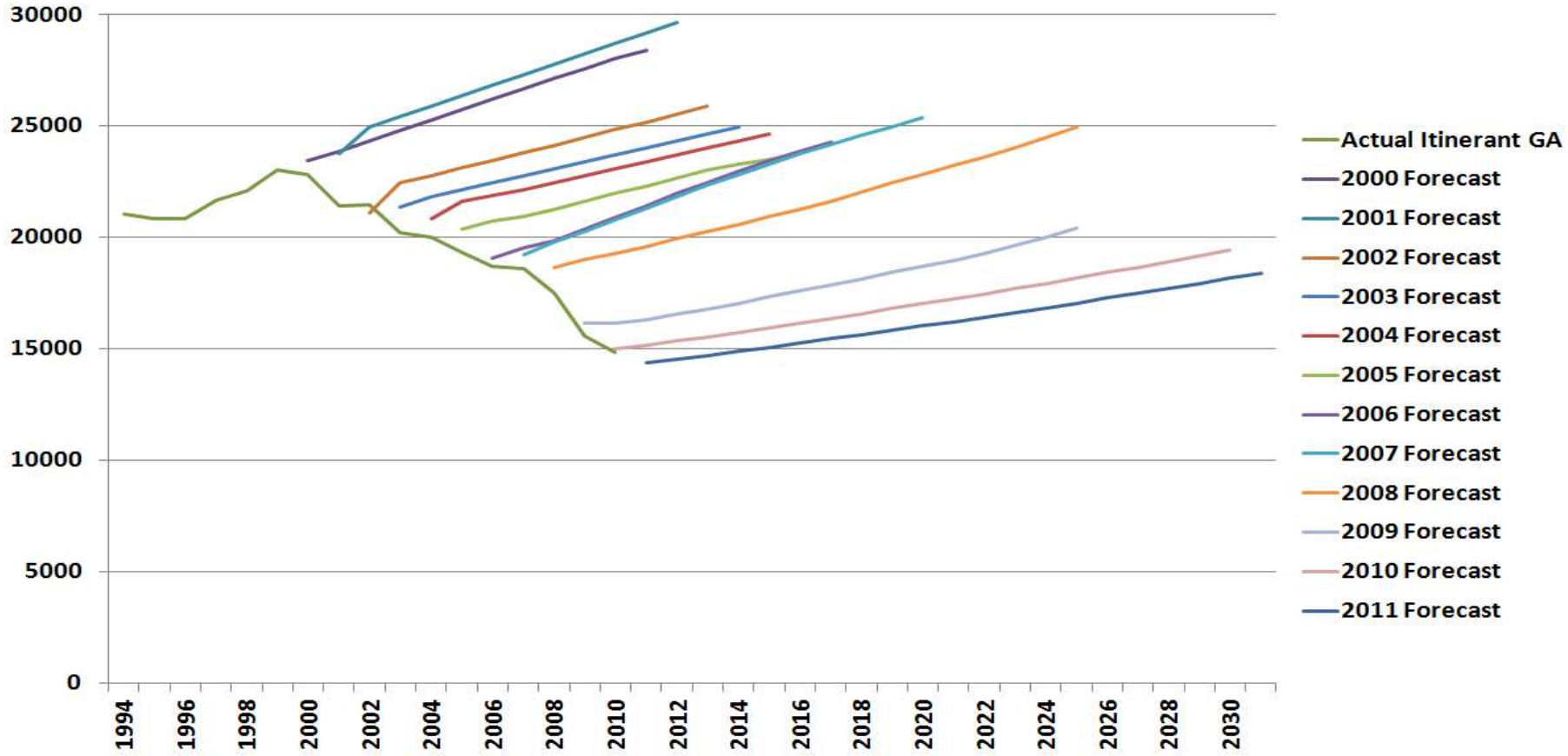
The FAA practice



Forecasts of itinerant general aviation operations at all US towered airports

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Influences of the Electric / Hybrid Aircraft Developments on Forecasting the Demand in Small Aircraft

1. Introduction
2. Forecast methodology
3. Electric / hybrid aircraft developments
4. Applied forecasting methodology
5. Results and discussions
6. Conclusions

1. Introduction

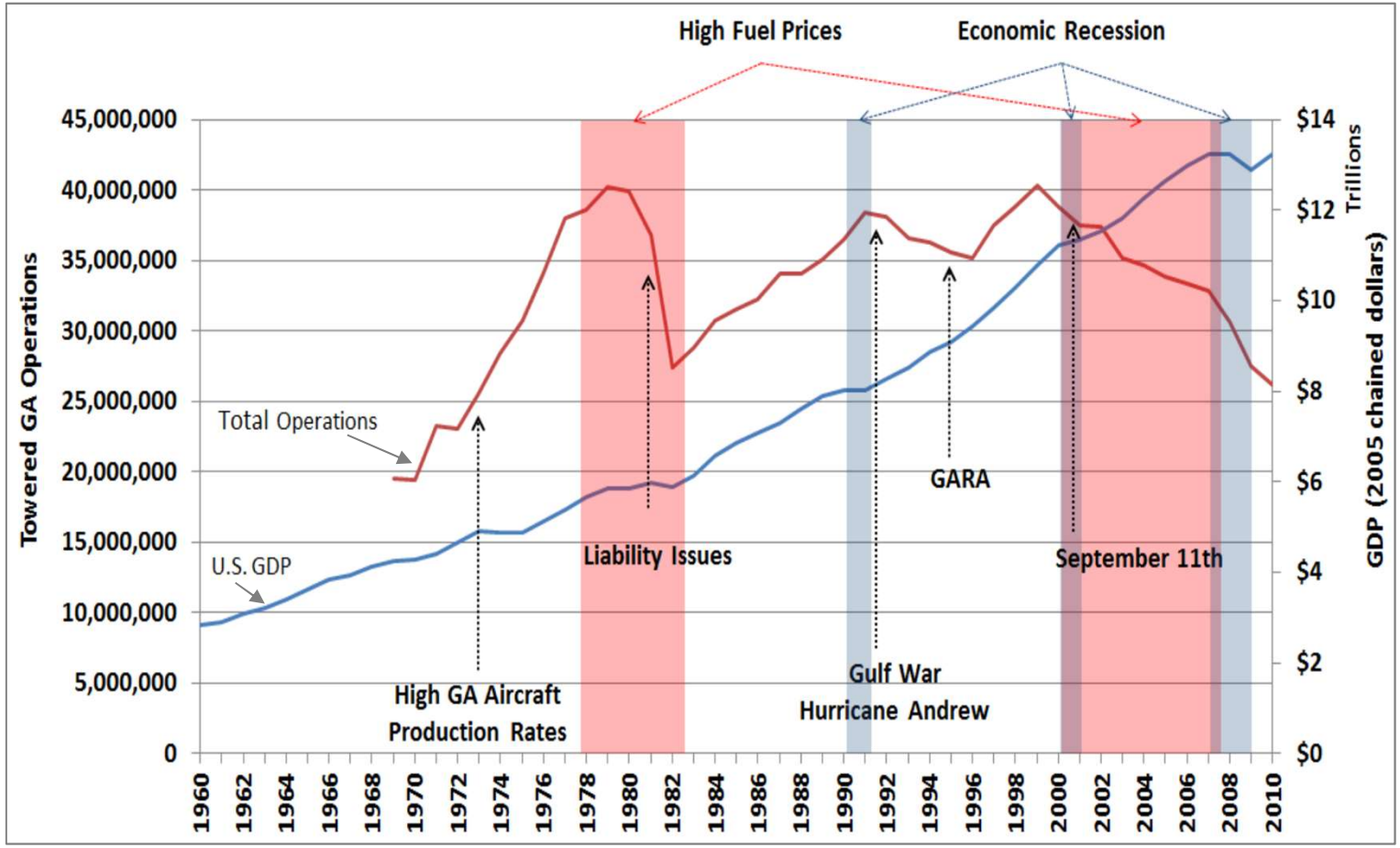
- Small aircraft transport (SATS) opens a new business segments in air transportation system
- The aircraft with electric / hybrid propulsion systems are most promising future cleaner technologies
- Because the barriers (low specific energy of batteries), first electric / hybrid aircraft will be introduced into the service in SATS
- Influence of electric / hybrid aircraft on demand in SATS is an important, but not so simple solvable task.
- Practice in SATS forecasts (EPATS, SAT-Rdmp, PPLANE, ESPOSA, etc.) support this work

