Modeling and Forecasting Passenger Demand for a New Domestic Airport with Limited Data

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Abstract : Forecasting of air travel demand using demand models enables better planning for infrastructure development for air transportation. Modeling for air travel demand is the process of relating a vector of socioeconomic variables and a vector of transport system variables to the demand for air travel. In microanalysis of air travel demand, when models are stratified by origin and destination, the resulting models are called city-pair models. In this study, a city-pair model for the demand for domestic air travel has been developed based on the air travel in large city in India. The model was calibrated with aggregate cross-sectional data using multiple linear regression analysis. The model has been validated by two different procedures: the cross-validation technique and a backward prediction method to know the statistical and logical validity of the model for use in travel demand forecasting. As an illustration of the usefulness of the model in travel demand forecasting, the model was used to predict future demand for air travel.Adequate information on travel behavior of people is often unavailable in developing countries, making demand modeling for a new airport difficult. This paper presents a simple modeling approach which uses limited aggregate information about a country to generate a forecast for passenger patronage in a new airport. The model utilizes aggregate time series information on national level and patronage at other airports to develop a gravity type demand model for the country. This modeling approach is applied to forecast the demand of a new airport.

Keywords
Air travel demand, passenger demand forecast, airport, panel econometrics

1. INTRODUCTION

Feasibility analysis is an important part of any transport infrastructure project and a standard practice in almost all countries in the world. In order to carry out such feasibility studies, it is important to understand the benefits (and costs) arising from the proposed projects. In a typical new airport project (and most transportation infrastructure projects), the major benefits are generally the savings in the generalized travel costs to the users as a result of the project. And in order to understand the total savings it is important to determine the number of users, i.e. the demand, of the proposed airport project over its life time. In addition to benefits modeling for new airports, passenger demand forecasts are also important for existing airport authorities in order to better plan the expansion or contraction of the facilities, Economic or for airlines to make decisions about new flights or altar existing flight patterns. In developing countries such information is often unavailable. Even crossSectional or time series aggregate data on cities or regions, representing the origins and destinations of travel, may not be available. This paper presents an approach where passenger demand for a proposed domestic airport in India is modeled using national aggregate data. In particular, we develop an econometric demand model relating regional air travel and national GDP and population information, and calibrate it for a specific origin-destination set making use of small questionnaire surveys. We believe our simplified but novel approach of combining nationwide econometric estimations and location specific calibration can be useful to researchers and practitioners alike when extensive location or individual specific information is not available.This paper is structured as follows. Section 2 gives an overview of the air transportation system in India and the context of the proposed airport. Section 3 briefly reviews travel demand forecasting models for air travel with emphasis of gravity models. Section 4 describes our own demand model for air travel in Indian like country. Section 5 presents the calibration of the demand model for forecasting travel demand for a specific new airport. Section 6 presents the scenarios for demand forecasts and the forecast results. Section 7 concludes.

2. AIR TRAVEL IN INDIA

Current status of air travel-

India is large country. 486 total airports, airstrips, flying schools and military bases available in India. Indira Gandhi International Airport is the largest and busiest air port India. Aviation in India, broadly divided into military and civil aviation, is the fastest-growing aviation market in the world according to the International air transport association (IATA). The hub of the nation's aviation manufacturing industry is at Bangalore which has a 65% share of this economic sector.1 The government's UDAN (regional connectivity scheme) is driving the growth of civil aviation and aviation infrastructure in India. India had the world's third-largest civil aviation market in 2017, with the number of passengers growing at an average annual rate of 16.3% between 2000 and 2015. It recorded an air traffic of 131 million passengers in 2016. Despite this growth, much of the country's aviation potential remains untapped. IndiGo, Air India, SpiceJet and GoAir are the major carriers in order of their market share. These airlines connect more than 80 cities across India, and are joined by several foreign airlines in providing international routes.

The Ministry of Civil Aviationis responsible for civilian aviation, through regulatory oversight by the Dirctorate General of Civil Aviation (DGCA). National Civil Aviation Policy 2016 sets broad goals for safety and operations. The UDAN (regional connectivity scheme) is a plan to develop a sustainable air network in over 400 tier-2 cities across India, with an estimated expenditure of □500 million (US$7.0 million) per airstrip.

