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Statistical Analysis of Foreign Investment Using Neutrosophic Interval Based Approach

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Abstract

Pakistan, a nation at the crossroads of South Asia, has been actively striving to attract foreign investment to boost its economic growth and development. As a country rich in natural resources, with a young and vibrant workforce, and a strategic geographic location, Pakistan offers significant opportunities for foreign investors seeking to explore new markets and tap into its potential. The foreign investment policies in Pakistan have undergone substantial reforms over the years to create a more investor-friendly environment. These policies are designed to facilitate and incentivize foreign direct investment while ensuring the protection of investors' rights and contributing to the overall economic progress of the country. The government of Pakistan, recognizing the critical role of foreign investment in driving economic transformation, has implemented various initiatives and measures to attract investors from around the world. The purpose of this study was to investigate the use of Neutrosophic Analysis during Statistical Analysis of Foreign Investment using Imprecise Information, and this approach provides remarkable results. The neutrosophic approach has provided a comprehensive understanding of the various perspectives and uncertainties involved in foreign investment strategies. This study's results demonstrated that this Interval-Based Approach may be used for better understanding instead of the classical approach.

Keywords: Foreign Investment; Imprecise Information; Neutrosophic Approach; Statistical Analysis

1. Introduction

The policy of the host country plays an important role and influences foreign investment; host nations may implement measures to encourage international investment or may impose various restrictions on foreign engagement in their economies[1]. The amount of investment by these corporations is influenced by the political statements of host countries. In addition, policies of the host country can direct investors to invest in those areas that are thought to be particularly crucial for the development of the nation[2]. Globalization has made the world a small, interconnected community, and emerging nations are working to adapt foreign investment policies[3]. They constantly work to entice foreign investment inflow into their economy in order to overcome the shortage of technology and cash. Both the investor and the invested party take advantage of the foreign investment in their country. The ability to withdraw skill resources from the host nation is made possible by the local market[4]. As compared to local investment in the country, foreign direct investment helped its contribution to financial growth by creating employment possibilities for local people. Foreign direct investment flows are crucial for both emerging and developed countries. Because capital is scarce in emerging countries, the peripheral productivity of capital is higher. Investors in the industrialized world, on the other hand, are looking for substantial returns on their money; there is an advantage to both parties when capital moves internationally[5].

In Pakistan, over the past ten years, foreign direct investment has grown at a rate that is at least twice as fast as trade; the government's top priority is to increase foreign direct investment[6]. Pakistan is a desirable location for international investment due to its geographical location. With a population of more than 241 million, Pakistan offers a sizable market for consumer goods as well as a developing middle class with sufficient purchasing power, access to cheap labor to lower production costs, and a strategic location in South Asia[7]. Pakistan is a rich country due to its geographical location but lack of resource management. Now Pakistan makes favorable policies to encourage foreign direct investment. Investment is typically focused on industries, which leads to the development of the economy and increases productivity. Foreign investment is a combination of finance, technological management, and market access; as investors earn profit they frequently reinvest their earnings rather than sending them elsewhere. Another advantage of

foreign investment is boosting confidence. Foreign investment inflows increase domestic investment confidence, which could lead to positive feedback on both domestic and foreign investment as well as international commerce and output[8]. The impact of foreign investment on the host nation's balance payments has ramifications. Foreign direct investment in developing countries helps to make their economy strong. Every field of the state grows up with the help of FDI. The state makes such policies that attract foreign investment so that they invest in every field and the state is responsible for facilitating the FDI investor[9].

The focus of this study was to investigate the use of Neutrosophic Analysis during Statistical Analysis of Foreign Investment using Imprecise Information. This study will provide a deep insight into the;

- Use of Neutrosophic Approach for Interval-Based Data Sets of Foreign Investment in Pakistan
- Comparison of Classical and Neutrosophic Approaches Used for Statistical Analysis of Foreign Investment
- To provide Methodological Innovation for Decision-Making under Uncertainty for Statistical Analysis

2. Prior Investigation

Foreign investment policies play a crucial role in shaping a country's economic development and attracting foreign capital[10]. In the case of Pakistan, there has been significant academic research and prior investigation exploring various aspects of foreign investment policies and their implications.

A common theme in the literature is the importance of liberalization and policy reforms to attract foreign investment[11]. Pakistan has undertaken several reforms to create a more favorable investment climate, such as the establishment of Special Economic Zones (SEZs), deregulation, and simplification of investment procedures. Pakistan also has taken steps to liberalize its economy and create a more open investment climate[12]. The country has implemented policies to facilitate foreign investment, reduce bureaucratic hurdles, and simplify investment procedures. These measures aim to encourage foreign investors to enter various sectors of the economy. Research emphasizes the role of investment incentives in attracting foreign capital. These incentives include

