Modelling the Value of an Airport Slot

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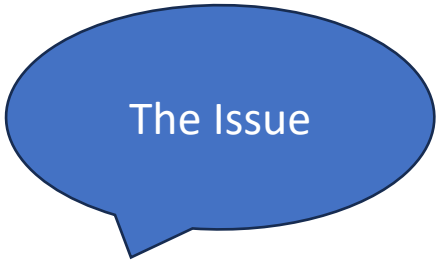
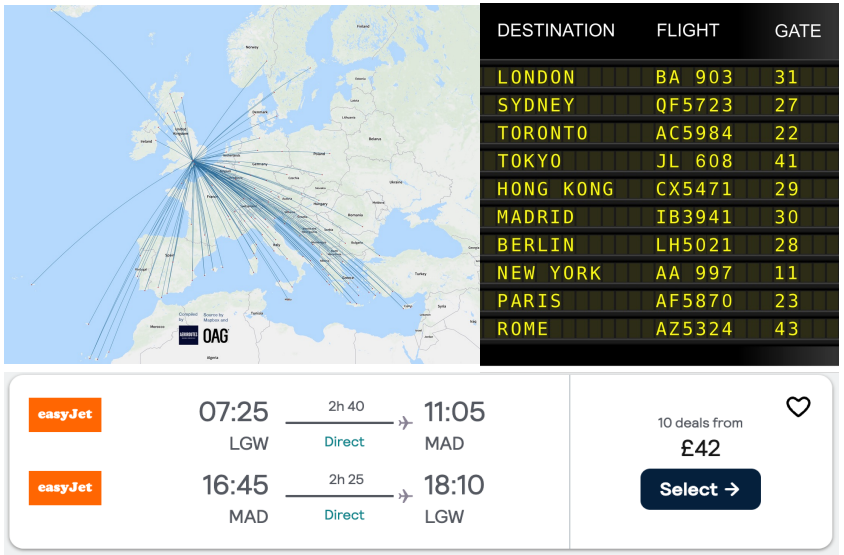
Slots at Congested Airports



- Many airports are at full capacity for aircraft movements
- New runway infrastructure often prohibited
  - Local and/or global environmental impacts
  - Planning and space restrictions
  - Cost

- One current solution is slot allocation
- A method for finding slot value is sought by airlines, airports and governments
- **Objective is to determine slot value, focusing on Gatwick Airport**

Modelling the Value of an Airport Slot: **Important components to consider**



- Current operations of the airline

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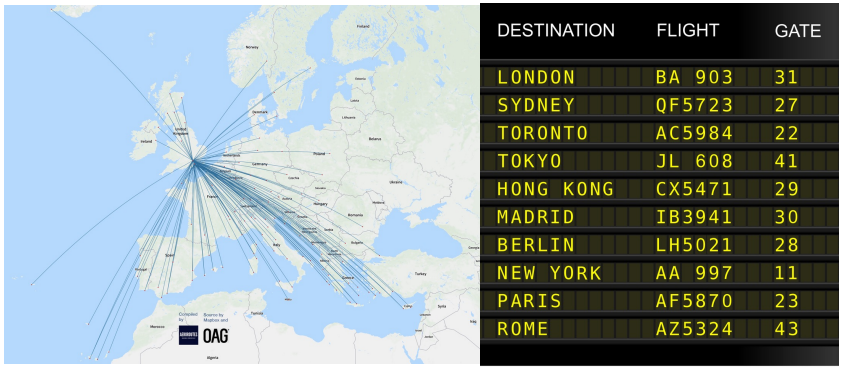

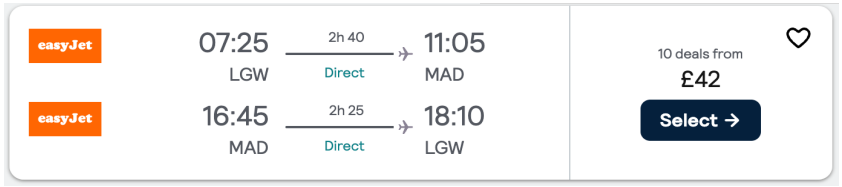

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- Competitor airlines' operations