2. Forecast methodologties

- **Drivers:**
  - economic: GDP per capita, net income,
  - societal: population, ages, traveling habits
  - technical, technological aspects: transport infrastructure, airports net,
  - dummies: events, step changes in future trends or their slopes.
- **Methods:**
  - simple regression models
  - nonlinear models, soft computing
  - specially developed models
  - using the travel budget, innovation diffusion theory – „S” - curves

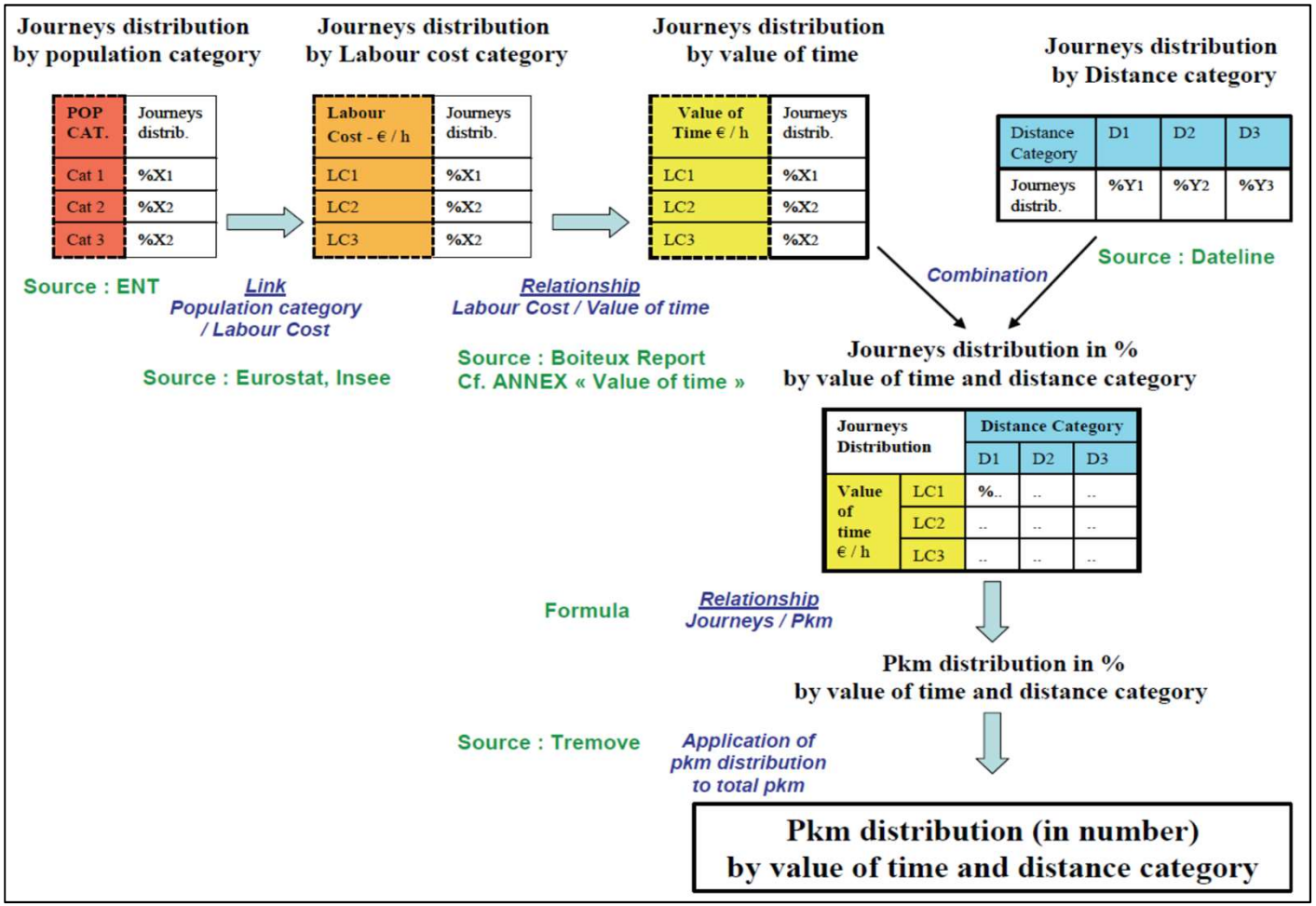
2. Forecast methodologies

- **Problem: independence from economic drivers No. 1., GDP**



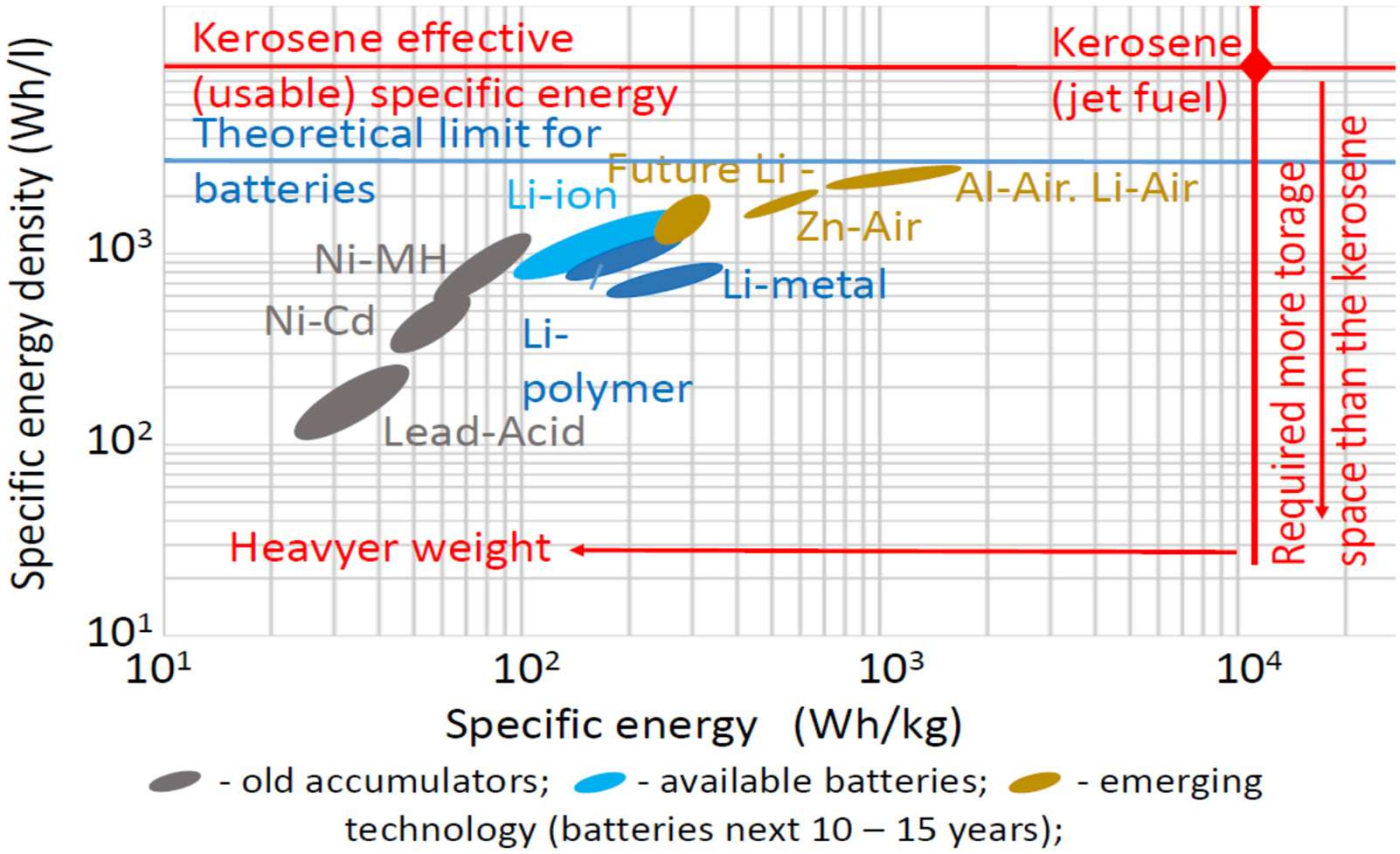
2. Forecast methodologies

- **Problem: independence from economic drivers No. 1., GDP**



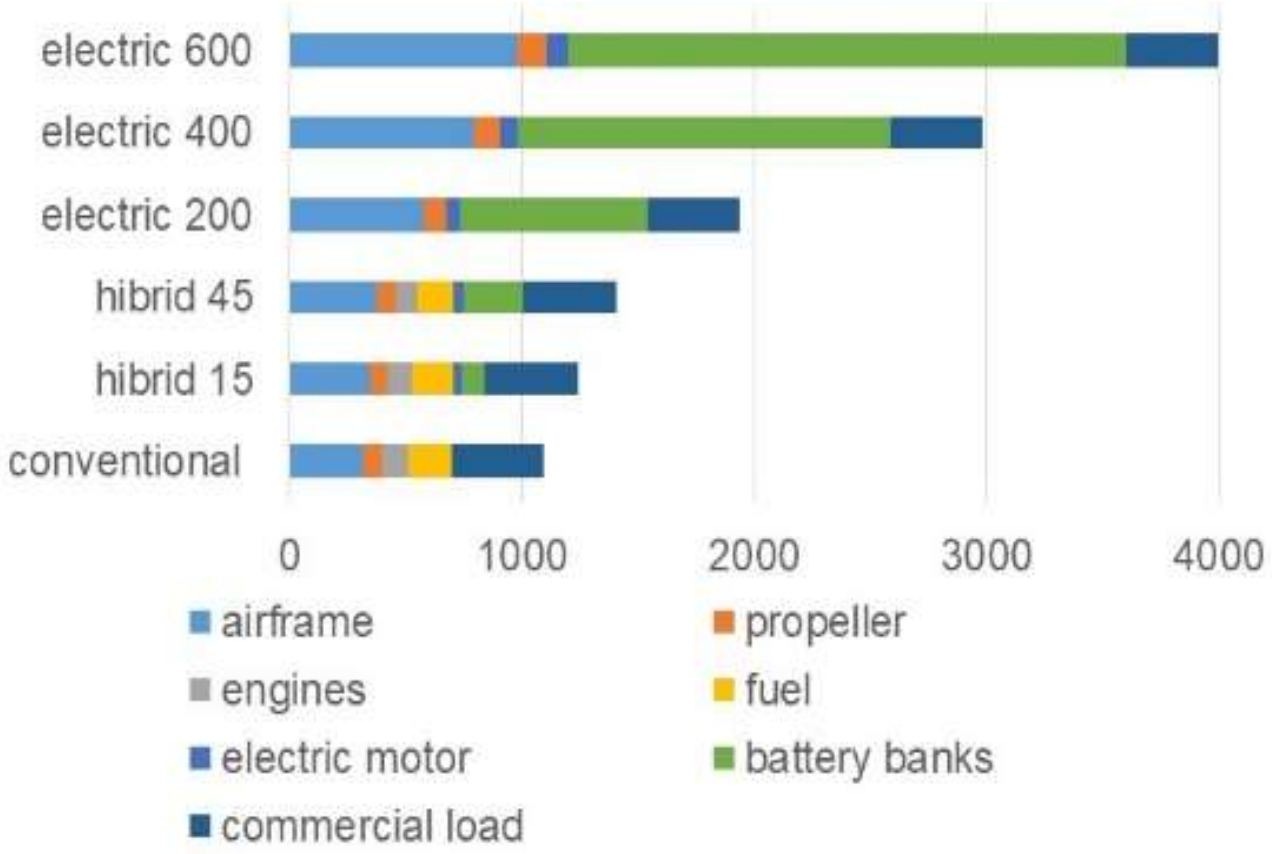
3. Electric / hybrid aircraft developments