tax breaks, exemptions, repatriation of profits, and protection against expropriation. Pakistan offers a range of investment incentives to attract foreign capital. These incentives include tax exemptions, repatriation of profits and dividends, and remittance of capital. In certain sectors or regions, additional incentives may be provided, such as reduced customs duties or land allocation. Pakistan has established Special Economic Zones to provide a conducive environment for foreign investment. These zones offer various benefits to investors, including tax incentives, streamlined regulations, and infrastructure support[13]. The government has identified several priority sectors for investment within these zones, such as manufacturing, information technology, and export-oriented industries. To attract foreign investment in strategic sectors, Pakistan has established sector-specific policies. These policies aim to encourage investment in areas such as energy, infrastructure development, telecommunications, agriculture, and tourism[14]. The government has also implemented changes to make doing business in industries easier. The focus is on evaluating the impact of these policies on investment inflows, technology transfer, employment generation, and overall scrotal development. The institutional framework and governance structures also receive attention in the literature. Scholars assess the efficiency and effectiveness of institutions responsible for implementing foreign investment policies in Pakistan. They analyze issues related to bureaucratic procedures, legal framework, corruption[15], and transparency, which can affect investor confidence[16]. Pakistan has entered bilateral investment treaties with multiple countries to encourage and safeguard foreign investment. These agreements offer legal protection to foreign investors, encompassing provisions related to dispute resolution and compensation in the event of expropriation[17]. Ensuring effective intellectual property rights protection is crucial for attracting foreign investment. Pakistan has made efforts to strengthen its intellectual property regime and align it with international standards. The government has taken steps to enhance enforcement mechanisms and raise awareness about the importance of intellectual property rights[18]. Pakistan has been working to improve investor protection mechanisms. The country has established the Securities and Exchange Commission of Pakistan (SECP) to regulate the capital market and protect investor interests[19]. Efforts have also been made to strengthen corporate governance practices and enhance transparency in business operations.

3. Contradictory and Incomplete Information

The nature of foreign investment data often involves contradictory or incomplete information. Neutrosophic Theory allows for the consideration of these contradictions within its logical framework, providing a more comprehensive analysis compared to traditional methods.

3.1 Theoretical justification

Neutrosophic Theory is the most suitable theoretical framework for this it aligns well with the document's objectives of analyzing foreign investment data under conditions of uncertainty, imprecision, and indeterminacy. Its ability to handle interval-based data and contradictory information makes it a superior choice for this specific analysis[20].

3.2 Handling Uncertainty and Imprecision

The study deals with the analysis of foreign investment data that is inherently uncertain and imprecise. Neutrosophic Theory is designed to handle such conditions by allowing for the inclusion of indeterminate, true, and false values simultaneously. This flexibility is crucial in analyzing complex, real-world data where traditional binary logic might fall short.

3.3 Interval-Based Analysis

The study employs interval-based data analysis, where each data point is represented as an interval rather than a single value. Neutrosophic Theory excels in this area by providing a framework that can accommodate the vagueness and uncertainty inherent in interval data, making it a more suitable approach than classical statistical methods.

3.4 Decision-Making under Uncertainty

The study emphasizes making informed decisions in the face of uncertainties, such as foreign investment strategies in Pakistan. Neutrosophic Theory supports decision-making in such uncertain environments by offering a more nuanced and adaptable analytical framework. Following fig. 1 represents conceptual framework of this study;