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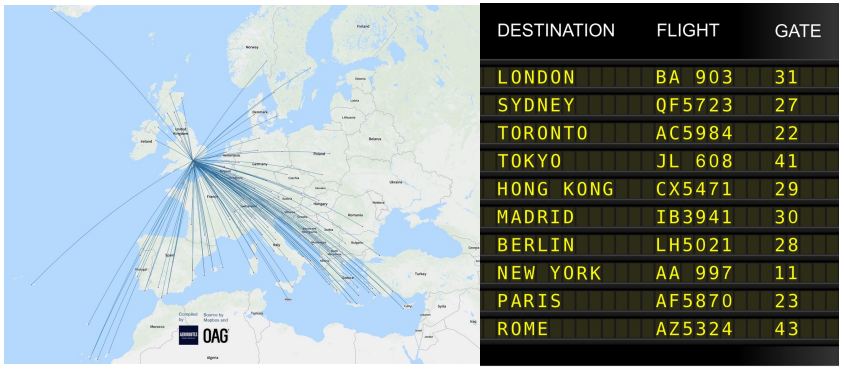

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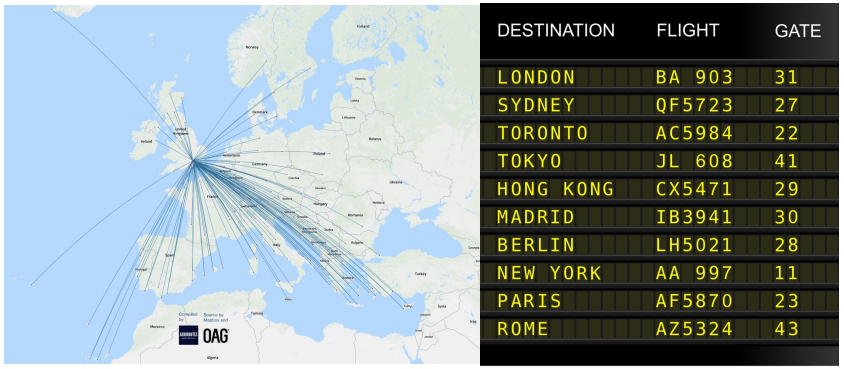

- Current operations of the airline
- Competitor airlines' operations
- Passenger behaviour
- A profit motive for the airlines
- **The Airline Behaviour Model (ABM) encapsulates this**

ABM: Airline Behaviour Model

- Objective function: each airline (M) sequentially maximizes profits (P) within its network
- Decision variables: airfare (Fare), flight frequency (Freq) of type of aircraft (a)

$$P_M = \sum_{i \in ITN_M} (Fare_i \cdot Pax_i + Arev_M \cdot Pax_M) - \sum_{j \in SEG_M} \sum_{a \in AC_j} Opcost_{a,j} \cdot Freq_{a,j} - \sum_{j \in SEG_M} \sum_{a \in AC_j} Paxcost_{a,j} \cdot Pax_{a,j}.$$

Revenues | Flight-related costs | PAX-related costs

- Set of linearized constraints
  - E.g. Airport capacity constraint:

$$\sum_{j \in SEG_p} \sum_{a \in CRFT_j} Freq_{a,j} \leq max_p \qquad \forall p \in APT,$$

- Airlines take turns incrementally adjusting decision variables
- Iterate until profit equilibrium

