Modeling Business Investment Attractiveness of Countries Using Time Series Approaches

Data Science Institute
COLUMBIA UNIVERSITY

**Authors: Di Mu(dm3686), Freddy Wong(ww2615),
Hanlin Yan(hy2654), Jace Yang (jy3174), Yuan Heng(yh3416)
Industry Mentor: Pramanik Paritosh**

Data Science Capstone Project
with Accenture

1. Topic Definition

Business investment is a major pillar of economic growth and an important corporate decision. Lots of econometric research is devoted to assess the investment attractiveness of an economy[1][2]. Our topic is to use a ML/DL time series techniques to turn it into a modeling pipeline in which we provide reliable insight.

2. Methods

To identify opportunities in structural transformation of sectors, we target Manufacturing and Service value added as a percentage of GDP of 9 countries, modeling it with indictors carefully selected from World Bank. 11 imputation techniques are experimented to deal with over 50% missingness, and 8 models are finally stacked to predict into future 5 years(2022-2026).
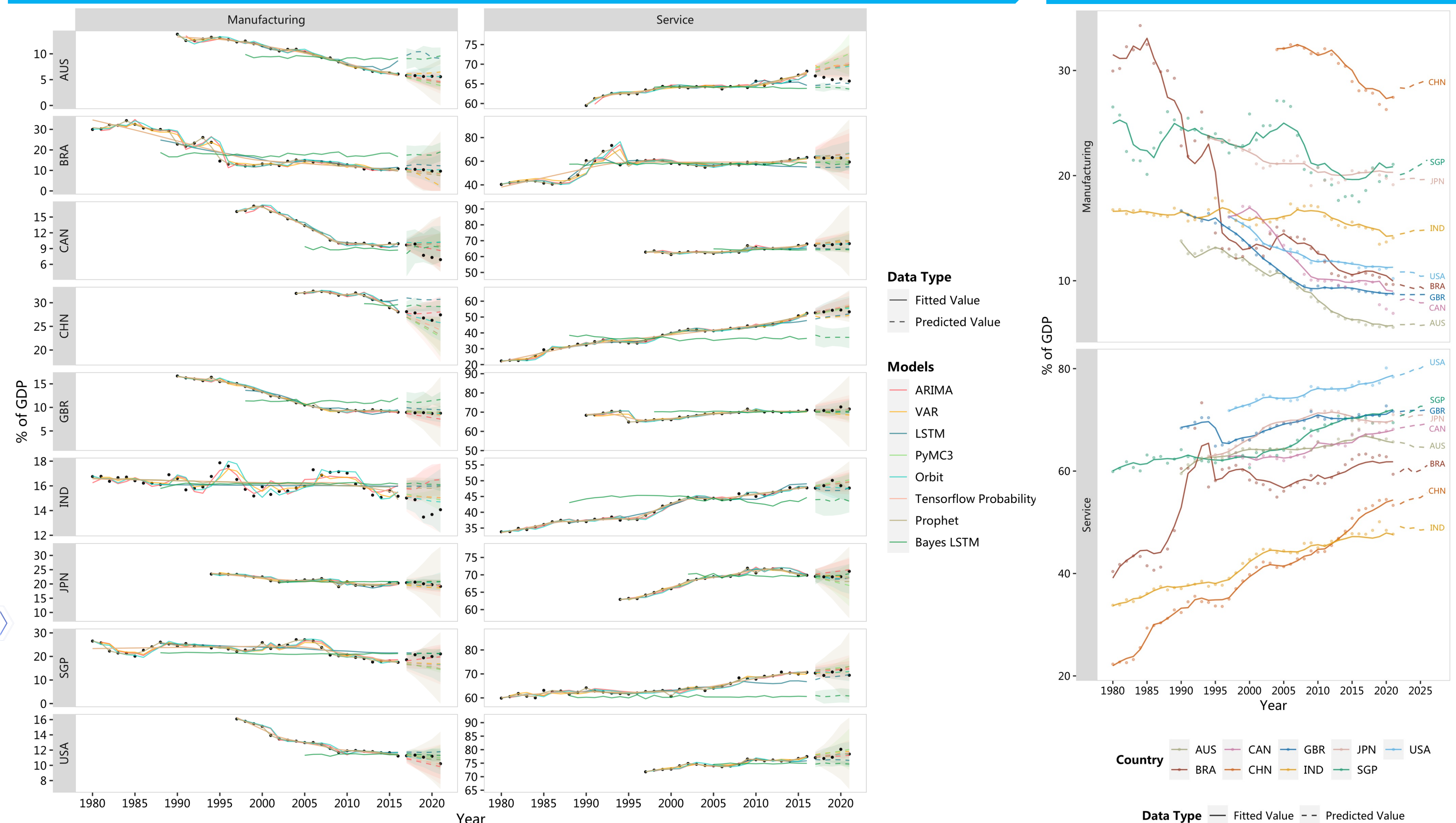

Figure 1. Model & Data pipelines and demo output for the project

3. Results

In the evaluation status, we found Orbit perform well in general in terms of MAPE. But it still vary from countries to countries and assessment metric.

Table 2. Average MAPE of all models in 2 tasks' test set (2017-2021)

Task	ARIMA	VAR	LSTM	PyMC3	Orbit	Tensorflow Probability	Prophet	Bayes LSTM
Manufacturing	0.075	0.225	0.138	0.114	0.062	0.088	0.118	0.170
Service	0.022	0.027	0.040	0.028	0.018	0.022	0.022	0.102

Inspired by Kurz, et al (2020)[3], we stack the model country-task-wisely weighted on their performance, which is equally defined by 1/MAPE, 1/MAE and 1/RMSE.

Table 3. Average weight considered by final stacked model (averaged across countries)

Task	ARIMA	VAR	LSTM	PyMC3	Orbit	Tensorflow Probability	Prophet	Bayes LSTM
Manufacturing	14.56%	10.68%	9.26%	12.23%	24.17%	12.73%	10.63%	9.30%
Service	13.40%	13.42%	10.19%	11.58%	17.29%	13.91%	13.54%	8.16%

4. Conclusions

In this project, we carefully examine toolkits for infrequent aggregated time series with severe missing value issue. Base on predictions on the countries we selected, Singapore is the best for service sector investment and China best for manufacturing in the future 5 years.

Table 4. Difference of % of GDP compared between 2021 and 2026(forecasted)

Task	CHN	SGP	USA	CAN	IND	BRA	JPN	GBR	AUS
Service	2.458	3.196	2.546	1.096	0.949	1.727	-0.026	0.327	-1.117
Manufacturing	1.653	0.407	0.254	1.013	0.773	-0.586	-0.511	-0.076	0.243

References

[1] Ilyash, Olha, et al. "Evaluation of enterprise investment attractiveness under circumstances of economic development." Bulletin of Geography. Socio-economic Series 47.47 (2020): 95-113.

[2] Bruneckiene, Jurgita, et al. "Assessment of investment attractiveness in European countries by artificial neural networks: What competences are needed to make a decision on collective well-being?." Sustainability 11.24 (2019): 6892.

[3] Kurz, Christoph F., Werner Maier, and Christian Rink. "A greedy stacking algorithm for model ensembling and domain weighting." BMC research notes 13.1 (2020): 1-6.