Infrastructure

The primary civilian aviation hub is Indira Gandhi International Airport in the National Capital Region of Delhi.Since 2009, it has been the busiest airport in India in terms of passenger traffic and international traffic, and the second-busiest in terms of cargo traffic (after Mumbai).Since 2010, it has had the capacity to handle more than 40 million passengers per year, with a planned expansion for 100 million passengers by 2030.

UDAN is assessing 486 existing airports for potential development. Phase I of UDAN helped to raise the number of operational civil aviation airports to 131, a 34% increase over 20 months. In addition, the Airport authority of India (AAI) granted in-principal approval to 19 new airports in December 2017. In September 2018, the Civil Aviation Minister said that as many as 100 new airports would be built in the next 10 to 15 years to meet the growing domestic demand.

In 2015, there were 22 airlines operating in India, which add a total of about 50 airliners to their fleets each year. To support these fleets, several aviation-industrial parks are being set up, such as in Hisar, Gujrat, and Chennai.

3. THE PROPOSED AIRPORT

The Uttar Pradesh government is eyeing a record of sorts by developing two new international airports and upgrading a bunch of World War II vintage airstrips into functional airports in different parts of the state. Sixteen such airstrips, now used for elections campaigns and as flying clubs, are on the radar of the state and central governments for development now, especially since the elections are just a couple of years away.

4. KUSHINAGAR INTERNATIONAL AIRPORT

Though over a decade old, the Kushinagar International Airport has now become the pet project of not just the Uttar Pradesh Government but also the Centre with Chief Minister Yogi Adityanath and Union Civil Aviation Minister Hardeep Puri personally reviewing the project and announcing the start of operations by end of the year.

Always aimed at the Buddhist circuit potential, the airport's newfound interest is however more to do with its political significance also. When operations start, this will become the fourth international airport in the state after Lucknow, Varanasi and the under construction airport at Jewar.

Situated near the Nepal border and close of Bihar, Kushinagar would be the only international airport project in 150 km radius — Gorakhpur airport, about 51 km away, at best caters to a small number of domestic flights. The other airports in the area at at Patna in Bihar, Kathmandu in Nepal and Varanasi in Eastern Uttar Pradesh. This means the airport can also cater to domestic passengers, including the thousands of migrant workers from the area who work in the rest of India and the Middle East. So now Lucknow and Delhi airports cater to this region.

This could also be a showcase project for the Bihar Assembly elections which are expected in a couple of months given the project's possible impact on Siwan, Gopalkunj, Champaran and Saran districts.

Given cabinet clearance during Mayawati's reign in 2010, the project was supposed to come up along with the now abandoned Maitreya Buddha statue project. Legend has it that Buddha attained "Mahaparinirvana" in Kushinagar and this brings in tourists from countries like Thailand, China, Malaysia, Thailand, Japan and Singapore as well.

The existing 2100-meter airstrip at Kasia was chosen for the project and it was decided to extend the tarmac to 3200 meters as per international standards. In the feasibility surveys conducted in 2010 and 2013, it was found that the site would be less than 2 km from the East-West corridor (NH-28) connecting Porbandar in Gujarat to Silchar in Assam. It also noted the cargo potential given the fact that Nepal was a land locked country.

Despite all this, the Public Private Partnership model failed to attract investment because companies were not sure about its feasibility. Several attempts were made to revive the bidding process and even the project size was reduced, but to no avail.

Meanwhile, the farmers started demanding higher compensation for the land acquired as they saw similar demands in western Uttar Pradesh were being met. Amidst protests, the BSP government was finally able to acquire about 550 acre of land for the project in 2011-2012.

Despite the entire land parcel being available, the Samajwadi Party took time to reconsider the project. With the 2013 bidding process too not finding must takes, the Akhilesh Yadav-led UP government approached the Centre for viability gap funding — aimed at making a project feasible for private players. The Centre gave in principal approval for 20 per cent viability gap funding, with land on lease and other concessions being offered to the private players. Then government claimed it was the first airport project in the country to get this approved.

But with private players still not playing ball, the state approached Airports Authority of India in 2015. In March 2019, a Memorandum of Understanding was signed between AAI and UP government for "taking over the development and operationalisation of existing Kushinagar Airport belonging to State Government of Uttar Pradesh". In its official communiqué, AAI said this included the 589 acres along with the existing infrastructure like runway and apron. It also called for bids to operate flights to Lucknow and Gaya from Kushinagar under the UDAN-3 scheme.