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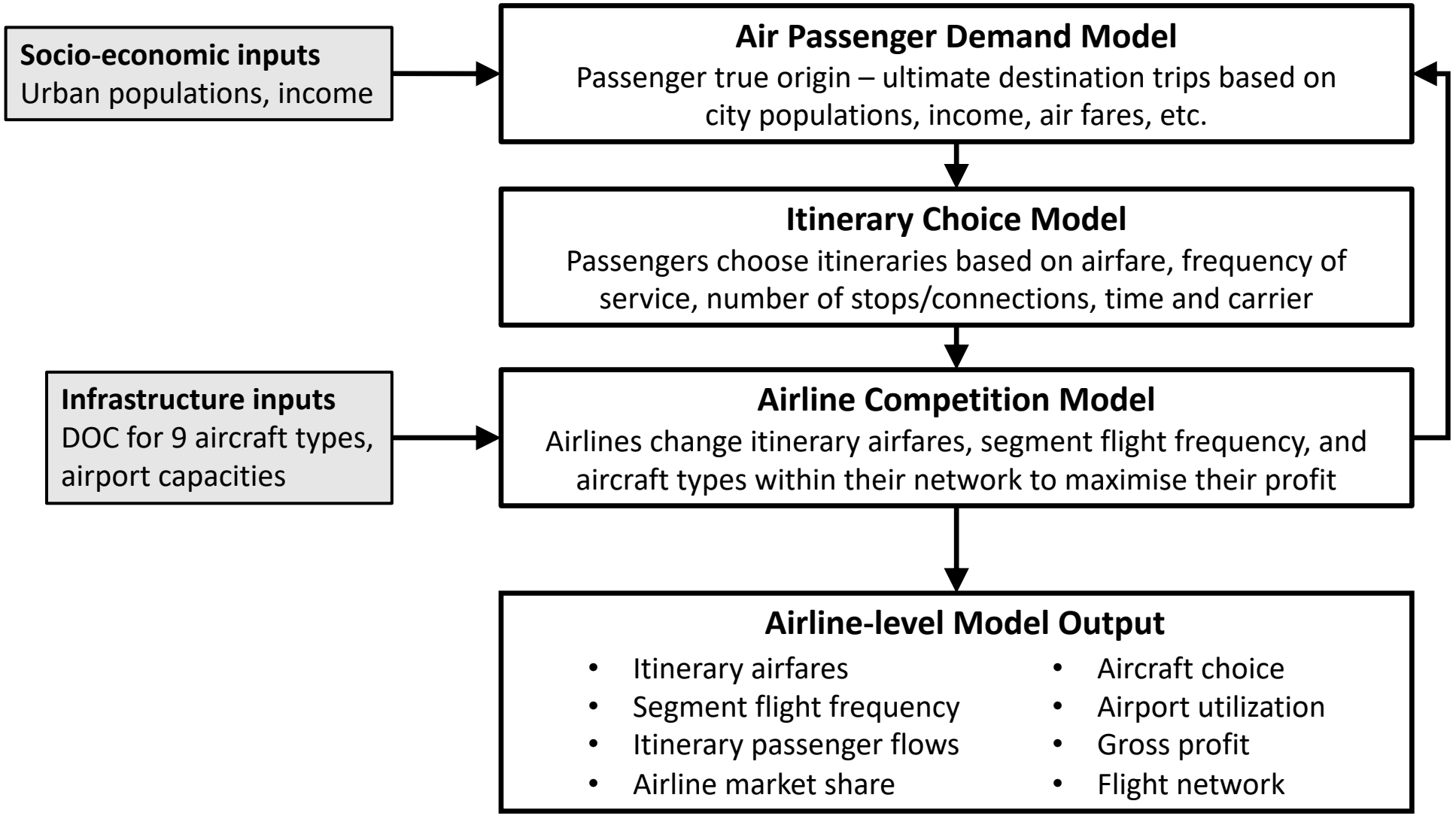

Iteration until equilibrium after each airline has optimized its operations in response to the other airlines

