Air passenger departures forecast models

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Background (1)

- Since 1999, MBIE has produced tourism forecasts annually for a seven-year projection period (http://www.med.govt.nz/sectors-industries/tourism/tourism-research-data/forecasts)
  - The forecasts cover only international arrivals by foreigners
- Auckland Airport has also produced forecasts on foreign visitor arrivals up to 2025 (http://www.ambition2025.co.nz/)
- The Aviation Security Service has developed a short-term forecast model for ***passengers undergoing security screening***
- However, no forecasts have previously been made for:
  - international departures by New Zealand residents, or
  - ***total*** domestic air passenger departures

Background (2)

- Our models forecast
  - international departures by NZ residents, and
  - total domestic departures* by both NZ residents and foreigners
- Although the conventional ordinary least square (OLS) approach could be used to develop a forecast model, it could be associated with the spurious regression issue due to common trends (non-stationary variables)
- Advanced methods have been used in our models to address the spurious regression problem

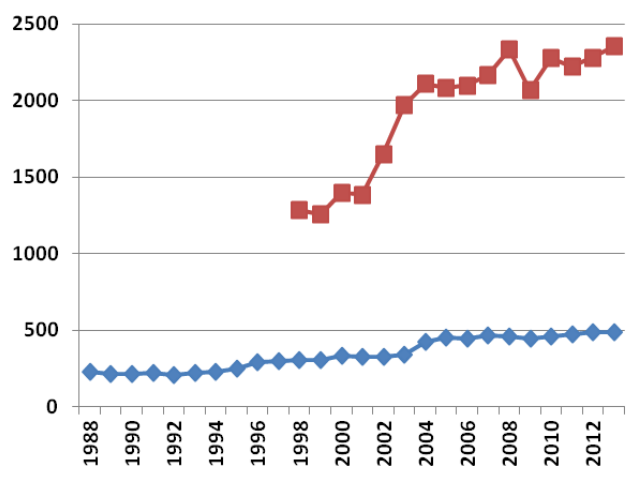
* Note: Exclude those who do not pay airfares

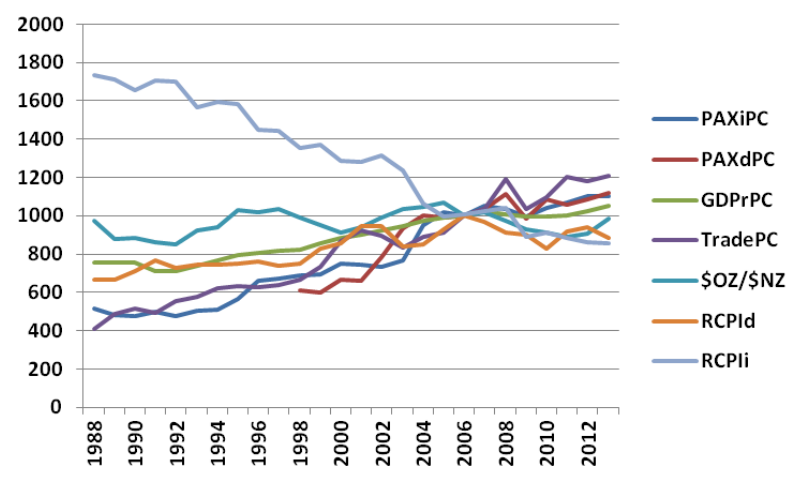
How we dealt with non-stationary variables

- The unit root(s) of a non-stationary variable can be removed by differencing (resulting in so-called ‘growth rate’ models)
- Error correction model (ECM) approach can handle non-stationary variables
  - the Engle-Granger two-stage ECM approach, and
  - the Wickens-Breusch ECM one-stage approach
- ECM methods were not applied to the domestic departure data (small sample size)
- Annual data were used
  - international departure module: data of 1988 to 2010
  - domestic module: data of 1998 to 2010
  - the 2011 and 2013 data were used for forecast evaluation

Variables considered

- real GDP
- international trade
- exchange rate
- crude oil price
- population
- unemployment rate
- CPI for both international (RCPIi) and domestic air transport (RCPId) based on airfares in real term