This June, amidst the lockdown, the Union Cabinet gave its nod for international status for the project citing its strategic location and importance from the point of view of being a Buddhist pilgrimage site.

5. AYODHYA AIRPORT

With both the Central and UP governments hoping to make Ayodhya an international tourism hub after the work on the Ram Temple was launched by Prime Minister Narendra Modi last month, the state has started work on a detailed development plan for the town with an International Airport at the top of its agenda. The state has already approved Rs 525 crore for the construction of the airport, likely to be named after Ram. Though in 2014 an MOU was signed with the Airports Authority of India for upgradation of the existing airport, the project could not take off. Last year, the state got a feasibility study conducted on the 178 acre area used for flying club activities and non-scheduled fights by small aircraft. The target is to start the first phase of what will be an International Airport project by end of 2021.

Jewar International Airport

Being developed in Gautam Budh Nagar district of the National Capital Region, the long-pending project was first proposed during the Rajnath Singh-led BJP government in

the state in 2001. In 2007, when the BSP came to power in the state, chief minister Mayawati tried to pursue the project. She even got the centre to form a Group of Ministers to study the project. But this was never an easy project given that there was the Indira Gandhi International Airport at Delhi within a 150-km radius. When the Samajwadi Party was in power, Akhilesh Yadav was in favour of ditching this project for an International Airport in Agra and even allocated land for the same. When the BJP returned to power in 2017, the project was expedited, a company was formed and funds allocated for land acquisition. The contract for development and operation of the project was given to Zurich Airport in November 2019 with a completion date of 2023.

6. AIR TRAVEL DEMAND MODELING AND FORECASTING

In order to determine the feasibility of a new airport, it is necessary to forecast its demand over its design life. The Transportation Research Board in its synthesis of aviation activity forecasting methods for US airports, find four general approaches to model and forecast airport specific demand.

These are:

. Market share forecasting
. Econometric modeling
. Time series modeling
. Simulation modeling

Market share forecasting is a top down approach where demand at an airport is a proportion of national or regional demand for which a demand prediction already exists. Time series modeling extrapolates existing historical data at an airport using time series econometric techniques or more recently using neural network or fuzzy regression Neither of these two approaches can be used for our purpose since no airport, and therefore no data on passenger travel through the airport, exists at the proposed location. The third approach, econometric modeling, involves establishing a causal relationship between passenger demand and a set of independent explanatory variables. This is the most commonly used model to predict passenger demand in airports. Simulation models actually use the output of the previous three types of models to simulate the activity patterns of passengers or movement patterns of aircrafts within an airport. Results are useful for detailed planning and design of airports, but not for predicting passenger demand.

Econometric demand modeling is one of the most active and extensively researched areas in transportation. Recent advances in the field include sophisticated activity based models utilizing the random utility theory. Although random utility based demand models are now common in some countries especially for road traffic demand, their application in air travel demand is still not as widespread.

Random utility models are especially suited for predicting demand of a new transport mode, such as provided by a new airport as in our case. However, the models require extensive information on travel behavior of individuals, as well as the distribution of various socio-economic characteristics in the study area. Choice experiment surveys, the basis for the random utility models in the absence of pre-existing information on an individual basis, require careful preparation and field administration by expert surveyors for a valid and unbiased result. Since pre-existing information on individual travel behaviorand socio-economic information is often unavailable and expertise in the advanced demand models is still in its infancy in the developing countries, gravity models are the preferred option for demand modeling and forecasting. We also note that, gravity models are still popular in many developed countries, as evident by the recent air transport demand models for the UK, USA, Germany, or Greece.

Gravity type demand models originate from the laws of gravity in physics which state that the force between two terrestrial bodies is proportional to their masses and inversely proportional to their distance.

In gravity type demand models, the travel demand between two cities or regions is proportional to the mutual attraction factors and inversely proportional to their distance . Therefore, it is assumed that there exists no competition between origins or destinations or different transport modes and that demand is solely a function of the characteristics of the city-pairs. The mutual attraction factors in gravity models are generally expressed by employment opportunities and/or GDP of the cities, although, researchers have used various combination of other explanatory factors as well.1 Similarly, distance generally represents the barriers to travel, and can take the form of not only physical distances but also travel time, fare, generalized travel costs etc.