- **Used energy of 1 l kerosene → 3 kWh → 9 – 10 kg batteries**



3. Electric / hybrid aircraft developments

- **Mass breakdown → reducing the range in %**

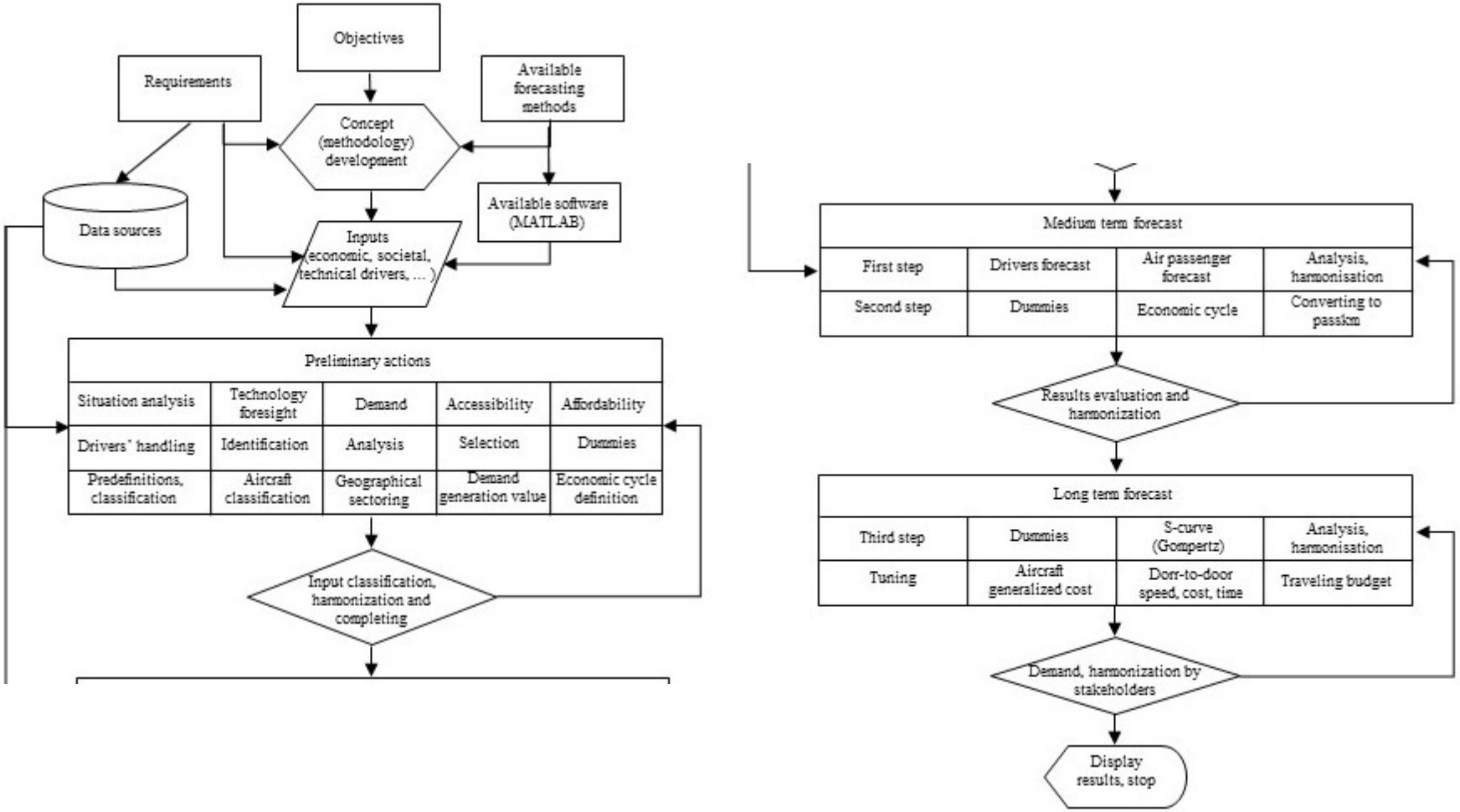


	Range reduction
electric 600	41 %
electric 400	60 %
electric 200	72 %

3. Electric / hybrid aircraft developments

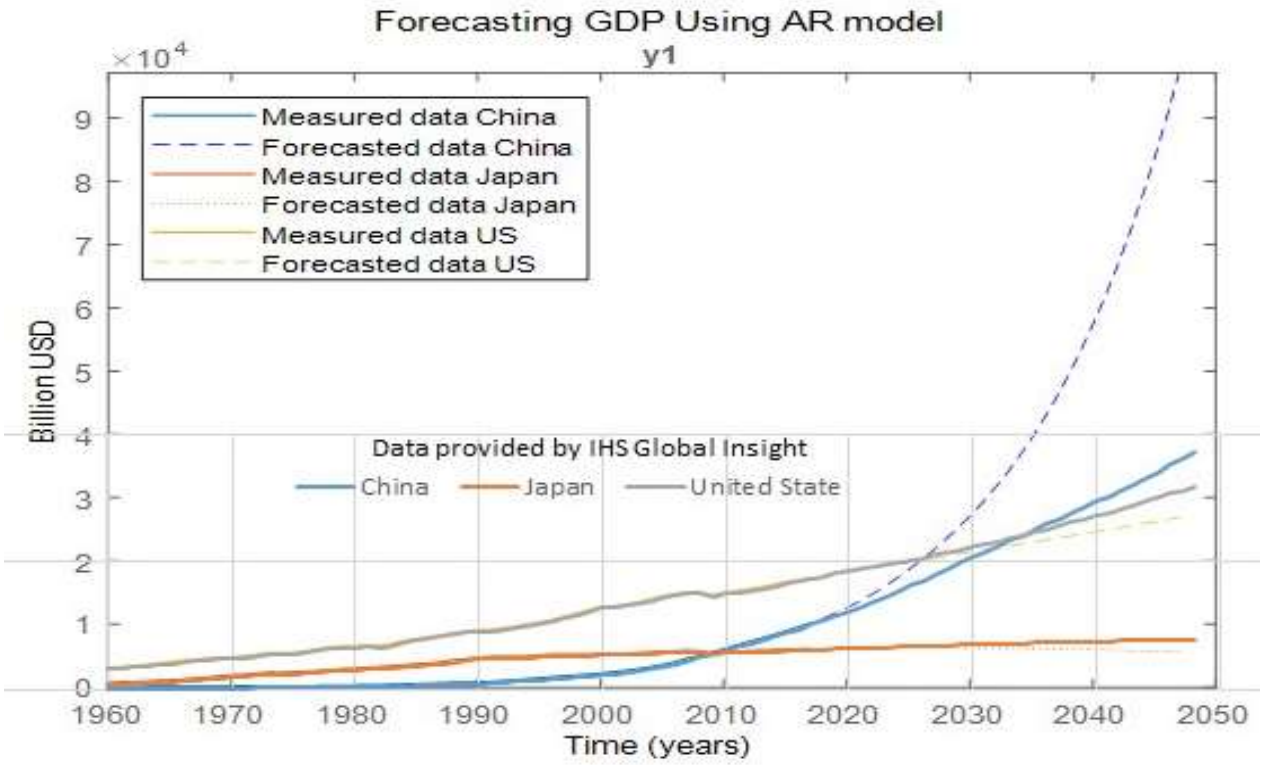
- **Dummies:**
  - 2020 – 22: small , 2-seaters aircraft – 7 – 10 % increases for 3 – 5 years,
  - 2026 – 28: 4 – 9 seater aircraft – change slope for 4 – 6 %
  - 2033 – 35: small aircraft with range up to 1000 km (increasing) and regional aircraft decreasing the slope) final effect increasing for 2 – 3 %