Notes: (a) PAXiPC = International departures per capita (per 1000 NZ population)
(b) PAXdPC = Domestic departures per capita (per 1000 NZ population)
(c) Variables are indexed to 2006 = 1000, except for RCPIi and RCPId
(d) RCPIi and RCPId were worked out through dividing the CPIi and CPId data obtained from Stats NZ by all groups CPI

Dummy variables for major events

- For international departures
  - the 2008/09 Global Financial Crisis (GFC)
  - the introduction of a low-cost operation model by Air NZ for short-haul international flights (late 2003)
  - the 11th September 2001 terrorist attacks (SEP11)
  - the SARS epidemic (Nov 2002 – July 2003)

- For domestic departures
  - the 2008/09 Global Financial Crisis (GFC)
  - the introduction of a low-cost operation model by Air NZ (mid-2002)
  - Jetstar entered the NZ market in June 2009

Scenarios

- Base case scenario
  - Treasury's forecasts on GDP, international trade, and exchange rates
  - 50th percentile of Stats NZ's population forecasts
- Low-growth scenario
  - 70% of the growth in base case for GDP and trade
  - 25th of Stats NZ's population forecasts
- High-growth scenario
  - 130% of the growth in base case for GDP and trade
  - 75th percentile of Stats NZ's population forecasts
- Exchange rates and airfare indices were assumed to be the same in different scenarios

Forecasts on economic variables (base case)

- Forecasts on GDP (up to 2028), international trade and exchange rates (up to 2018) are from the Treasury
- Forecasts on RCPIi and RCPId are based on their historic trends

Calendar Year	OZ$/NZ$	GDP (Real)	TRADE (Adjusted)	TRADE (Nominal)	RCPId (Domestic)	RCPIi (International)
	Base case scenario					
	Enter ex rate	*Input annual growth rate, e.g. 2.1%*				
2014	0.8454	3.30%	1.55%	3.50%	0.80%	-1.00%
2015	0.8851	2.80%	3.50%	6.10%	0.80%	-1.00%
2016	0.8847	2.05%	6.70%	8.90%	0.80%	-1.00%
2017	0.8556	2.10%	6.20%	8.00%	0.80%	-1.00%
2018	0.8014	2.20%	4.80%	7.00%	0.80%	-1.00%
2019	0.8000	2.27%	3.80%	6.00%	0.60%	-0.80%
2020	0.8000	2.35%	2.50%	5.00%	0.60%	-0.80%
2021	0.8000	2.47%	2.50%	5.00%	0.60%	-0.80%
2022	0.8000	2.44%	2.50%	5.00%	0.60%	-0.80%
2023	0.8000	2.43%	2.50%	5.00%	0.60%	-0.60%
2024	0.8000	2.39%	2.50%	5.00%	0.40%	-0.60%
2025	0.8000	2.38%	2.50%	5.00%	0.40%	-0.60%
2026	0.8000	2.32%	2.50%	5.00%	0.40%	-0.60%
2027	0.8000	2.25%	2.50%	5.00%	0.40%	-0.40%
2028	0.8000	2.20%	2.50%	5.00%	0.40%	-0.40%
2029	0.8000	2.20%	2.50%	5.00%	0.40%	-0.40%
2030	0.8000	2.20%	2.50%	5.00%	0.40%	-0.40%

Model evaluation – international departures

- Against the 2011 to 2013 data
- Using mean absolute percentage error (MAPE) and root mean square error (RMSE)

International departures		
Model	**MAPE**	**RMSE**
Naïve 2	**5.23%**	**130,447**
OLS	**3.13%**	**93,812**
Growth 1	**8.05%**	**180,529**
Growth 2	**1.33%**	**47,371**
ECM	**1.21%**	**31,383**

- The Growth 2 and ECM models have the best and similar forecasting performance. Both models are statistically robust

International departures by NZ residents (1)

Growth 2 model: D(Ln(Pax Per Capita)) = 0.8511D(LnGDPrPC(-1)) - 0.4170D(LnRCPIi)
+ 0.1188 AirNZ_Int'l - 0.0991GFC + 0.0143

Adj. R^2 = 0.64

ECM model: D(Ln(Pax Per Capita)) = - 0.5682D(LnRCPIi) - 0.6237Residual(-1)
+ 0.1150 AirNZ_Int'l - 0.089GFC + 0.0163

Adj. R^2 = 0.63

The residuals for the ECM model are worked out based on its long-run equation (OLS model)