Although a few researchers employ advanced econometric techniques, most use simple Ordinary Least Squares (OLS), which may sometimes be the incorrect approach, given the data types.

7. DEMAND MODEL IN THIS STUDY

Structure of the demand model

The review of the existing demand models above indicate that the most important explanatory factors for air travel between two cities are population, GDP or income and costs of travel. GDP or income represents the size of the economy of the origins and destination: the larger the GDP, larger is the attraction. GDP on a per capita basis also represents how well off the population is. Since air travel in the developing countries is still a luxury mode, per capita GDP is thus an indicator of the share of people able to fly. Population determines the potential pool of travelers. It is also a determinant of the size of the economy of the origins and destinations. The costs of travel enter the gravity model as the deterrence factor. Ideally it includes the costs associated with travel time (which also takes care of the distance aspect) and out of pocket costs, such as air fare, taxi fare to the airport etc. However, we also introduce an element of competition in our demand model through the cost term. As mentioned earlier, road and rail can often become competitive with air travel in India, with road being more competitive for passenger travel in the luxury segment. We therefore believe that the ratio of travel costs between air and road would better represent the demand rather than the costs for air travel alone. Our reduced form demand model to understand the relation between air travel demand, GDP percapital, population and travel cost ratio is:

$DEM_{ij} = f\,(GPCi\ ,GPCj\ ,POPi,POPj\ ,CRij\ )$Where,

DEM = demand between city pairs i and j

GPC = GDP per capita of cities i and j
POP = population of cities i and j and
CR = ratio of costs between the cities i and j by air travel and alternative road travel demand models, simplifying the model further.2 Also, generalized cost data is not available, so travel time ratio (TRi) between air and road travel is used instead of cost ratio . The model thusis specified below:
DEM= f (GPC_i, POP_i, TR_i) -(3)
We follow the log-log functional form, as is common in the literature, for the demand model.

8. DATA

Unavailability of reliable data is a major constraint in quantitative modeling such as the demand modeling in most developing countries. The ideal data for modeling air transport demand according to
Eq. 3 above would be a panel dataset with time series of air passenger demand, and its explanatory factors per capita GDP, population around the airport cities or regions, and the generalized cost ratio between air and road travel for existing different airports in the country. Passenger data for different airports are available as a time-series for all airports in India. But per capita GDP or population around the airport's zone of influence are not. The definition of district and city boundaries has changed over the years, making the available city-specific GDP and population data unsuitable in the time series context. Therefore, we proxy these variables by national GDP and national population. Using such aggregate measures may impart some bias in our model estimates. However, as long as the GDP and population of the airport regions followed the same variations in time as the national data, our results should not be significantly biased. Also, note that our primary objective is to forecast passenger demand in a new airport, and the national data only serves as an indicator to understand the relationship of air travel demand with per capita GDP and population. Because of the lack of time series cost data for air travel and road travel between Indira Gandhi airport and other cities we use time ratio of travel (TRi) to proxy for cost ratio in Eq. 3. The time ratio was calculated on the basis of road distance and average speed (considering obstacles like ferry crossings over the rivers) using Roads and Highways Division (21) information. Although air travel times change by only very small amount over the years, the road travel time, and thus time ratio, changes over time because of construction of new bridges over the rivers, widening and straightening of existing roadways and increased congestion on some highways. Note that by replacing cost ratio by time ratio, we ignore the impact of air fare. While adding air fare in our model would have improved the model, such time series data is not available. Also, air travel in India is a luxury good, and most of the travel is for business purposes. It is therefore not unreasonable to assume that the passengers are less sensitive to air fare. In addition, as long as the prices are orthogonal to our other explanatory variables, the parameter estimates should be unbiased. Passenger travel data in the chosen airports and national GDP and population was collected from ministry of statistic and program implementation from 2000 to 2018. GDP data was converted to real GDP by using consumer price index information, also available from the ministry of statistic and program implementation. We use the different cities because these cities to continue show an increasing trend despite significant improvements in road conditions, a trend expected for the proposed airport in Uttar Pradesh.

