions	Deregulated market, state-owned institutions control the airports and market	State-regulation revisited, public offering of %1 share of THY, privatisation of ground and catering services,	Free market environment, public-private partnership for construction of airports, airports operated by private companies
Regional airports	Istanbul Atatürk and Ankara	Istanbul Atatürk, Ankara and Izmir	Istanbul Atatürk, Ankara, Izmir, Antalya	Istanbul Grand, Istanbul Sabiha Gökçen, Ankara, Izmir, Antalya, Trabzon, Samsun, Kayseri

The regulations in the 2015 legislation are similar to those in the 2013 legislation. However, the second and fourth regulations in 2013 were changed in the 2015 version (DGCA 2015). The 2015 version set June 1, 2015 as the start date for flight service;

failure to start on that date would lead to allocation cancellation. Moreover, the 2015 version made provisions for both the cancellation and suspension of domestic flights. The 2015 Circular on Promoting New Flight Lines has led to new lines between major airports and secondary and small airports (DGCA 2015).

Turkey has been a very attractive destination for Russian and European tourists, especially during the sea–sand–sun tourism period in 2010 when visas were mutually lifted for the citizens of Turkey and Russia. However, the unstable and unpredictable environment caused by the Syrian war (which started in 2011 and turned into an international crisis in 2015), high volumes of refugees escaping ISIS violence in 2015, a failed coup attempt in 2016, and the tension between Turkey and Russia following the shooting down of a Russian warplane near Turkey's Syrian border in 2016 have affected Turkey's tourism sector and air passenger volume substantially (Ersen 2017). The failed coup attempt in 2016 led to an unstable economic environment that severely damaged Turkey's aviation sector, as well as other economic sectors. For example, Borajet, servicing smaller airports via a regional aviation strategy, exited the market in 2017 (DGCA 2017).

However, Turkey's aviation sector is growing fast, and the demand for new fleets, airports, and ground services are increasing daily along with technological developments. This has caused a need for a new airport. Istanbul Airport, the city's third airport and projected to be the largest in the world, is being constructed in the northern part (the European part) of the city in four phases. The first phase began in 2019 after an almost two-year delay. When Istanbul Airport is completed, it is expected to serve over 200 million passengers annually. Istanbul Airport is also being constructed through the BOT model under a state guarantee. Ataturk Airport is now closed.

Conclusions

Turkey's aviation sector has transitioned from a state-dominated structure to a liberalised market. This transition has been remarkable, and its geographical and historical mechanisms and patterns are worth analysing. This study's time-series analyses reveal the existence of four main developmental periods based on market dynamics, aviation policies, and regulations.

The state-regulated period is the longest of the four. It covers Turkey's initial aviation-based investments, such as those for airport construction and ground services. In this period, Turkish aviation activities were controlled solely by state-owned enterprises, institutions, and organisations – consistent with Turkey's overall economy. The liberal transition period (1980–1990) started with the military coup of 1980, which led to a major change in Turkey's economic environment, and this uncontrolled liberalisation period continued till to the 1990 Gulf War. The state's control over the economy decreased due to the new liberalisation programs, which

were mainly based on free market principles. The aviation sector was also liberalised in 1983. New companies started providing aviation services on both domestic and international lines by competing with THY. During the Gulf War, new regulations were implemented to protect THY's market share and position. This began a new period of state regulation. This period starts with the Gulf War and ends with the new neoliberal agenda implemented in 2003 by the government that has been ruling the country since 2002. This liberalised market period starts with the deregulation of the aviation market. In this period, new low-cost aviation companies entered the market, and new airports were constructed. The aviation market enjoyed a boom due to increased demand for air passenger services. Istanbul Airport, considered the largest airport in the world, opened in 2018.

Though state regulation and control still play direct and indirect roles in Turkey's aviation sector, the sector was deregulated consistent with the neo-liberalisation of the national economy. The aviation sector boomed after the 2003 deregulation, but wide disparities persist across the TAN. Most major airports are located in the major cities, whereas there are few airports in the rest of the country.

This study showed that milestones in the history of Turkey's aviation sector can be identified via time-series analysis using simple and easily accessible data. The results reveal that the periods derived through the time-series analyses are consistent with the major changes discussed in the literature. The main drawback of this study is that, due to the unavailability of data regarding passenger traffic between airport pairs, we cannot measure how Turkey's deregulation and regulation policies affected the spatial configuration of the TAN. This issue should be addressed in future research.

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