OLS model: Ln(Pax Per Capita) =1.0179LnGDPrPC + 0.3879Ln(OZ$/NZ$)
- 0.7011LnRCPIi – 0.0894SARS + 0.4342

Adj. R^2 = 0.98

International departures by NZ residents (2)

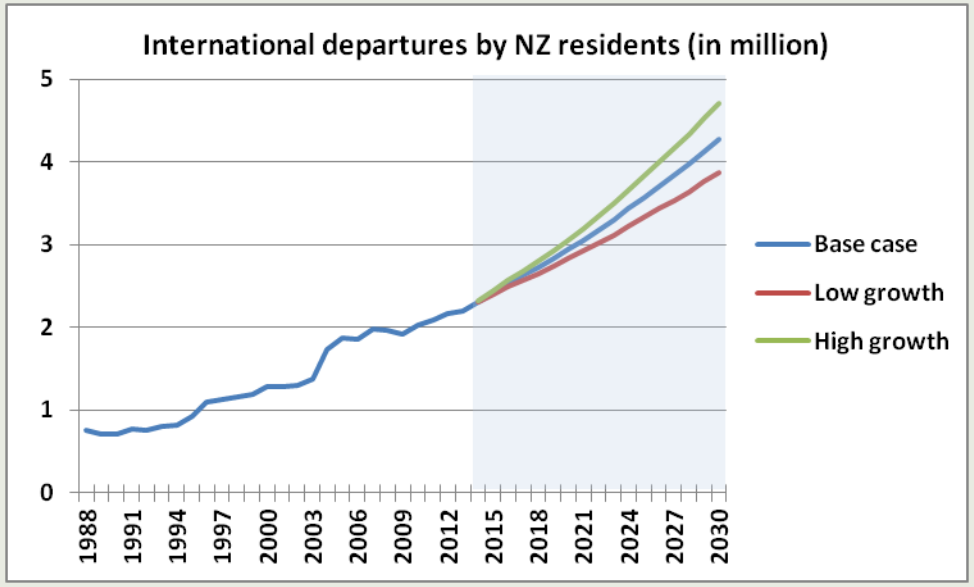
Growth 2	Actual	Estimated	Difference
2011	2,096,342	2,099,764	0.16%
2012	2,171,720	2,173,886	0.10%
2013	2,197,400	2,279,349	3.73%

ECM	Actual	Estimated	Difference
2011	2,096,342	2,109,863	0.64%
2012	2,171,720	2,156,836	-0.69%
2013	2,197,400	2,247,901	2.30%

- Although forecasting performance of the ECM model is slightly better, its forecasts for the next few years appear to be a bit too ambitious
- The ECM model is more complex than the Growth 2 model
- The ECM model is more sensitive to changes in RCPIi than the Growth 2 model

We have therefore decided to use the Growth 2 model to forecast international passenger departures (the ECM as an alternative)

International departures by NZ residents (3)



Forecast growth 2014 - 2030			
(Number in millions)	**Base case scenario**	**Low growth scenario**	**High growth scenario**
Departures in 2013	**2.2**		
Departures in 2030	**4.3**	**3.9**	**4.7**
Growth over 2013	**94%**	**76%**	**114%**
CAGR	**4.0%**	**3.4%**	**4.6%**

Note: CAGR refers to compound annual growth rate

- If we assume all short-term foreign visitors depart relatively soon after arrival, we can forecast ***total*** international passenger departures by combining our forecasts on international departures by NZ residents with
  - MBIE's tourist arrival forecasts in a medium term (seven years), or
  - Auckland Airport's tourist arrival forecasts in a long term (up to 2025)

Model evaluation - domestic departures

Domestic departures		
Model	**MAPE**	**RMSE**
Naïve 2	**21.77%**	**2,362,891**
OLS	**6.66%**	**928,492**
Growth 1	**1.33%**	**178,088**
Growth 2	**4.69%**	**489,352**

- The Growth 1 model has the best forecasting performance (significant improvement over the OLS model), followed by the Growth 2 model

Domestic air departures by both NZ residents and foreigners (1)

Growth 1: DLn(Pax per capita) = 0.6869D(Ln(Adj TradePC)) - 0.4784D(LnRCPId) + 0.1798AirNZ + 0.010