9. ESTIMATION OF THE MODEL

Since we have time series information for two airports, our dataset is a panel one (with stronger time dimension). Although it is not uncommon in literature to pool all the data and run an OLS method to estimate the model X, this is not the appropriate method for panel data. Instead, we treat the panel characteristics of the data explicitly and use the fixed effect panel data techniques for estimating the model. This allows for a city specific effect in passenger demand in the model and more efficient estimation of the model. The demand model, at its current state (Eq. 3), is non-linear. By taking logarithm of both sides in Eq.3, and acknowledging the errors for each data point, we find (with t representing the time dimension of data):
$DEM=\alpha'+\beta\ InGPC+\gamma\ InPOP+\lambda\ InTR+\varepsilon$ (4)

The errors in the time series data can often have serial correlation, i.e. the error in time period t can be related to time period t-1, making OLS inappropriate again. We correct for possible autocorrelation of the errors in our econometric estimation as well. Our model thusincorporates:
it $\varepsilon=\rho.\varepsilon+v$ - (5)
Where ρi is the serial correlation parameter and ν is the traditional random error, identically and independently distributed.

10. RESULTS OF ESTIMATION

Presents the results of the econometric estimation of the model using three methods. Model 1is the preferred model estimated by fixed effect panel techniques with correction for serial correlation.Models 2 and 3 are presented for a comparison. Model 2 assumes that there is no serial correlationbetween the errors but uses the fixed effects panel methods, whereas Model 3 pools all data together andruns an OLS regression.
The difference between Models 1 and 2 is not very large, indicating serial correlation does not affect our estimation much. However, there are significant differences in the estimation parameters between Models 1 or 2 and Model 3. This indicates that panel treatment of the data was required in our model. The estimated parameters all had expected signs: population and GDP have positive signs, since an increase in either should increase the passenger patronage of the airports. Ratio of travel times between road travel and air travel also has a positive sign, indicating road and air travel are substitutes, i.e. if the travel time on road increases some passengers will switch to air transport, increasing the number of passengers through airports. We note that some of the parameters are not statistically significant at the conventional 90% confidence. However, we accept 85% confidence for statistical significance because we could not use the Delhi specific GDP or population in our calculation. leading to some inefficiency in the design. The parameter estimates have direct interpretation in economics. Because of the specific log-log functional form, the parameters represent elasticities of demand with respect to corresponding variables.
Thus, a parameter estimate of 1.24 for GDP per capita means a 1% change in GDP per capita increases the air

travel ridership by 1.24%. Clearly per capita GDP has the largest impact on the passenger demand.
Air travel has generally been income elastic, i.e. 1% change in GDP results in a greater than 1% increase in demand (22), with recent UK estimates indicating an income elasticity of 1.3 (8). Our model results therefore agree very well with this established view.

11. CALIBRATION OF THE MODEL FOR KUSHINAGAR AIRPORT

Calibration requirement and process

In a traditional demand model, as estimated above, demand for a city pair can be predicted or forecast
using city-pair specific (here one city specific) information for the explanatory variables. However,
although our demand model is similar to a traditional gravity model, this model should not be directly
applied using Gorakhpur's GDP, population and travel time ratio. This is because, in our model, we proxied local GDP and population by national dataset and therefore the regression constant (α) will be different for different locations. Thus, simply inserting Gorakhpur's GDP, population and travel time ratio in Eq. 3 directly will lead to a wrong demand projection for the new airport.However, we can assume that the underlying relationship between demand and GDP or population, i.e. the demand elasticities from our estimated model remains valid for other places because these works on a percentage difference basis. Since the future GDP and population projections generally are based on per cent growth basis, rather than in absolute terms, we can use these elasticity estimates as long as a new model for Gorakhpur can be calibrated using these elasticity parameters. Thus, we can calibrate the same equation as in Eq. 3 for kushinagar air port, but this time parameters β, γ, and λ are known (from Table 3) and the constant α needs to be determined. Alternately, we can calibrate a slightly different form of the model using the initial passenger demand, as long as our focus is on forecasting passenger demand at the proposed airport in Uttar Pradesh. This is possible because Eq. 3 leads to the following:

$$DEM_t = DEM_{t-1} (GPC_t/GPC_{t-1})^a (pop_t/pop_{t-1})^\beta (TR_t/TR_{t-1})^\lambda$$

For forecasting purpose we can assume starting values of per capital GDP and population to be 100 in kushinagar . This allows us to use the GDP and population growth rates directly into the forecast model.