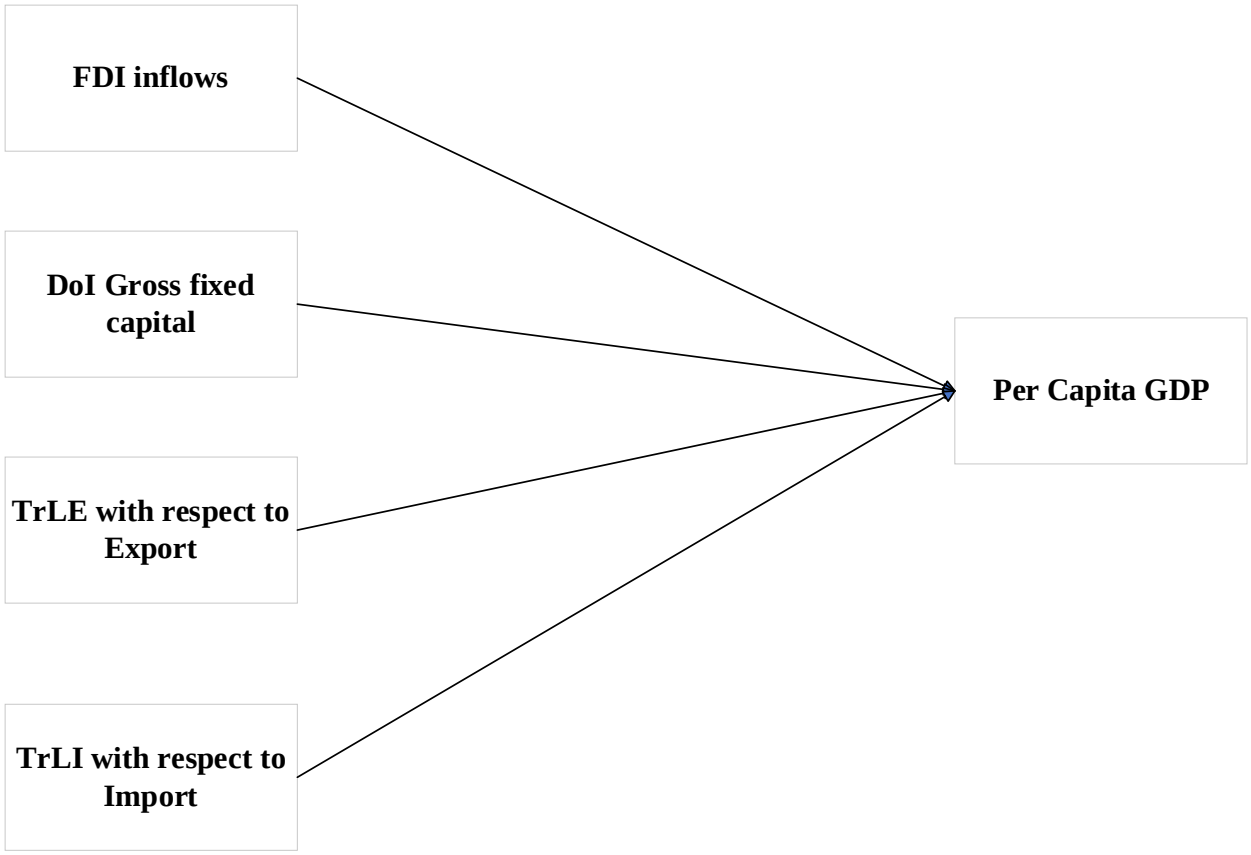

Fig 1: Conceptual Framework

4. Methodology and Analysis

This research explores the correlation between financial growth in Pakistan and foreign direct investment (FDI), offering more up-to-date analysis than previous research. The study utilizes annual data covering the period from 2013 to 2023 to explore the co-integration, or link, between domestic product and foreign direct investment. While monthly or quarterly data would have provided more observations, such data is not widely available for most variables in this study. In this study, the focus lies on the dependent variable, which is the economic output; FDI (Foreign Direct Investment), DoI (Domestic Investment), and TrL (Trade Liberalization) are among the independent variables, represented by imports and exports combined. The data used for analysis is sourced from the *World Bank* Development Indicators.

4.1 Classical Data Analysis

This study investigates the correlation between financial growth (Y) and the variables of FDI, DoI, and TrL; to examine the relationship between economic development and Foreign Direct

Investmen. The following table 1 shows a detail list of variables used to complete this study along with their classical data analysis;

Sr #	Details of Variable	Mean	Median	Mode	Standard dev.
01	Dependent Variable = Per Capita GDP of Pakistan	1444.9	1437.2	1669.6	120.3
02	Independent Variable = FDI inflows with respect to annual percentage of GDP	0.58	0.60	0.50	0.24
03	Independent Variable = DoI Gross fixed capital formation percentage of GDP	14.05	15.4	15.4	4.69
04	Independent Variable = TrLE with respect to Export	2.04	-1.30	-11.10	10.79
05	Independent Variable = TrLI with respect to Import	6.39	2.50	-28.90	16.91

Table 1: Classical Data Analysis of Variables

4.2 Neutrosophic Analysis

The neutrosophic method provides a framework to analyze and reason with incomplete, uncertain, or contradictory information[21]. In many real-world scenarios, especially in domains like decision-making, risk assessment, and expert systems, uncertainties and contradictions are prevalent. The neutrosophic method helps in better understanding and representing such complex situations[22].

Sr#	Year	Interval	Neutrosophic Analysis
1	2013	[1236.9, 1259.6]	$1236.9 + 1259.6\ I_G$; $I_G \epsilon [0, 0.018]$
2	2014	[1259.6,1303.2]	$1259.6 + 1303.2\ I_G$; $I_G \epsilon [0, 0.033]$
3	2015	[1302.2,1421.9]	$1303.2 + 1421.9\ I_G$; $I_G \epsilon [0, 0.083]$
4	2016	[1421.9,1468.9]	$1421.9 + 1468.9\ I_G$; $I_G \epsilon [0, 0.031]$
5	2017	[1468.9,1567.7]	$1468.9 + 1567.7\ I_G$; $I_G \epsilon [0, 0.063]$
6	2018	[1567.7,1620.8]	$1567.7 + 1620.8\ I_G$; $I_G \epsilon [0, 0.032]$
7	2019	[1620.8,1437.2]	$1620.8 + 1437.2\ I_G$; $I_G \epsilon [0, -0.127]$
8	2020	[1437.2,1324.1]	$1437.2 + 1324.1\ I_G$; $I_G \epsilon [0, -0.085]$
9	2021	[1324.1,1507.9]	$1324.1 + 1507.9 I_G$; $I_G \epsilon [0, 0.121]$
10	2022	[1507.9,1592.1]	$1507.9 + 1592.1 I_G$; $I_G \epsilon [0, 0.052]$
11	2023	[1592.1,1390.8]	$1592.1 + 1390.8 I_G$; $I_G \epsilon [0, -0.144]$

Table 2: Per Capita GDP of Pakistan

Table 2 is highlighting the neutrosophic analysis of Per Capita GDP of Pakistan. Neutrosophic formula provides a flexible equation for each interval with indeterminacy interval. In 2013 the maximum value of interval is 1259.6 and the minimum value is 1236.9.

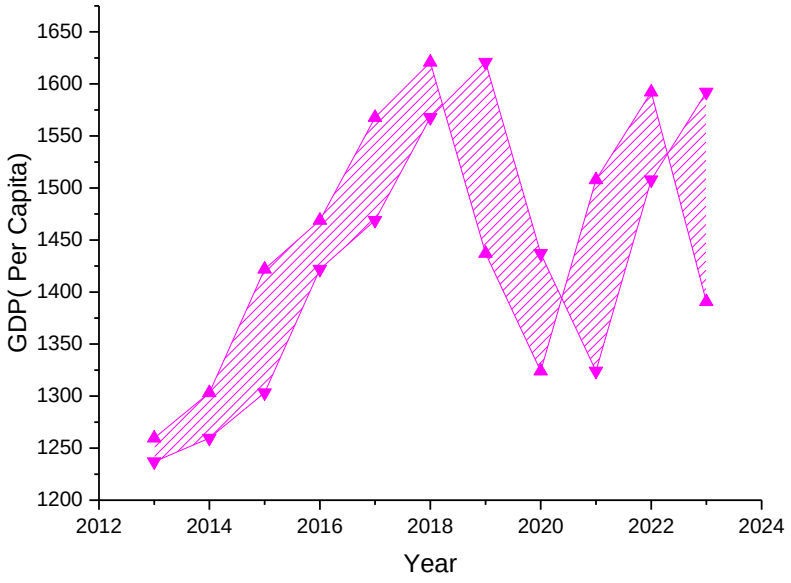

Fig 2: Graphical Representation of Per Capita GDP of Pakistan

The neutrosophic Graphical Representation of Per Capita GDP of Pakistan is shown in fig 2. The value lies between 1259.6 and 1303.2 in the year 2014, which was calculated through the neutrosophic formula by putting value from its undetermined interval.

