CLEAN SKY - TECHNOLOGY DIFFUSION MODELING FOR A BETTER UNDERSTANDING OF THE AIR TRANSPORTATION FUTURE

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Overview

Air transportation plays an important role in enabling global mobility. Between the year 1990 and 2014, global scheduled flights have increased by 80%, and this is forecasted to see a 45% further growth between 2014 and 2035. At the same time, flight emission of carbon dioxide is growing at the same rate while the nitrogen oxides emission doubled during the same time period and is predicted to grow by a further 43% until 2035 (EASA, 2016). As a result, air transportation exerts a significant effect on atmospheric climate change (Berntsen and Fuglestvedt, 2008). As a response to both increasing air traffic demand and environmental concerns, various new aircraft technological innovations are under way to ensure a sustainable growth in aviation. It is therefore paramount to study how past aircraft models are adopted and diffuse in the market, which would in turn advise the design and the market diffusion projection of newer aircraft models as well as the assessment of their potential emission impact. Our goal is to examine the historical diffusion process of fixed-winged aircraft into the world market. In addition, we aim to develop a model that allows a pre-launch prediction of new aircraft model diffusion.

Methods

We employ a two-stage approach combining Bass Model (Bass, 1969) specification, estimated by Non-linear Least Squares and regression analysis. We build upon previous studies on diffusion modeling as well as the more recent approach by Lee et al. (2014), and establish a model that depicts the relation between aircraft model characteristics and their respective diffusion patterns, which can then be applied to new aircraft models with known product level parameters in order to forecast their future market diffusion and air pollution emission implications.

Results

Preliminary analysis shows a significant difference between diffusion rates of various aircrafts. In addition, the range, by-pass ratio of the engine and entry-into-service date (EIS) have a high impact on the diffusion speed. More specifically, a higher bypass ratio is linked to faster adoption, whereas later EIS and longer range seem to suggest slower adoption. The exact cause of this development and its implications for sustainable aircraft technology design and adoption needs to be investigated further.

Conclusions

The results yield an improved understanding regarding how various aircraft models are adopted and, therefore, advise policy and other decision makers the design and development of newer and more sustainable aircraft technologies.

References

Bass, F. M. (1969). A new product growth model for consumer durables. *Management Science* 15(1), 215227.

Berntsen, T. and J. Fuglestvedt (2008). Global temperature responses to current emissions from the transport sector. *Proc. Natl. Acad. Sci. U. S. A.* 105, pp. 19154–19159.

EASA (2016). European Aviation Environmental Report

Lee, H. et al. (2014). Pre-launch new product demand forecasting using the Bass model: A statistical and machine learning-based approach. *Technological Forecasting and Social Change* 86, pp. 49–64.