$$DEM_t = DEM_{t-1}(100+ \text{GPC growth rate}_t/100)^\beta (100+\text{pop growth rate}_t/100)^\gamma (TR_t/TR_{t-1})^\lambda$$

12. PASSENGER SURVEY

We conduct a passenger questionnaire survey in order to understand the socio-economic background of the travelers as well as the pattern of travel behavior. The survey was conducted on air travel passengers delhi kushinagar route and luxury bus and rail passengers on Delhi kushinagar route. Luxury coach and rail passengers were included since we assume that only passengers on luxury surface modes can switch to the new airport because of the higher fare structure for flights. All passengers were handed in the questions and the response rates were above 70% for air and luxury coach and less than 50% for luxury rail. Number of valid responses was 113, 276 and 89 respectively for air, luxury coach and luxury rail. The primary objective of the survey design for air travelers was to identify the proportion of passengers whose ultimate destination (or origin) is kusinagar. The survey questionnaire for luxury coach and train passengers was designed to assess their potential to switch to aviation. For all three modes, there was a specific question designed to understand the impact of a bridge on river Yamuna and ganga, which would significantly reduce the surface travel time between delhi and kusinagr.The passenger intercept method was used to carry out the questionnaire survey. For air travel, passengers of two airlines (out of three operating) were surveyed, whereas for luxury coach travel, passengers on all three operators were included. Only two trains run fromdelhi to kushinagar, and the passengers on the first class sections of both the trains were surveyed. In order for the respondents to clearly understand the questions, all the questions were set in hindi.The origin-destination survey of the aviation passengers on the delhi-lucknow via gorakhpur route reveals that almost 62% of the passengers are originating from or traveling to kusinagar region. Clearly, for these 62% passengers, the proposed new airport will be the primary airport. When asked about the reason for choosing air travel over other modes, 83% mentioned that it was less time consuming. Therefore, air passengers clearly value their time highly. A large majority of 69% of the respondents expressed their willingness to switch to road or rail mode once the yamuna bridge becomes operational. Among the luxury coach passengers surveyed, 77% were departing from or travelling to kushinagar. Majority (55%) of the luxury bus passengers mention that they would use the new airport. However only 18% of the total coach passengers (thus, one-thirds of potential airport users) surveyed were willing to use the airport in the presence of yamuna bridge. The share of potential airport users shifting to surface modes in the presence of a bridge on the Yamuna is consistent between air and luxury bus travelers (Table 4), providing some confidence in the result. This has important implications on the passenger forecast for the airport in Kusinagar: if these passengers indeed switch from aviation to other modes, the passenger demand forecasts for the new airport should be based on the remaining passengers, not on the basis of all potential passengers as from our demand model. This is discussed further in section 6.2 later. Unlike aircrafts or luxury buses, trains to kusinagar stop at many intermediate stations, with only a few traveling all the way to kusinagar(the delhi-kusinagar trip by train is around twelve hours longer than by bus). Also, the income distribution of luxury rail passengers shows that they are, on average, less well off than luxury coach or air travelers (Table 4). We therefore neglect the potential of modal shift from rail to air. The income distribution of the passengers on the three modes is also presented in Table 4, along with the proportion of trips that were business or work related. Only 8% of the luxury coach passengers had a monthly household income more than BDT 150,000 per month, the highest income group considered in the survey, as compared to almost a quarter for air passengers. Similarly, only 17% of the luxury coach passengers had household incomes larger than BDT 75,000, the corresponding share for air travelers were 46%. Around 63% of all trips by air were undertaken for work or business, while for luxury buses, this share drops to around one third. This reinforces the assumption

that air travel is primarily undertaken by the wealthier segment of the population for work trips.