Adj. R^2 = 0.83

Growth 2: DLn(Pax per capita) = 0.8243D(Ln(TradePC)) + 1.308D(LnGDPrPC, 2) - 0.3670D(LnRCPId) + 0.1977AirNZ + 0.007

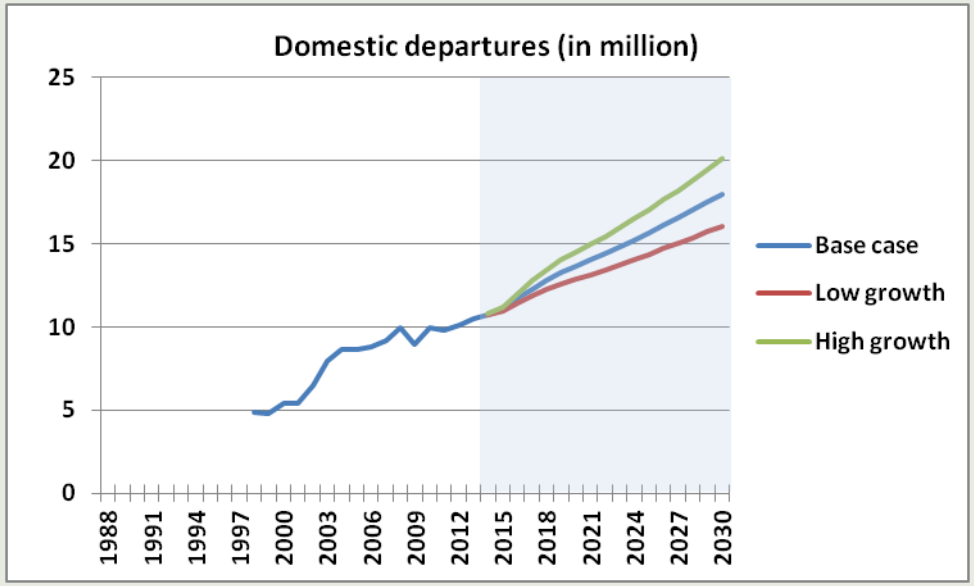
Adj. R^2 = 0.95

Growth 1 model	Actual	Estimated	Difference
2011	9,797,678	10,097,792	3.06%
2012	10,115,242	10,083,685	-0.31%
2013	10,522,709	10,586,596	0.61%

Growth 2 model	Actual	Estimated	Difference
2011	9,797,678	10,443,660	6.59%
2012	10,115,242	10,463,444	3.44%
2013	10,522,709	10,946,806	4.03%