4. Applied forecasting methodology



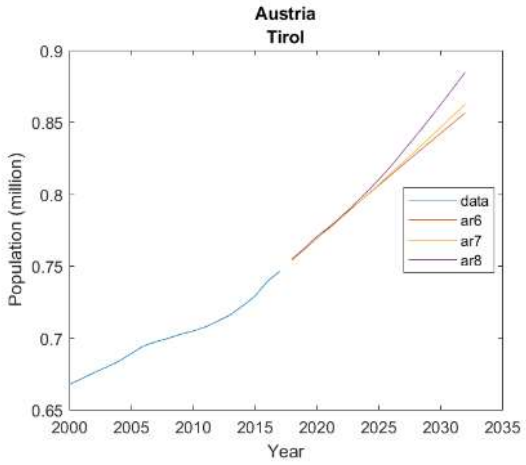
4. Applied forecasting methodology

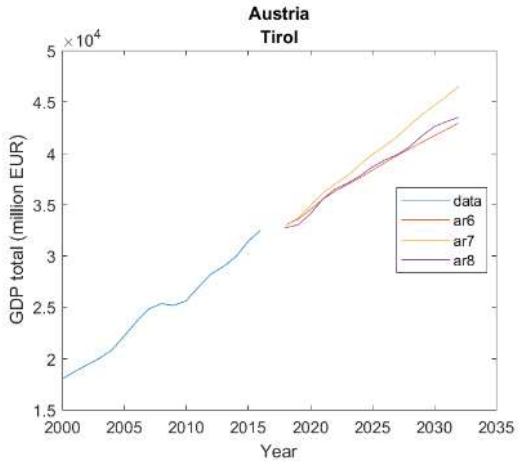
- **Examples: comparison: GDP forecast and forecasted input**

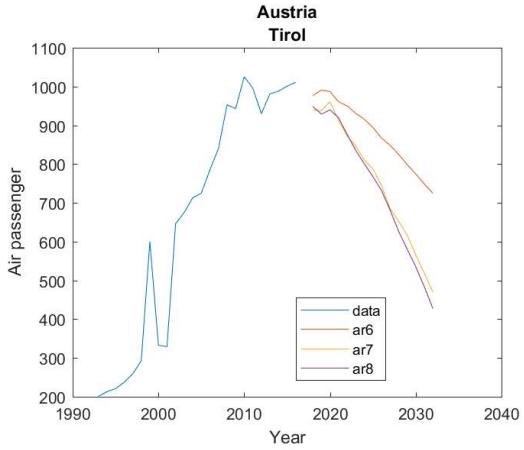


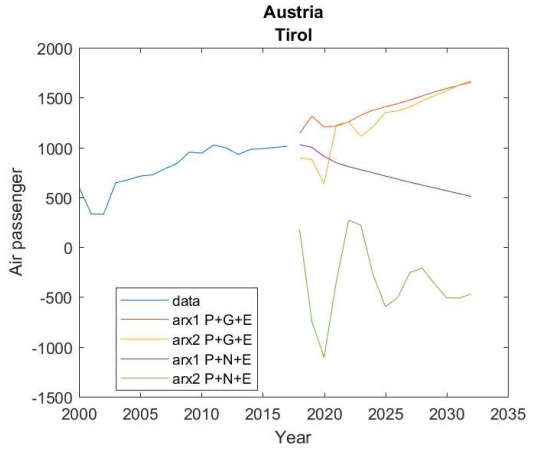
4. Applied forecasting methodology

- **Examples: using different AR and ARX models**
  - AR estimation:
    - Estimate drivers
  - ARX estimation:
    - Use AR estimated drivers as exogenous inputs
  - Tuning:
    - Select stable polynomial orders
    - Select drivers depending on availability and data quality