Sr#	Year	Interval	Neutrosophic Analysis
1	2013	[0.3,0.5]	$0.3+ 0.5I_F$; $I_F \epsilon [0, 0.4]$
2	2014	[0.5,0.6]	$0.5+ 0.6I_F$; $I_F \epsilon [0, 0.166]$
3	2015	[0.6,0.3]	$0.6+ 0.3I_F$; $I_F \epsilon [0, -1]$
4	2016	[0.3,0.8]	$0.3+ 0.8I_F$; $I_F \epsilon [0, 0.625]$
5	2017	[0.8,0.7]	$0.8+ 0.7I_F$; $I_F \epsilon [0, -0.142]$
6	2018	[0.7,0.8]	$0.7+ 0.8I_F$; $I_F \epsilon [0, 0.125]$
7	2019	[0.8,0.9]	$0.8+ 0.9I_F$; $I_F \epsilon [0, 0.111]$
8	2020	[0.9,0.7]	$0.9+ 0.7I_F$; $I_F \epsilon [0, -0.285]$
9	2021	[0.7,0.5]	$0.7+ 0.5I_F$; $I_F \epsilon [0, -0.4]$
10	2022	[0.5,0.5]	$0.5+ 0.5I_F$; $I_F \epsilon [0, 0]$
11	2023	[0.5,0.1]	$0.5+ 0.1I_F$; $I_F \epsilon [0, -4]$

Table 3: FDI inflows with respect to annual percentage of GDP

Table 3 is highlighting the neutrosophic analysis of FDI inflows with respect to annual percentage of GDP. Neutrosophic formula provides a flexible equation for each interval with indeterminacy interval. In 2016 the maximum value of interval is 0.8 and the minimum value is 0.3.

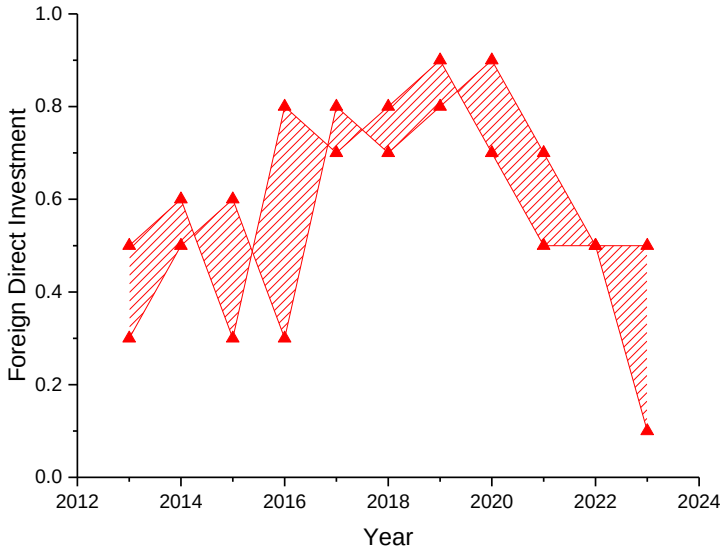

Fig 3: Graphical representation of FDI inflows with respect to annual percentage of GDP

The neutrosophic Graphical Representation of FDI inflows with respect to annual percentage of GDP are shown in fig 3. The value lies between 0.8 and 0.7 in the year 2017; that was calculated through the neutrosophic formula by putting value from its undetermined interval.

Sr#	Year	Interval	Neutrosophic Analysis
1	2013	[16.9,16.1]	16.9+ 16.1I_D; $I_D\epsilon$[0, -0.049]
2	2014	[16.1,15.6]	16.1+ 15.6I_D; $I_D\epsilon$[0, -0.032]
3	2015	[15.6,15.4]	15.6+ 15.4I_D; $I_D\epsilon$[0, -0.012]
4	2016	[15.4,14.7]	15.4+ 14.7I_D; $I_D\epsilon$[0, -0.047]
5	2017	[14.7,15.3]	14.7+ 15.3I_D; $I_D\epsilon$[0, 0.039]
6	2018	[15.3,16.6]	15.3+ 16.6I_D; $I_D\epsilon$[0, 0.078]
7	2019	[16.6,15.7]	16.6+ 15.7I_D; $I_D\epsilon$[0, -0.057]
8	2020	[15.7,15]	15.7+ 15I_D; $I_D\epsilon$[0, -0.046]
9	2021	[15,15.4]	15+ 15.4I_D; $I_D\epsilon$[0, 0.025]
10	2022	[15.4,14.8]	15.4+ 14.8I_D; $I_D\epsilon$[0, -0.040]
11	2023	[14.8,0]	14.8+ 0 I_D; $I_D\epsilon$[0, 0]

Table 4: Domestic Investment Gross fixed capital formation percentage of GDP (private sectors)

Table 4 is highlighting the neutrosophic analysis of Domestic Investment Gross fixed capital formation percentage of GDP (private sectors). In 2014 the maximum value of interval is 15.6 and the minimum value is 16.1.