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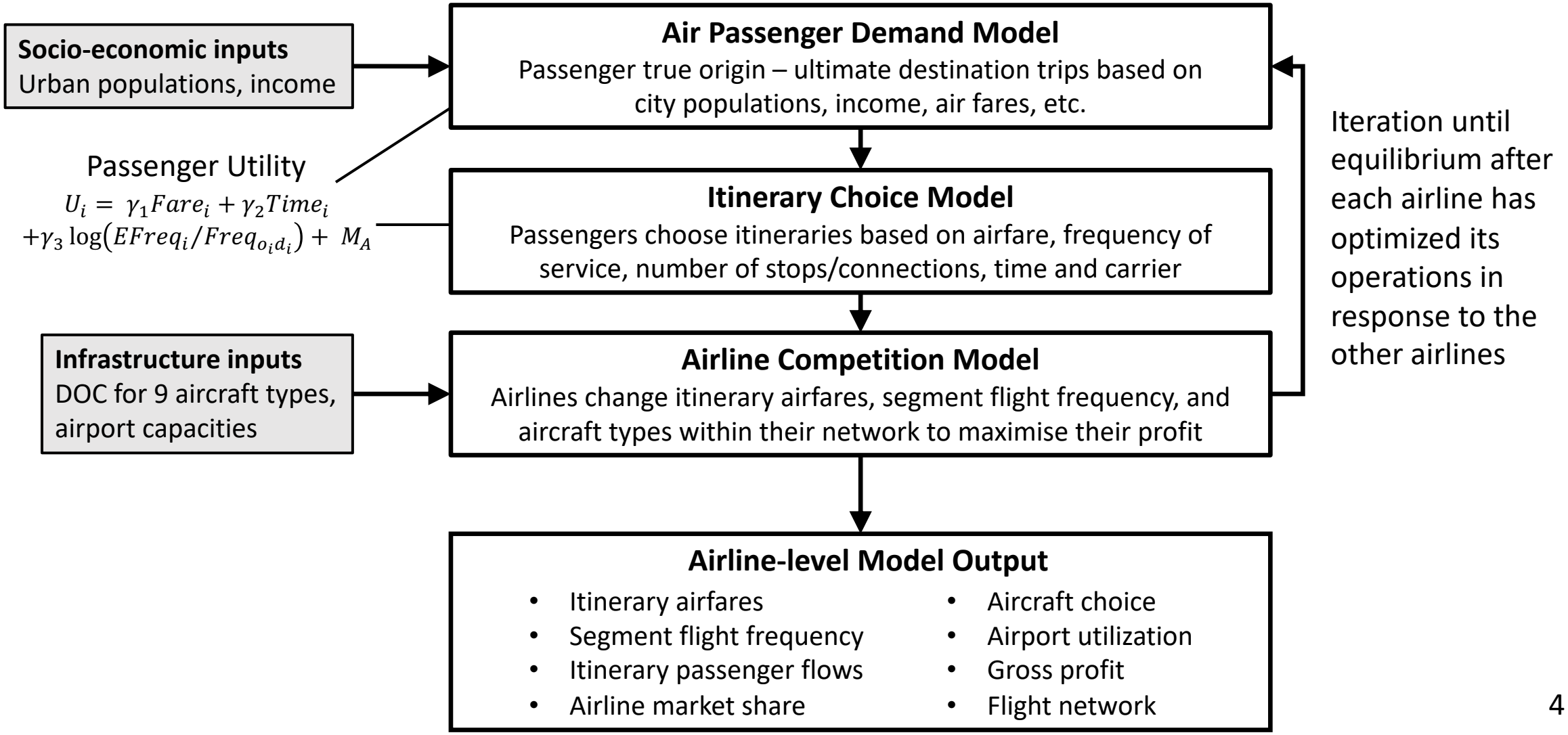


ABM: Adapted for Slot Prices

- Add an extra term to the Airline objective (profit) function:

$$P_M = \sum_{i \in ITN_M} Fare_i \cdot Pax_i + Arev_M \cdot Pax_M - \sum_{j \in SEG_M} \sum_{a \in AC_j} Opcost_{a,j} \cdot Freq_{a,j} - \sum_{j \in SEG_M} \sum_{a \in AC_j} Paxcost_{a,j} \cdot Pax_{a,j} - \boldsymbol{C_p \cdot N_{M,p}}$$

- Adjust the model constraints:

When making additional (purchasable) slots available:

$$\sum_{j \in SEG_p} \sum_{a \in CRFT_j} Freq_{a,j} \leq max_p + \boldsymbol{N_{M,p}}$$