13. ESTIMATION OF INITIAL DEMAND

Ministry of statistic reports that 200000 passengers are catered 2010. Which are 100000 are bound from Gorakhpur region. Zaidi points out that while declaring an airport an international one, many things need to be looked at, including defence air space management and the airport's potential to receive international tourist and business travellers. Many regulatory bodies are involved in declaring an airport an international one as an international airport needs to have facilities such as those for customs, immigration formalities and even areas where animals can be quarantined. Nripendra Singh, Industry Principal, Aerospace, Defence and Security Practice, Frost & Sullivan, adds that international status is given to an airport depending on the airport's ability to handle flights to/from foreign countries. "High growth in e-commerce business across India creates an opportunity for airports that can facilitate faster movements of goods, both domestically and internationally. Even without high volumes of passenger traffic, airports can address the supply-chain needs of the region through cargo movements," he says.On June 24, the Cabinet approved international airport status for Kushinagar airport in Uttar Pradesh. Now that this has been done, the Ministry of Civil Aviation can include Kushinagar in the airports that are available for domestic and international airports for international flights when it has bilateral talks with foreign countries.Since Kushinagar is an important Buddhist site, it is possible that when India holds air services bilateral talks with countries where Buddhism is a dominant religion, it could see some traction from airlines from Mynamar, Sri Lanka and Thailand for landing directly at Kushinagar airport. Right now, any foreigner wanting to reach Kushinagar to visit the Buddhist sites has to land in Gorakhpur and then drive 50 km.

14. MORE CHOICE

Singh points out that increased tourism activities will strengthen economic activity in and around the airport. "The travel and tourism sector in India accounts for an estimated 14 per cent of the total employment opportunities. Post-approval, a greater inflow of tourists is expected. However, the real beneficiary of this change will be the Indian consumer, who will have even more choices. More economic reforms and liberalisation policies are the way forward," he says.

With Kushinagar airport being designated an international airport, construction is likely to start soon.

Similarly, the Uttarakhand government has given the clearance for an international airport to come up in Pantnagar. Once the airport is ready, the State government can approach the Centre for Cabinet approval, after which it will be in a position to directly receive foreign visitors. In order to determine the induced traffic, we follow two scenarios. Firstly, the travel time through the new airport would be reduced by half. Using the elasticity of air travel demand with respect to travel time ratio of 0.436 from Table 3, we find there will be additional 7,000 passengers through the new airport. In our alternate estimate, we use information from the passenger survey. Although 55% of the luxury coach passengers mention they would switch to air travel, the number appear very high.4 On the other hand, 59% of the high income passengers mentioned that they would use the new airport. We believe these passengers indeed would shift to air travel. Considering 17% of the luxury bus passengers were from this segment, and 77% were for kusinagar this adds 80000 extra passengers a year. Our best estimate for the initial demand for the new airport is between 200000 and 300000 a year.

15. PASSENGER FORECAST TILL 2030

Any attempt to make projections into future based on existing data has significant uncertainties associated with it. Although we develop an econometric demand forecast model, the model is a function of variables that themselves require forecasts or assumptions about future values. This encourages the use of scenario developments and making demand projections based on different probable scenarios. The passenger demand projection in this work is therefore based on an econometric demand model and on
two scenarios. The assumptions about the future values of GDP per capita, population and time ratio
under the two scenarios considered are explained in Table .

16. FORECAST RESULTS

Given the assumptions about independent variables, and our econometric demand model, calibrated for kusinagar airport as in section 5, the future potential passenger demand is presented in Fig. 3. Note that, instead of point prediction over the years, we provide a range, reflecting two scenarios. Scenario one is for low initial passenger demand followed by low economic growth and high modal shift to surface mode after the different bidges. The other scenario is the high initial passenger demand combined with most likely economic growth and low modal shift due to some bridge. We believe the actual demand will lie somewhere in between. The dark line represents the average of the two scenarios.

17. CONCLUSIONS

Understanding the potential passenger demand over the design life of an airport is an important planning input. For a new airport it is especially challenging since no previous data is available to forecast the demand. We have developed a passenger demand forecasting model for a new airport using information available at the national level. We estimate a gravity type econometric model using national aggregate data and calibrate it further for predicting demand in a new airport using a simple passenger questionnaire survey. We have also introduced competition between air travel and its closest mode in our demand model, which can be important for demand modeling in countries where air travel distances are small. We note that traditional gravity models either uses past data for projecting demand for an existing airport, or, when used to make predictions for a new airport, uses regional GDP and population information for estimation purposes. Our proposed approach does not require either. The minimal data requirement at nationally aggregated level makes our approach attractive to the practitioners, especially in locations where reliable data is not available at the required resolution (e.g. time series regional information) or where sufficient resources are not available to collect extensive new data (as in stated preference surveys). The results of passenger forecasts from the simple yet useful approach can be used to plan ahead the

airport facilities or to measure user benefits in a feasibility analysis. Using this method, we forecast the potential passenger patronage at aproposed new airport in India under two future scenarios.