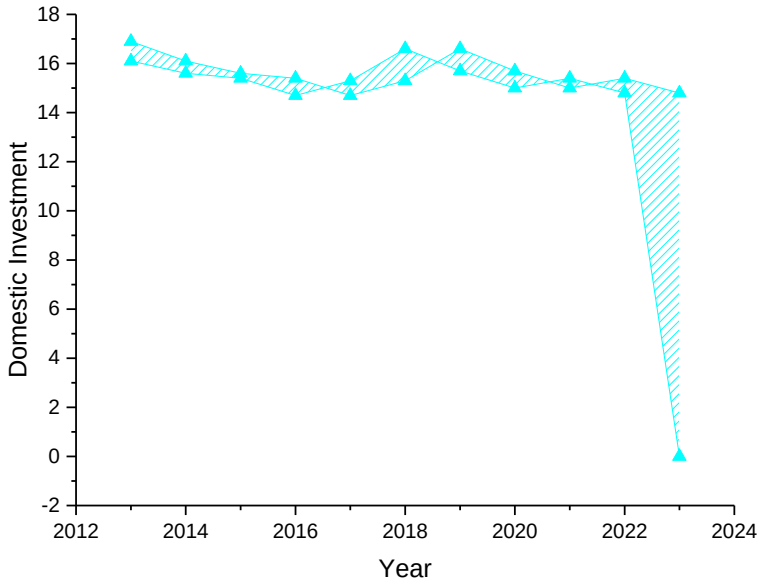

Fig 4: Graphical representation of DoI Gross fixed capital formation percentage of GDP

The neutrosophic Graphical Representation of DoI Gross fixed capital formation percentage of GDP are shown in fig 4. The value lies between 15.3 and 16.6 in the year 2018, which was calculated through the neutrosophic formula by putting value from its undetermined interval.

Sr#	Year	Interval	Neutrosophic Analysis
1	2013	[-4.4,6]	-4.4+ 6I_{TE}; $I_{TE}\epsilon$[0, 1.733]
2	2014	[6,-3.5]	6 -3.5I_{TE}; $I_{TE}\epsilon$[0, 2.714]
3	2015	[-3,5,-1.5]	-3.5- 1.5I_{TE}; $I_{TE}\epsilon$[0, -1.333]
4	2016	[-1.5,-8.5]	-1.5- 8.5I_{TE}; $I_{TE}\epsilon$[0, 0.823]
5	2017	[-8.5,1.8]	-8.5+ 1.8I_{TE}; $I_{TE}\epsilon$[0, 5.722]
6	2018	[1.8,9.7]	1.8+ 9.7I_{TE}; $I_{TE}\epsilon$[0, 0.814]
7	2019	[9.7,-1.3]	9.7-1.3I_{TE}; $I_{TE}\epsilon$[0, 8.461]
8	2020	[-1.3,-7.4]	-1.3-7.4I_{TE}; $I_{TE}\epsilon$[0, 0.824]
9	2021	[-7.4,12.9]	-7.4+12.96I_{TE}; $I_{TE}\epsilon$[0, 1.573]
10	2022	[12.9,25.4]	12.9+ 25.4I_{TE}; $I_{TE}\epsilon$[0, 0.492]
11	2023	[25.4,-11.1]	25.4- 11.1I_{TE}; $I_{TE}\epsilon$[0, 3.288]

Table 5: Trade Liberalization with respect to Export

Table 5 is highlighting the neutrosophic analysis of Trade Liberalization with respect to Export. In 2021 the maximum value of interval is 12.9 and the minimum value is -7.4.

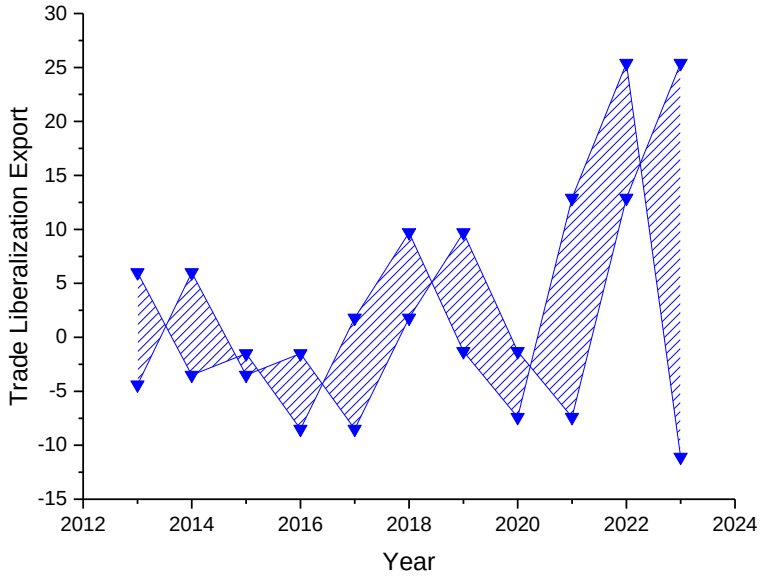

Fig 5: Graphical Analysis of Trade Liberalization with respect to Export

The neutrosophic Graphical Representation of Trade Liberalization with respect to Export are shown in fig 5. The value lies between 9.7 and -1.3 in the year 2019, which was calculated through the neutrosophic formula by putting value from its undetermined interval.