Domestic air departures – forecasts using the Growth 1 model

- Include both NZ residents and foreign visitors who travel within NZ

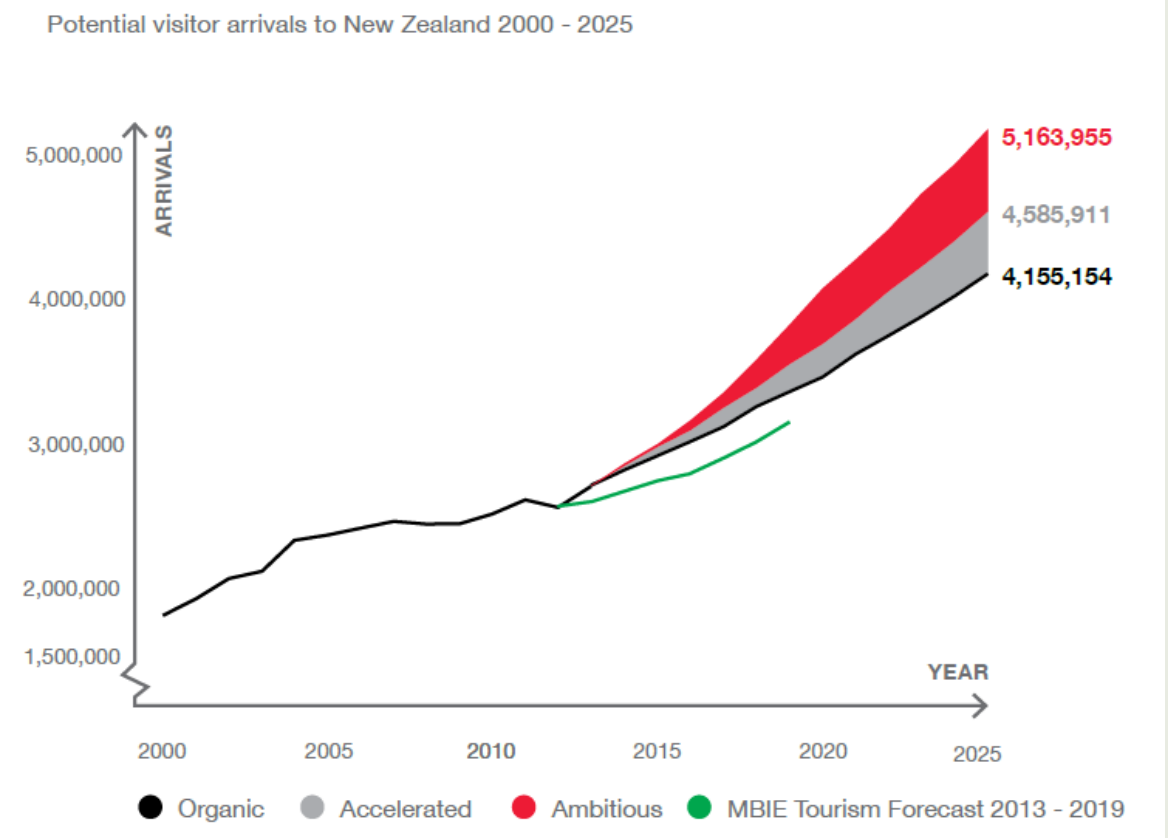


Forecast growth 2013 - 2030			
(Number in millions)	**Base case scenario**	**Low growth scenario**	**High growth scenario**
Departures in 2013	**10.5**		
Departures in 2030	**18.0**	**16.1**	**20.1**
Growth over 2013	**71%**	**53%**	**91%**
CAGR	**3.2%**	**2.5%**	**3.9%**

Note: CAGR refers to compound annual growth rate

Other relevant forecasts

- Auckland Airport forecasts: 3.6% – 5.5% growth p/a in foreign visitor arrivals to NZ (2013-2025)
- Tourism Research Australia forecasts: over 4% growth p/a in the next couple of years from NZ to Australia
- Wellington Airport forecasts: international passengers: 5.1% growth p/a; domestic passengers: 2.5% growth p/a (2015-2024)



Source: Auckland Airport, Ambition 2025

Sensitivity analysis – for RCPIi/RCPId

- International departures – for the Growth 2 model
  - Tested for RCPIi by ±50% changes: forecasts changed by ±0.2% to ±2.6% (increase over time)

- Domestic departures – for the Growth 1 model
  - Tested for RCPId by ±50% changes: forecasts changed by ±0.2% to ±2.4% (increase over time)

Summary

- These models are not associated with the spurious regression issue
- The models developed using advanced methods generally have a better forecasting performance than the conventional OLS models, especially for domestic departures
- Our forecasts are broadly consistent with some relevant forecasts from other sources
- Larger uncertainty is associated with the longer-term forecasts




Likely implications of the forecasts (1)

- On a per-capita basis, New Zealanders already fly more than the vast majority of people in other countries. The forecasts indicate that demand for air transport in New Zealand has not reached its peak, with steady growth in the foreseeable future
- Stronger growth in foreign visitor arrivals is forecasted by Auckland Airport than the forecast growth in international departures by NZ residents
- Airlines (especially Air NZ with respect to domestic operations) will likely meet the increased demand by increasing the size of aircrafts they use and the frequency of flights

Likely implications of the forecasts (2)

- Most airports have already taken account of a projected increase in demand when preparing their long-term master plans, but some larger regional airports may need to consider whether their runway, terminal, and other facilities are sufficient to cope with the expected increase in demand
- In the short to medium term, domestic air travel is expected to be focused through the three main hub airports: Auckland, Wellington and Christchurch
- Auckland Airport has the space to complete construction of a second runway and a new domestic terminal. Its share of air travel would increase over time
- The development of some regional airports may be constrained by physical space limits

Caveats/Limitations

- Variables on the supply side (e.g. available seats and routes) are not included. However, RCPIi and RCPId are closely related to supply
- Also depends on ‘good’ forecasts of the economic variables included
- Treasury’s forecasts on trade and exchange rates are only available until early 2018
- Can only forecast annual passenger departures at the national level