$$\boldsymbol{N_{M,p}} < 2 \times 365$$

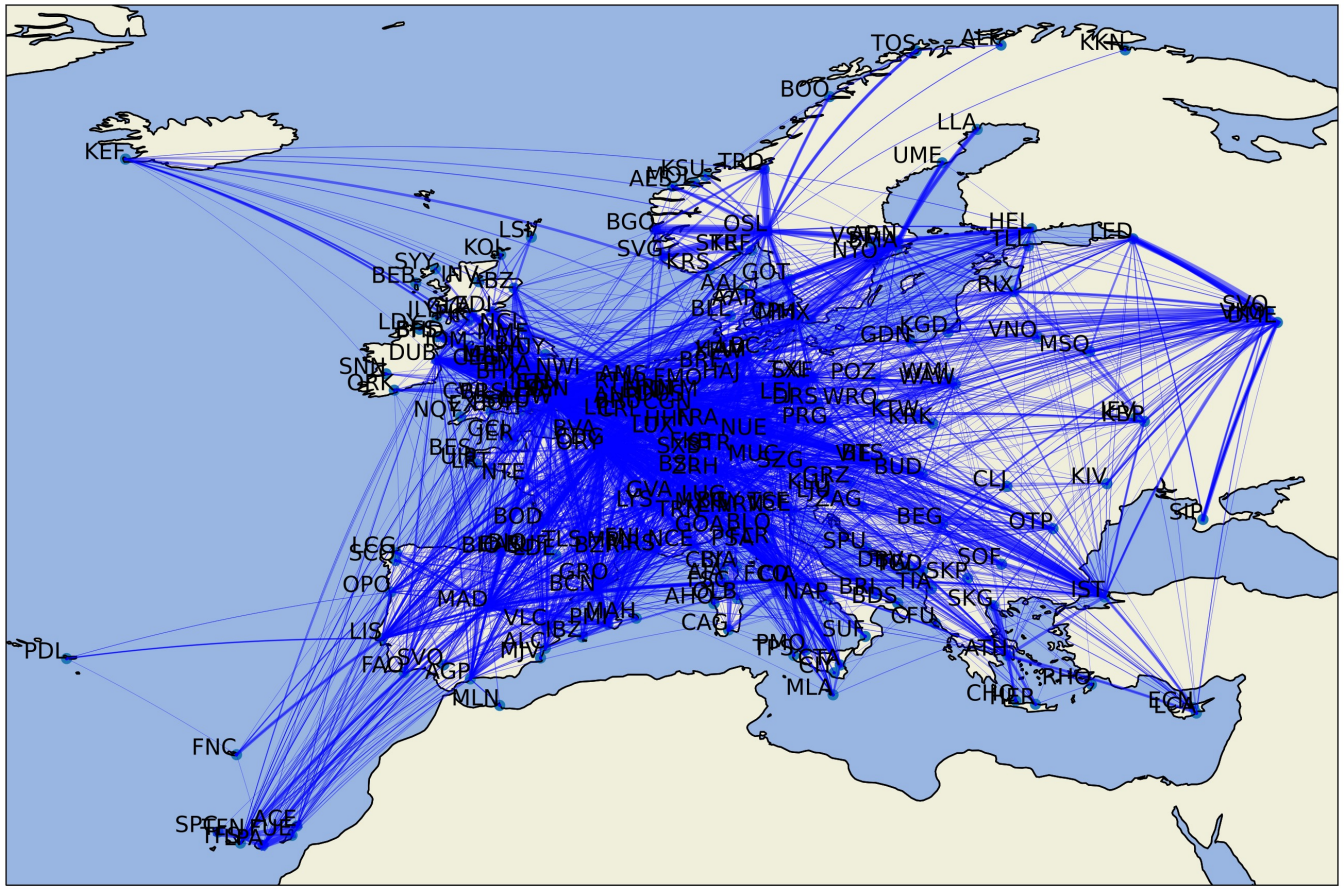
When emulating the sale of all slots at an airport:

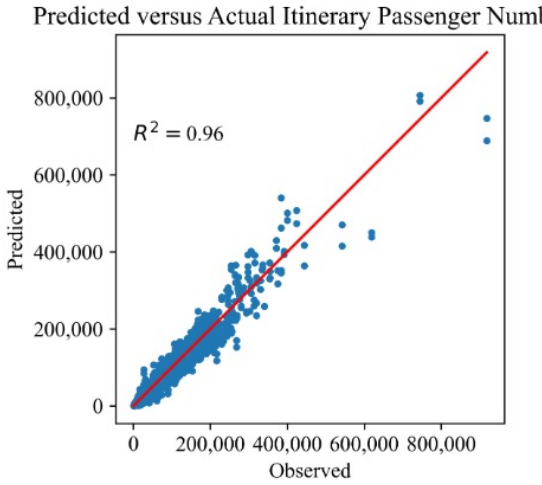
$$\sum_{j \in SEG_{M,p}} \sum_{a \in CRFT_j} Freq_{a,j} \leq \boldsymbol{N_{M,p}}$$

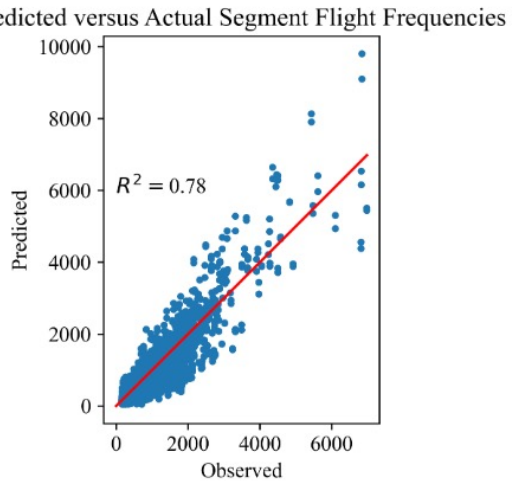
$$\sum_{M} \boldsymbol{N_{M,p}} \leq max_p$$