Sr#	Year	Interval	Neutrosophic Analysis
1	2013	[11.7,-0.5]	11.7 -0.5I_{TI}; $I_{TI}\epsilon$[0, 24.4]
2	2014	[-0.5,2.5]	-0.5 +2.5I_{TI}; $I_{TI}\epsilon$[0, 1.2]
3	2015	[2.5,1.1]	2.5+1.1 I_{TI}; $I_{TI}\epsilon$[0, -1.272]
4	2016	[1.1-0.2]	1.1 -0.2I_{TI}; $I_{TI}\epsilon$[0, 6.5]
5	2017	[-0.2,16.9]	-0.2 +16.9I_{TI}; $I_{TI}\epsilon$[0, 1.011]
6	2018	[16.9,16]	16.9 +16I_{TI}; $I_{TI}\epsilon$[0, -0.056]
7	2019	[16,-7.6]	16 -7.6I_{TI}; $I_{TI}\epsilon$[0, 3.105]
8	2020	[-7.6,16.6]	-7.6 +16.6I_{TI}; $I_{TI}\epsilon$[0, 1.457]
9	2021	[16.6,19.7]	16.6 +19.7I_{TI}; $I_{TI}\epsilon$[0, 0.157]
10	2022	[19.7,34.7]	19.7 +34.7I_{TI}; $I_{TI}\epsilon$[0, 0.4322]
11	2023	[34.7,-28.9	34.7 -28.9I_{TI}; $I_{TI}\epsilon$[0, 2.200]

Table 6: Trade Liberalization with respect to Import

Table 6 is highlighting the neutrosophic analysis of Trade Liberalization with respect to Import. In 2017 the maximum value of interval is 16.9 and the minimum value is -0.2.

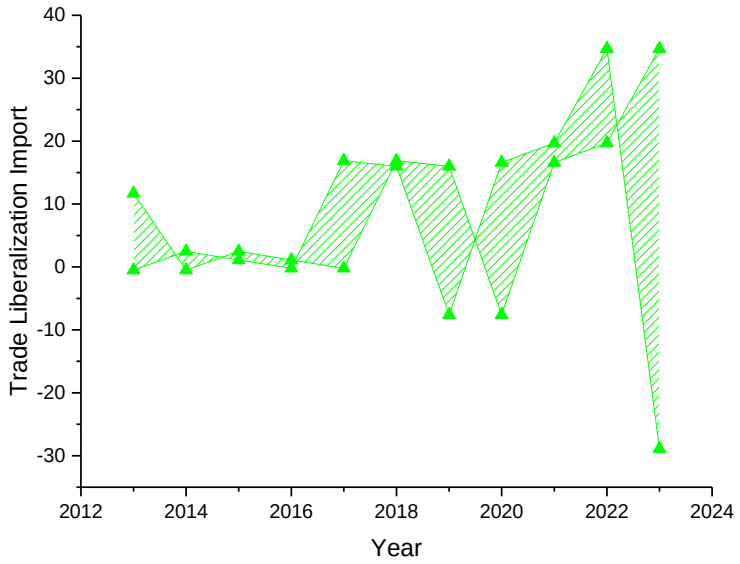

Fig 6: Graphical Representation of Trade Liberalization with respect to Import

The neutrosophic Graphical Representation of Trade Liberalization with respect to Import are shown in fig 6. The value of neutrosophic lies between -7.6 and 16.6 in the year 2020, which was calculated through the neutrosophic formula by putting value from its undetermined interval. The below mentioned table 7 shows the neutrosophic analysis of all variables sleeted to complete this study.