However, we note that our original demand model is based on the assumption that the estimation sample cities followed a similar growth pattern in GDP and population as the national average. The results could be erroneous if such assumptions do not hold. Also, the demand model used for calculations does not include any effect of air fare. The forecast passenger patronage will be different if the real air fare changes over time. However, as long as the information on air fare or costs of air travel is available to the researcher, they can be easily incorporated in this type of modeling approach.

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Place Name	Latitude	Longitude
Chandigarh International Airport, Chandigarh, Punjab, India	30.667767	76.786232
Diu Airport, Diu, Daman and Diu, India	20.714273	70.921616
Bhubaneswar Airport, Aerodrome Area, Bhubaneswar, Odisha, India	20.254713	85.816574
Kempegowda International Airport (BLR), Karnataka, India	13.199379	77.710136
Biju Patnaik International Airport (BBI), Bhubaneshwar, Odisha, India	20.254780	85.816521
Visakhapatnam Airport, Andhra Pradesh, India	17.728647	83.223549
Indira Gandhi International Airport (DEL), New Delhi, Delhi, India	28.556160	77.100281
Solapur Airport (SSE), Solapur, Maharashtra, India	17.625862	75.930717
Biju Patnaik International Airport (BBI), Bhubaneshwar, Odisha, India	20.256399	85.815758
Karad Airport, Varunji, Maharashtra, India	17.286358	74.157951
Chhatrapati Shivaji International Airport (BOM), Vile Parle East, Mumbai, India	19.097403	72.874245
Raxaul Airport, Ekderwa, Bihar, India	26.996279	84.82037

Table 2. Summary of selected studies using gravity models for air travel demand

BTCE (15)	Australiainternational	GDP, Income, airfare, exchange rate	Aggregate for cities, time series	Log-log	2 markets × 24 cities ×32 quarters	Dynamic, for each market and city
Jorge-Calderon (16)	Europe	Population, income, distance, frequency, aircraft size, economy fare, dummy	Aggregate for cities, cross sectional	Mixed, some in log, some linear	339 city-pairs	OLS
Alam and Karim (17)	Bangladesh	GDP and population of catchment, ratio of road to air travel time, dummy	Aggregate for cities, panel	Log-log	6 cities ×5 years	Pooled OLS
Profillidis (18)	Rhodes, Greece	Exchange rates	Aggregate for country, time series	Quadratic	22 years	OLS
Abed et al. (19)	Saudi Arabiainternational	Non-oil GDP, CPI, imports, population (best model)	Aggregate for country, time series	Linear	22 years	OLS
Abbas (20)	Cairo	Population, foreign tourists	Aggregate, time series	Linear	9 years	OLS
Alekseev and Seixas (6)	Brazil	GDP, fare per km, dummy	Aggregate, time series	Log-log	20 years	OLS

Table 3. Estimated parameters for the demand models

Parameter	**Model 1**	**Model 2**	**Model 3**
Constant	**-10.201**	**-9.181**	**-2.278**
GDP per capita	**1.783**	**1.826**	**1.128**
Population	**.789**	**.799**	**.457**
Time ratio	**.465**	**.357**	**-.679**
R^2	**.699**	**.694**	**.716**
Model type	**Fixed effect panel**	**Fixed effect panel**	**Pooled OLS**
Error correction	**YES**	**NO**	**NOT APPLICABLE**

significant at 95%, ** significant at 90%, * significant at 85%

Table 5. Assumptions underlying the demand forecasts under different scenarios

Scenario	Initial demand	GDP *per capita* growth	Population growth	Travel time ratio	Remarks
High	90000	4.5 till 2022, 5.6 for 2021, 6.1% after that	1.9 till 2021, 2.5% in 2022, 3.3% after that	No change till 2022, 50% change after that, econometric	National *real* GDP per capita grew by 5.3%. Currently kushinagar

				model describes modal shift	growth rate is smaller.
low	80000	4.5% till 2021, 5.3% for 2022,5.9% after that	1.8% till 2021, 2.0% after that	65% of air passengers switch to surface modes due to bridge and roads	Growth will be lower than anticipated. Combined real GDP growth rate 8.0%.