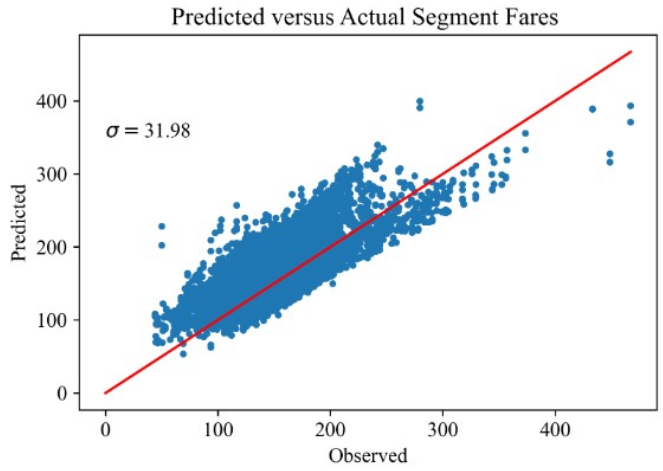
- Vary the cost, $\boldsymbol{C_p}$, and see if airlines acquire the slots

Airline Behaviour Model (ABM):
Trained and calibrated over Europe









Airline Behaviour Model (ABM): Results for Gatwick Airport

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- **Sale of extra slots at Gatwick**

(use amortization formula)

Price of a single slot	->	annual price of a daily slot-pair.	->	indefinite rights
$150-175		$110,000-128,000		$2.2-2.6 million

- Easyjet highest bidder (followed closely by British Airways)

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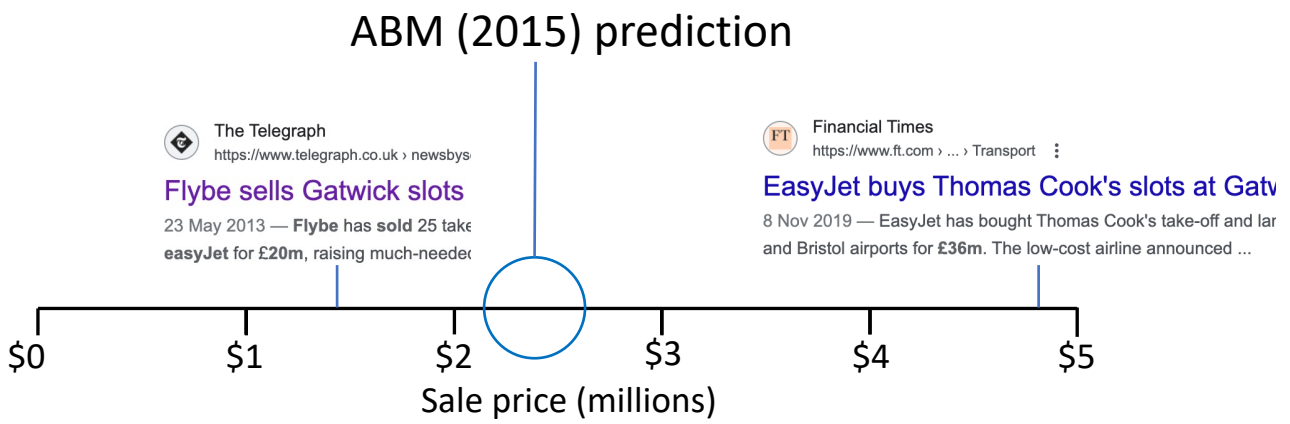