Sr#	Year	Var_1	Var_2	Var_3	Var_4	Var_5
1	2013	1236.9 + 1259.6 I_G; $I_G\epsilon$[0, 0.018]	0.3+ 0.5I_F; $I_F\epsilon$[0, 0.4]	16.9+ 16.1I_D; $I_D\epsilon$[0, -0.049]	-4.4+ 6I_{TE}; $I_{TE}\epsilon$[0, 1.733]	11.7 -0.5I_{TI}; $I_{TI}\epsilon$[0, 24.4]
2	2014	1259.6 + 1303.2 I_G; $I_G\epsilon$[0, 0.033]	0.5+ 0.6I_F; $I_F\epsilon$[0, 0.166]	16.1+ 15.6I_D; $I_D\epsilon$[0, -0.032]	6 -3.5I_{TE}; $I_{TE}\epsilon$[0, 2.714]	-0.5 +2.5I_{TI}; $I_{TI}\epsilon$[0, 1.2]
3	2015	1303.2 + 1421.9 I_G; $I_G\epsilon$[0, 0.083]	0.6+ 0.3I_F; $I_F\epsilon$[0, -1]	15.6+ 15.4I_D; $I_D\epsilon$[0, -0.012]	-3.5- 1.5I_{TE}; $I_{TE}\epsilon$[0, -1.333]	2.5+1.1 I_{TI}; $I_{TI}\epsilon$[0, -1.272]
4	2016	1421.9 + 1468.9 I_G; $I_G\epsilon$[0, 0.031]	0.3+ 0.8I_F; $I_F\epsilon$[0, 0.625]	15.4+ 14.7I_D; $I_D\epsilon$[0, -0.047]	-1.5- 8.5I_{TE}; $I_{TE}\epsilon$[0, 0.823]	1.1 -0.2I_{TI}; $I_{TI}\epsilon$[0, 6.5]
5	2017	1468.9 + 1567.7 I_G; $I_G\epsilon$[0, 0.063]	0.8+ 0.7I_F; $I_F\epsilon$[0, -0.142]	14.7+ 15.3I_D; $I_D\epsilon$[0, 0.039]	-8.5+ 1.8I_{TE}; $I_{TE}\epsilon$[0, 5.722]	-0.2 +16.9I_{TI}; $I_{TI}\epsilon$[0, 1.011]
6	2018	1567.7 + 1620.8 I_G; $I_G\epsilon$[0, 0.032]	0.7+ 0.8I_F; $I_F\epsilon$[0, 0.125]	15.3+ 16.6I_D; $I_D\epsilon$[0, 0.078]	1.8+ 9.7I_{TE}; $I_{TE}\epsilon$[0, 0.814]	16.9 +16I_{TI}; $I_{TI}\epsilon$[0, -0.056]
7	2019	1620.8 + 1437.2 I_G; $I_G\epsilon$[0, -0.127]	0.8+ 0.9I_F; $I_F\epsilon$[0, 0.111]	16.6+ 15.7I_D; $I_D\epsilon$[0, -0.057]	9.7-1.3I_{TE}; $I_{TE}\epsilon$[0, 8.461]	16 -7.6I_{TI}; $I_{TI}\epsilon$[0, 3.105]
8	2020	1437.2 + 1324.1 I_G; $I_G\epsilon$[0, -0.085]	0.9+ 0.7I_F; $I_F\epsilon$[0, -0.285]	15.7+ 15I_D; $I_D\epsilon$[0, -0.046]	-1.3-7.4I_{TE}; $I_{TE}\epsilon$[0, 0.824]	-7.6 +16.6I_{TI}; $I_{TI}\epsilon$[0, 1.457]
9	2021	1324.1 + 1507.9I_G; $I_G\epsilon$[0, 0.121]	0.7+ 0.5I_F; $I_F\epsilon$[0, -0.4]	15+ 15.4I_D; $I_D\epsilon$[0, 0.025]	-7.4+12.96I_{TE}; $I_{TE}\epsilon$[0, 1.573]	16.6 +19.7I_{TI}; $I_{TI}\epsilon$[0, 0.157]

10	2022	1507.9+ 1592.1I_G; $I_G\epsilon$[0, 0.052]	0.5+ 0.5I_F; $I_F\epsilon$[0, 0]	15.4+ 14.8I_D; $I_D\epsilon$[0, -0.040]	12.9+ 25.4I_{TE}; $I_{TE}\epsilon$[0, 0.492]	19.7 +34.7I_{TI}; $I_{TI}\epsilon$[0, 0.4322]
11	2023	1592.1+ 1390.8I_G; $I_G\epsilon$[0, -0.144]	0.5+ 0.1I_F; $I_F\epsilon$[0, -4]	14.8+ 0 I_D; $I_D\epsilon$[0, 0]	25.4- 11.1I_{TE}; $I_{TE}\epsilon$[0, 3.288]	34.7 -28.9I_{TI}; $I_{TI}\epsilon$[0, 2.200]

Table 7: Neutrosophic Analysis of all variables

5. Comparison of Classical and Neutrosophic Analysis

It is clear from the above mentioned analysis of data that unlike the classical method, the neutrosophic method allows for more nuanced reasoning. The neutrosophic method is designed to handle incomplete or partial data, where classical approaches may struggle[23]. It provides a means to deal with missing or imprecise information and can be useful in situations where limited or uncertain data is available for analysis. This flexibility allows the neutrosophic method to adapt to various scenarios where classical approaches may be too rigid or insufficient. It offers tools and techniques that can be tailored to address specific requirements and complexities[24]; this approach is best suited for interval-based data analysis. The neutrosophic approach offers several advantages over the classical approach when it comes to dealing with uncertainty and decision-making.

5.1 Handling Ambiguity and Vagueness

One of the key advantages of the neutrosophic approach is its ability to handle ambiguity and vagueness effectively. Traditional decision-making frameworks like the classical approach struggle with imprecise, incomplete, or contradictory information. Neutrosophic logic allows decision-makers to explicitly represent and reason with uncertainty, unknowns, and contradictions. This enables a more comprehensive analysis of complex problems where information is not clear-cut.

5.2 Flexibility in Decision-Making

In contrast to the rigid and deterministic nature of the classical approach, the neutrosophic approach offers greater flexibility in decision-making. Decision-makers can account for various levels of certainty, uncertainty, and indeterminacy when evaluating alternatives. This flexibility allows for a more nuanced consideration of trade-offs, conflicting objectives, and diverse perspectives, leading to more informed and adaptive decisions. Neutrosophic logic embraces contradictions and paradoxes as inherent aspects of complex systems. This is in stark contrast to the classical approach, which typically assumes that contradictions are unacceptable. By

acknowledging the presence of contradictions and evaluating truth values as true, false, and indeterminate, the neutrosophic approach enables decision-makers to grapple with conflicting information and make more robust decisions in scenarios where contradictory data is prevalent.

5.3 Tackling Uncertainty

Uncertainty is a fundamental aspect of decision-making, and the neutrosophic approach excels in addressing varying degrees of uncertainty. Unlike the classical approach, which often struggles to incorporate indeterminate or unknown factors, neutrosophic logic allows for a more comprehensive treatment of uncertainty. This enables decision-makers to make well-informed choices even in situations where information is incomplete or evolving. The neutrosophic approach enhances problem-solving capabilities by providing a richer and more nuanced representation of reality. By embracing ambiguity, uncertainty, and contradictions, decision-makers can explore a wider range of possibilities and outcomes. This can lead to innovative solutions, improved risk management strategies, and a deeper understanding of complex systems that may elude traditional decision-making approaches like the classical method.

