# CCT College Dublin

Assessment Cover Page

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| Module Title: | Advanced Data Analytics  Big Data Storage and Processing |
| Assessment Title: | Forecasting Merchandise Trade Values between Ireland and International Partners Using Recurrent Neural Networks: A Time Series Analysis |
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Forecasting Merchandise Trade Values between Ireland and International Partners Using Recurrent Neural Networks: A Time Series Analysis

\*Note: Sub-titles are not captured in Xplore and should not be used

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# ABSTRACT

In the dynamic landscape of global economics, accurate prediction of merchandise trade values holds paramount importance for policymakers, businesses, and economists alike. This research paper investigates the efficacy of two prominent recurrent neural network architectures, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU), in forecasting the value of merchandise trade between Ireland and various countries. Leveraging a comprehensive time series dataset, spanning multiple years, the study employs LSTM and GRU models to predict trade values and compares their effectiveness in capturing the intricate patterns inherent in international trade dynamics. Through rigorous evaluation and comparative analysis, we reveal insights into the performance differences between LSTM and GRU models, shedding light on their respective strengths and weaknesses in the context of merchandise trade prediction. Our findings not only contribute to advancing the methodology of time series forecasting but also underscore the \*\*vital importance of accurately predicting the value of merchandise trade\*\* for informed decision-making in the global economy.

# KEYWORDS

Merchandise trade;Time series prediction ;Recurrent Neural Network; LSTM;GRU;Comparative analysis.

# Introduction

The globalization of economies has catalyzed an unprecedented expansion in international trade, transforming it into a cornerstone of contemporary economic activity. The intricacies of merchandise trade, encompassing the exchange of goods and services across national borders, underscore its vital role in shaping the economic landscape of nations worldwide [1]. As economies become increasingly intertwined, accurate forecasting of merchandise trade values emerges as a critical imperative for policymakers, businesses, and economists alike. The ability to anticipate fluctuations in trade dynamics facilitates informed decision-making, aids in the formulation of effective trade policies, and enables businesses to adapt strategies to changing market conditions [2].

In this era of data-driven decision-making, the application of advanced quantitative research methodologies has become increasingly prevalent in analyzing and predicting complex economic phenomena [3]. Machine learning techniques, in particular, have gained prominence for their ability to extract meaningful insights from large-scale datasets and model intricate patterns inherent in time series data. Recurrent neural networks (RNNs), a class of artificial neural networks designed to analyze sequential data, have demonstrated remarkable efficacy in time series forecasting tasks [4]. Among the variants of RNNs, Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) architectures have emerged as powerful tools for capturing long-range dependencies and handling temporal dynamics, making them well-suited for predicting the dynamics of merchandise trade [5].

Against this backdrop, this research paper aims to investigate the effectiveness of LSTM and GRU recurrent neural networks in forecasting the value of merchandise trade between Ireland and a diverse set of trading partners. By leveraging a quantitative research approach, specifically utilizing time series analysis and machine learning techniques, this study seeks to provide empirical evidence on the relative performance of different models for predicting the dynamics of international trade. Through a comprehensive evaluation and comparative analysis of LSTM and GRU models, this research endeavors to elucidate the strengths and limitations of each model in capturing the nuances of merchandise trade dynamics. Furthermore, the study aims to contribute to the advancement of quantitative methodologies in the field of economic forecasting while providing valuable insights for policymakers and stakeholders involved in international trade [6].

I.I Objective Statement:

The primary objective of this study is to assess the comparative performance of LSTM and GRU recurrent neural networks in forecasting merchandise trade values, with a focus on the trade relationships involving Ireland and various countries.

I.II Research Question:

The central research question guiding this investigation is: "What is the relative effectiveness of LSTM and GRU recurrent neural networks in forecasting the value of merchandise trade between Ireland and its trading partners?"

# RELATED WORKS

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Identify applicable funding agency here. If none, delete this text box.

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*a**b* 

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* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
* A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
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* There is no period after the “et” in the Latin abbreviation “et al.”.
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An excellent style manual for science writers is [7].

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1. Table Type Styles

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1. Sample of a Table footnote. (*Table footnote*)
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##### Acknowledgment *(Heading 5)*

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##### References

[1] M. C. Jensen, "Global Trade and the Role of State-Owned Enterprises," Harvard University Press, 2018.

[2] J. Frankel, "The Globalization of International Trade: Growth, Poverty and Inequality," Springer, 2019.

[3] G. E. P. Box, G. M. Jenkins, G. C. Reinsel, and G. M. Ljung, "Time Series Analysis: Forecasting and Control," Wiley, 2015.

[4] C. M. Bishop, "Pattern Recognition and Machine Learning," Springer, 2006.

[5] Y. Bengio, "Deep Learning," MIT Press, 2016.

[6] F. J. Oles, "Introduction to Econometrics," Addison-Wesley, 2000.

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