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- **Sale of all slots at Gatwick airport**
  - Up to $190 per slot, all remain utilised.
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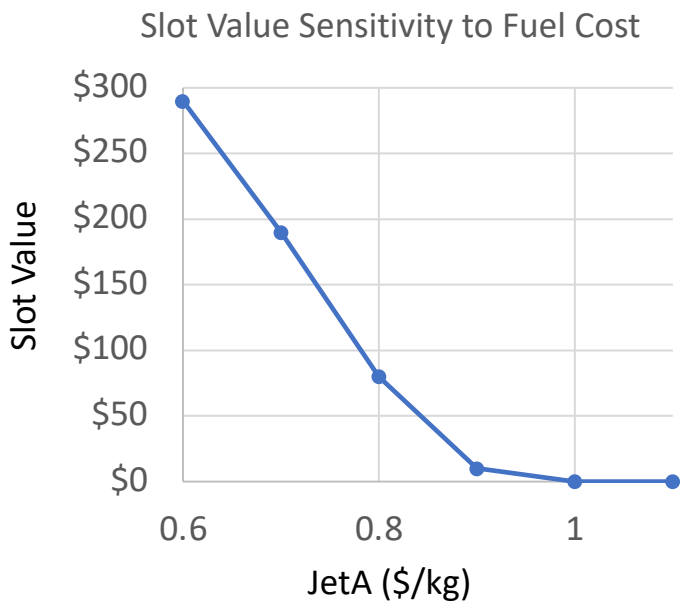

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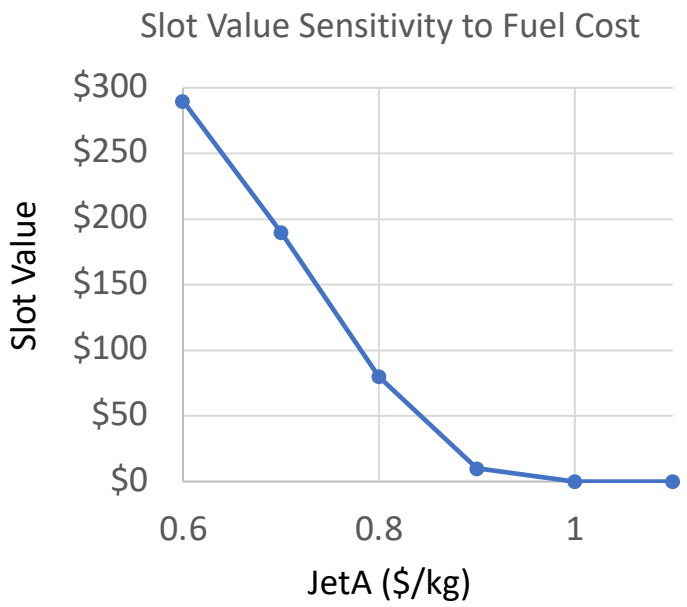

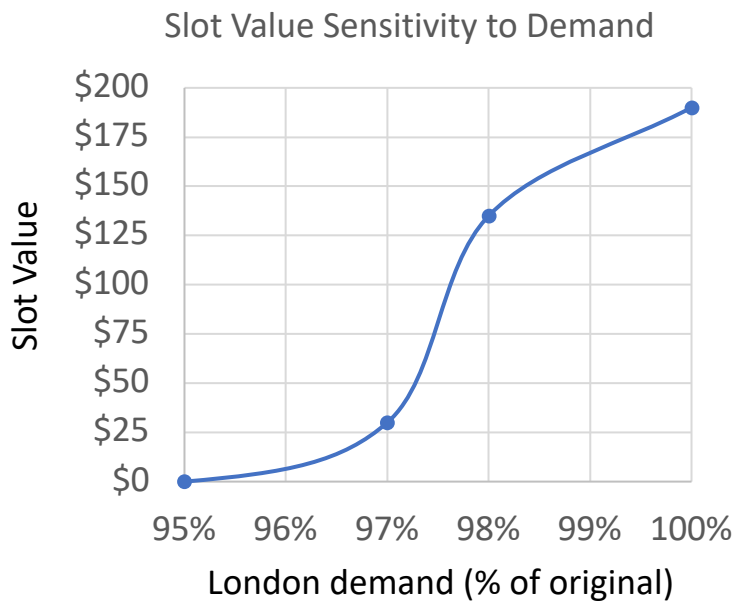

Airline Behaviour Model (ABM): Conclusions and Further Work

- Have used ABM to predict slot value at Gatwick airport
- Method is generalisable. Can be used for any/many airports
- Allows for a range of scenarios to be examined
- Can quantify the effects of exogenous changes (fuel price, demand)

- Caveats:
  - Lack of external buyers/new entrants
  - Yearly average slot value only
  - Model only covers Europe

- Further Work:
  - Expand ABM to global coverage

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