6. Discussion and Contribution of the Study

The research presented in *Statistical Analysis of Foreign Investment Using Interval-Based Approach* provides a distinctive methodology by applying Neutrosophic Analysis, particularly in addressing uncertainties and imprecise information related to foreign direct investment (FDI) in Pakistan. A comparison with previous studies highlights several key differences in approach and results, as well as a more nuanced understanding of FDI impacts.

6.1 Handling Uncertainty and Contradictions

Previous research on FDI in Pakistan and other developing nations typically relied on classical statistical methods, which often simplify the complexity of real-world data. For instance, studies like those by Reiter and Steensma[1] and Konara and Ganotakis[25] employ classical regression models that focus on identifying direct relationships between FDI and economic variables such as GDP, employment, and productivity. These approaches assume a certain degree of stability and completeness in data, which can overlook the uncertainties inherent in emerging markets.

In contrast, the current study's use of Neutrosophic Analysis offers a more adaptable framework; Neutrosophic logic accounts for indeterminacy by allowing values to be simultaneously true, false, or indeterminate, which is particularly useful in analyzing contradictory or incomplete data, a common issue in developing economies. This distinction provides a more flexible analytical tool

compared to the rigid assumptions of classical methods. The inclusion of indeterminacy allows policymakers to better interpret FDI impacts in environments where data reliability and consistency are often compromised.

6.2 Investment Policy Evaluation and Sectoral Focus

Previous studies, such as those by Biglaiser and DeRouen[11] and Mmieh and Owusu-Frimpong[9], emphasized the need for liberalization and the removal of investment barriers to attract FDI. These studies outlined how tax incentives, profit repatriation allowances, and sector-specific policies help boost investor confidence. However, they often did not delve into the indeterminate nature of how these policies are perceived or how they play out under real-world conditions marked by political and economic uncertainties.

The current study advances the conversation by not only analyzing the role of liberalization but also using interval-based Neutrosophic methods to capture the variability in the effectiveness of these policies. For example, while previous research points out the positive impact of SEZs and tax breaks, the Neutrosophic Analysis provides a clearer view of the uncertainty investors might feel due to fluctuating political conditions and governance issues. This gives a more comprehensive picture of how FDI incentives work under varying levels of economic and political stability.

6.3. Sector-Specific Impacts and Data Precision

Previous studies, such as by Baharumshah and Thanoon[8], have explored the importance of FDI in sectors like manufacturing, infrastructure, and energy, often using precise but static data sets. These studies typically show how FDI leads to technology transfer and job creation, enhancing productivity in target sectors. However, they do not account for the long-term variability or possible contradictions in the success of such investments over time.

The current research takes this sectoral focus further by introducing Neutrosophic intervals that highlight fluctuations and uncertainties in FDI inflows across different years. For instance, the study points out how FDI in Pakistan fluctuated between 0.3% to 0.9% of GDP from 2013 to 2023, with significant variations depending on global market conditions and domestic political stability. By using an interval-based approach, the study gives a more dynamic view of how sectoral investments perform over time.

6.4. Methodological Innovation

Another significant contrast is the focus on decision-making frameworks. Traditional studies often provide static conclusions based on average or median values, such as GDP growth or employment figures. These studies, while informative, tend to offer limited flexibility when applied to uncertain environments like Pakistan's. Decision-making frameworks in previous research rely heavily on classical approaches that might fail to consider future risks and uncertainties. The Neutrosophic approach, however, explicitly incorporates uncertainty into the decision-making process. By allowing for the consideration of both contradictory and indeterminate information, it offers a more refined tool for policymakers. This is particularly relevant in Pakistan's case, where political instability and economic volatility can quickly alter the investment landscape. This method provides a clearer framework for predicting outcomes and adjusting policies in real time, something classical approaches do not handle well. In comparison to previous research, the current study offers significant advancements in understanding FDI inflows in Pakistan. The Neutrosophic Analysis goes beyond traditional methods by addressing data uncertainty and contradictions more effectively, which is crucial for countries like Pakistan with fluctuating political and economic environments[26, 27]. By incorporating flexible decision-making and recognizing the indeterminacy of certain variables, this study provides a more comprehensive tool for policymakers. It bridges the gaps left by earlier studies, offering deeper insights into how foreign investments can be attracted and sustained amid uncertainties.

7. Conclusion

In conclusion, the study has utilized the neutrosophic approach to assess and analyze the various aspects of foreign investment in the country. The neutrosophic approach has helped deal with the uncertainties, contradictions, and indeterminacies in this complex area. From the analysis of foreign investment trends, it is evident that Pakistan has witnessed a steady increase in foreign investment inflows over the years. The neutrosophic approach has provided a comprehensive understanding of the various perspectives and uncertainties involved in foreign investment strategies for sustainable development in Pakistan. The neutrosophic approach offers distinct advantages over the classical approach by providing a more flexible, adaptive, and comprehensive framework for decision-making in the face of uncertainty, ambiguity, and contradictions. By leveraging neutrosophic logic, decision-makers can navigate complex, unpredictable situations with greater confidence and arrive at more robust and nuanced solutions that account for the inherent complexities of real-world problems.

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