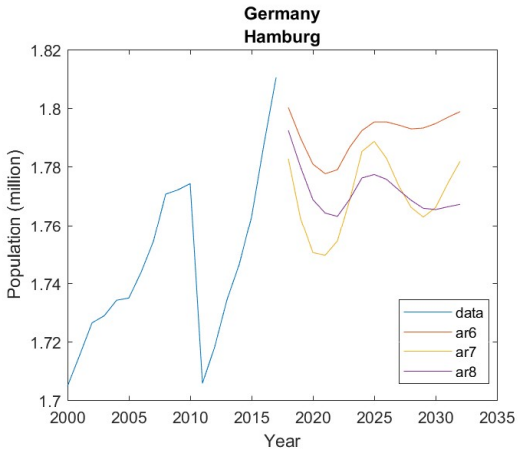


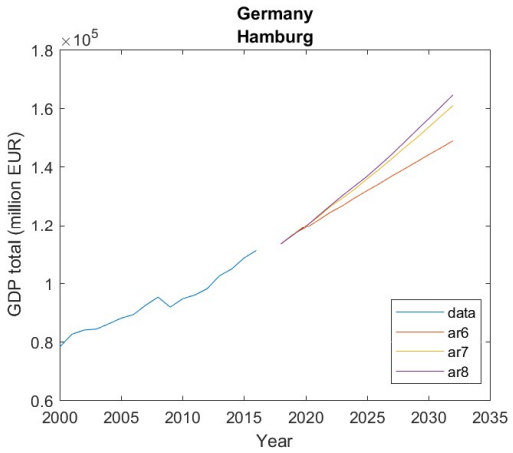


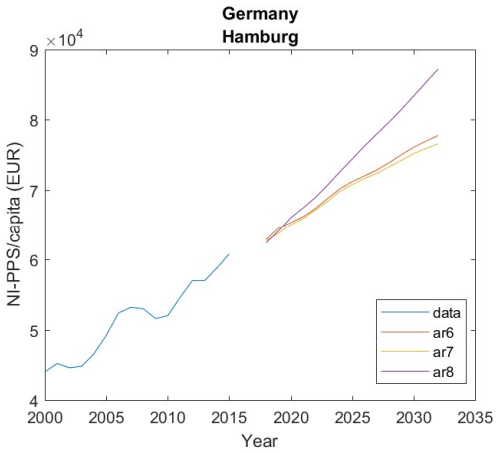


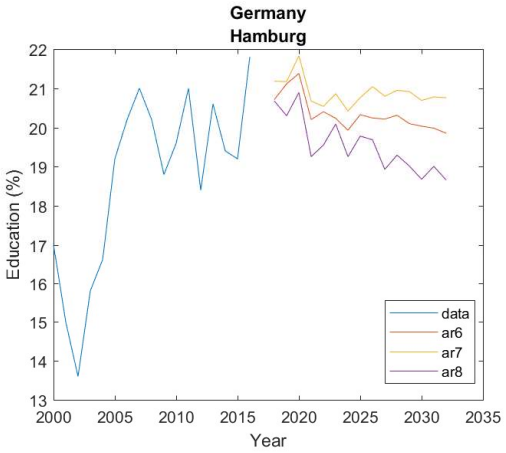
4. Applied forecasting methodology

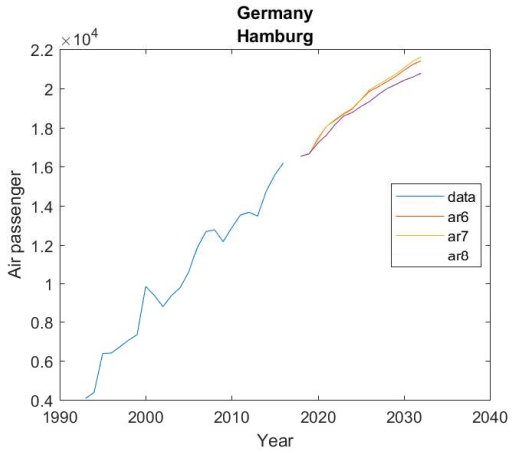
➢ Examples: using different AR and ARX models

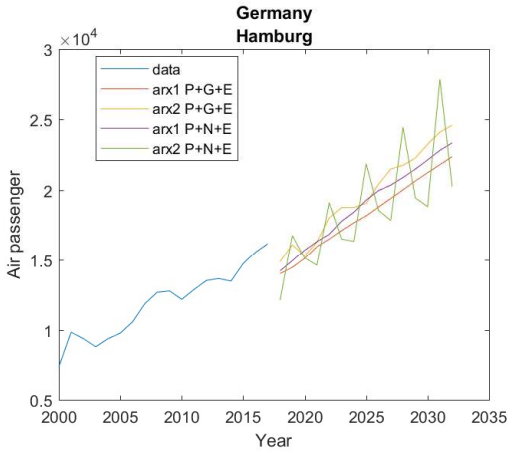






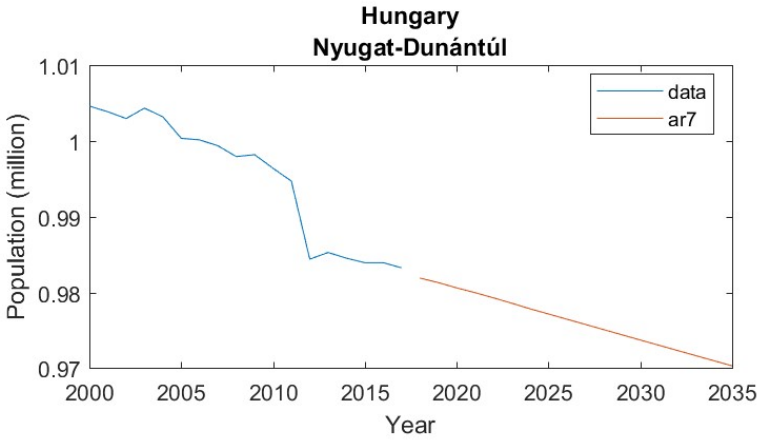


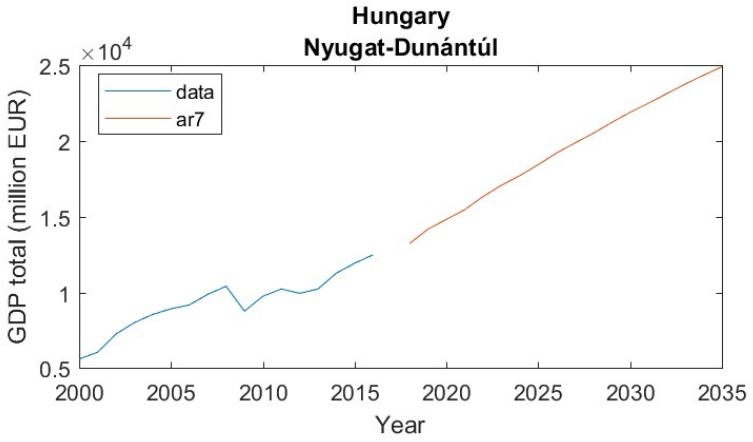


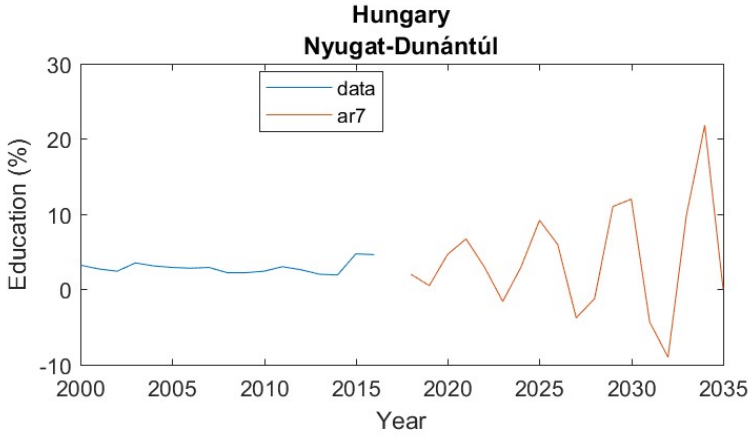


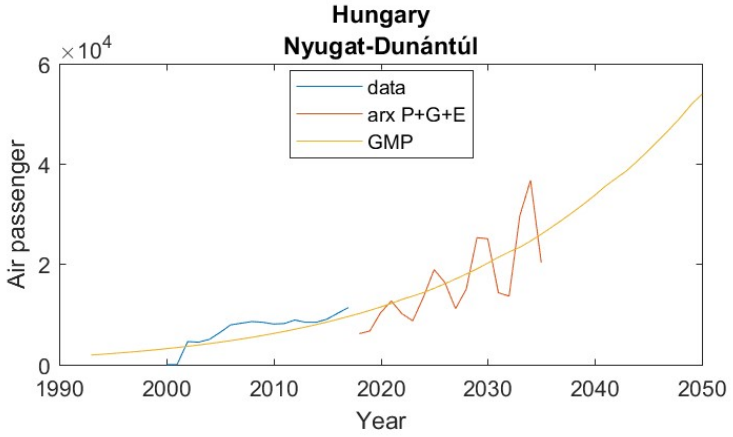
4. Applied forecasting methodology

➢ Examples: fitting Gompertz curve



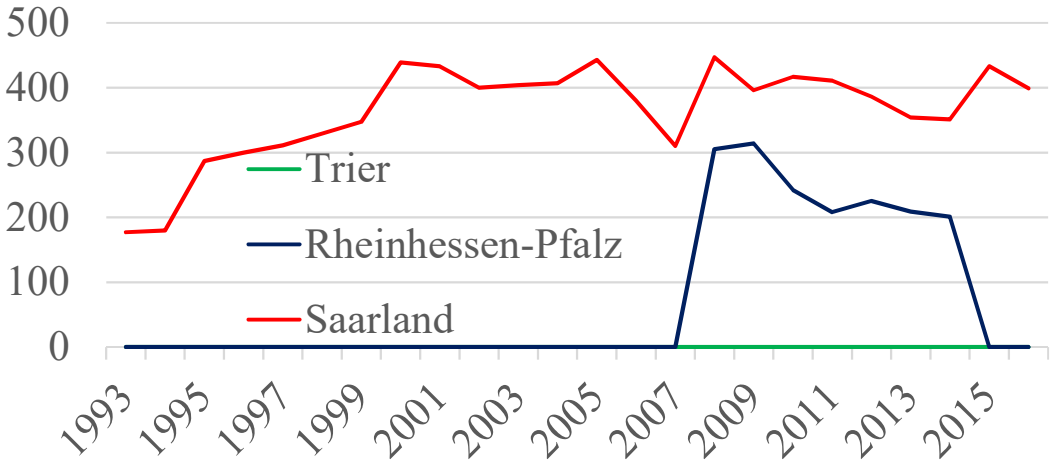


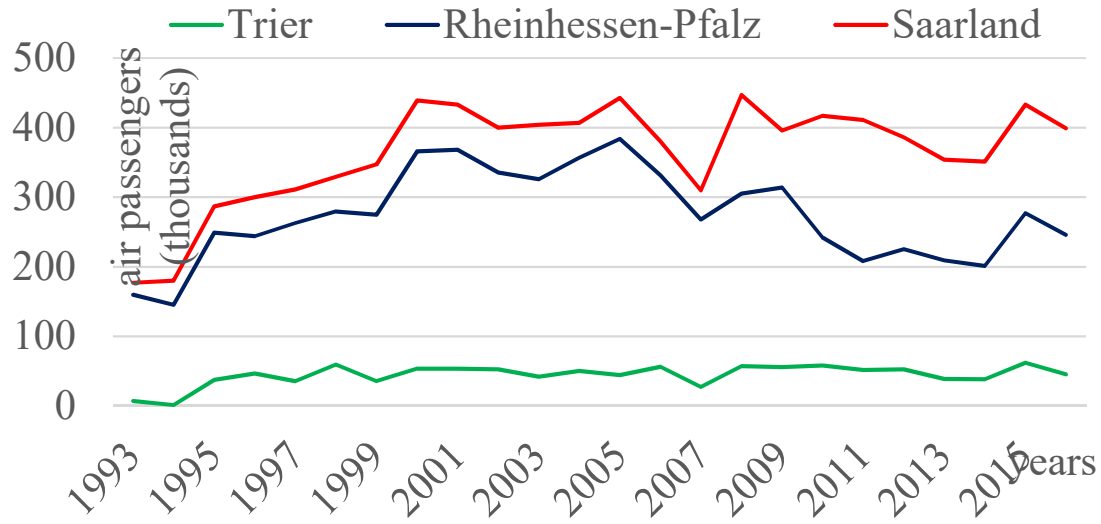




4. Applied forecasting methodology

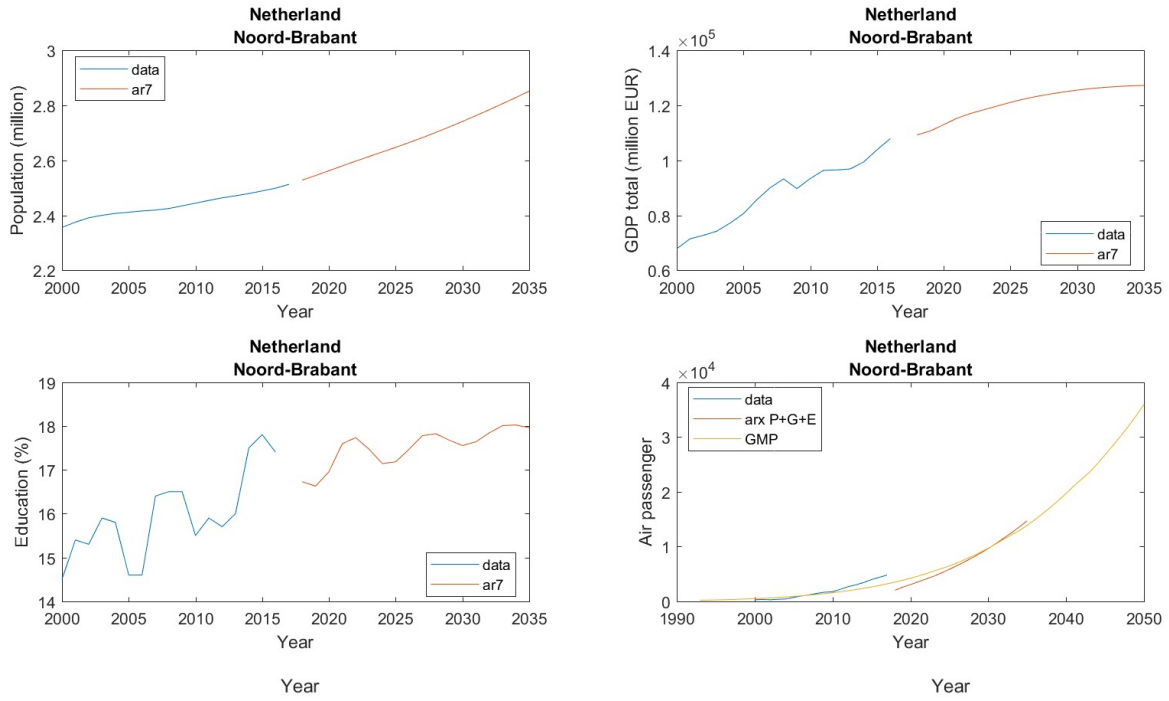
➢ Examples: input harmonization and correction



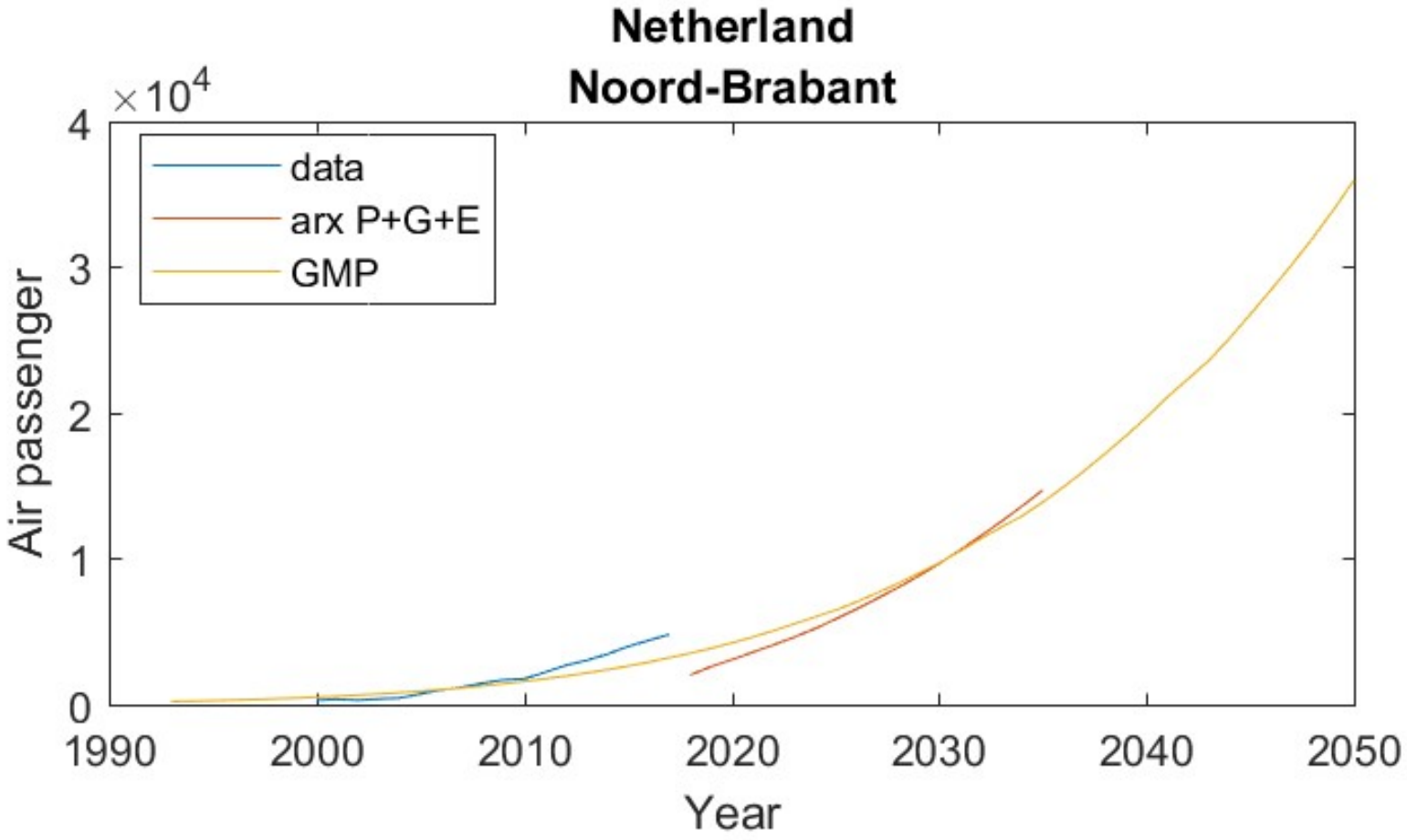


5. Results and discussions

- **Finalize estimation :**
  - Correct for economical cycles, short and long term
  - Use dummy factors for unique events



5. Results and discussions



6. Conclusions

- The electric / hybrid aircraft will be entered into operation in the small air transport systems.
- They will have considerable effects on demand in SATS
- A special forecasting methodology was developed
- It uses dummies identifying the electric /hybrid aicraft entering into service
- The methodology shows predicted effects of electric / hybrid aircraft on demand in SATS

7. Acknowledgement

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