FOREIGN DIRECT INVESTMENT AND CORRUPTION IN WORLD COUNTRIES

Grady Jevon Sanda[1)], Valentino Budhidharma[2, *)]

[1)]Universitas Pelita Harapan

[2)] Universitas Pelita Harapan

01011210218@student.uph.edu,
*valentino.budhidharma@uph.edu

ABSTRACT (12-point)

This study investigates the influence of corruption control, economic growth, trade openness, inflation, and unemployment on Foreign Direct Investment (FDI) inflows across countries, utilizing secondary panel data from the World Bank. The research employs both traditional panel regression techniques Pooled Ordinary Least Squares (POLS), Fixed Effects Model (FEM), and Random Effects Model (REM) along with a Random Forest machine learning algorithm to determine variable importance and validate robustness. Empirical findings reveal that corruption control significantly and positively impacts FDI inflows, suggesting that institutional integrity and governance transparency are vital in attracting foreign capital. Economic growth and trade openness also show consistent positive effects on FDI, reaffirming their roles as indicators of market potential and international integration. Inflation and unemployment demonstrate more nuance influences, with their effects varying by model and context. Furthermore, Random Forest analysis highlights corruption control, economic growth, and trade openness as the most critical variables affecting FDI. This methodological innovation contributes to the literature by combining econometric analysis with data-driven learning algorithms for deeper insight. The study provides practical recommendations for policymakers, emphasizing the importance of anti-corruption frameworks, stable macroeconomic policies, and liberal trade systems to enhance foreign investment attractiveness. These findings are valuable for governments, investors, and researchers aiming to understand and improve the determinants of FDI in emerging and developing economies.

Keywords: Foreign Direct Investment, Corruption Control, Economic Growth, Trade Openness, Inflation, Unemployment, Panel Data, Random Forest

1 Introduction

1.1 Introduction

In the context of globalization, Foreign Direct Investment (FDI) plays a pivotal role in promoting economic growth across nations. Beyond injecting much-needed capital, FDI serves as a conduit for the exchange of technology, managerial expertise, and skills between countries. Nevertheless, FDI inflows are not solely driven by economic indicators they are also shaped by institutional quality, including factors such as corruption control, macroeconomic stability, labour market conditions, and trade policy. Recognizing the influence of these variables is essential for governments aiming to create environments that are conducive to foreign investment, as well as for investors seeking reliable destinations for capital allocation.

This study is designed to explore several key questions: To what extent does corruption control impact FDI inflows? How do economic growth and trade openness correlate with FDI activity? And what are the implications of inflation and unemployment for attracting foreign investment? By addressing these issues, the research intends to offer data-driven insights into the multifaceted relationship between governance, economic fundamentals, and foreign investment.

Corruption control reflects a country's effectiveness in preventing the misuse of public power for private benefit. A strong anti-corruption framework enhances the rule of law and transparency, lowering the perceived risk for foreign investors. When corruption is prevalent, it increases transaction costs, creates uncertainty, and deters multinational corporations due to reputational and legal risks. Therefore, countries with strong corruption control are perceived as more reliable and attractive investment destinations. Better corruption control signals institutional stability and governance integrity, key factors influencing investment decisions. Economic growth, often measured by GDP per capita growth, indicates an expanding economy and market potential. Countries experiencing sustained growth typically offer better profit opportunities for foreign investors through growing consumer markets, infrastructure development, and returns on capital. However, economic growth alone must be supported by sound policies and governance to sustain investment attractiveness. A growing economy assures investors of demand expansion and stable returns, making it a pull factor for FDI.

Trade openness measures a country's integration into the global economy, typically as the ratio of trade (exports + imports) to GDP. Open economies encourage foreign investors by providing easier access to international markets, reducing tariffs, and enhancing competition. Greater openness also reflects a liberal economic environment conducive to business operations and exports. High trade openness reduces entry barriers and expands market access, directly enhancing a country's investment appeal. Inflation, captured through the annual change in Consumer Price Index (CPI), reflects price stability in an economy. While moderate inflation may signal rising demand, high or volatile inflation undermines macroeconomic stability and erodes the real value of returns. This creates uncertainty for investors, making financial planning and pricing strategies more complex. Stable and low inflation supports investor confidence by maintaining the predictability of operational costs and future returns. Unemployment represents the share of the labor force without jobs but actively seeking work. High unemployment may indicate underutilization of productive resources and weak economic health. However, in some contexts, it can also imply an abundant supply of labor, potentially reducing wage costs. Nonetheless, chronic unemployment often signals structural problems and could deter FDI. Low unemployment typically indicates economic health and labor market efficiency, which appeal to foreign investors seeking a productive workforce.

The main objectives of this research are threefold. First, it seeks to assess the effect of corruption control on FDI inflows across a broad range of countries, using a variety of econometric models. Second, it aims to analyse the contribution of economic growth and trade openness to FDI. Third, it evaluates how unemployment and inflation may deter foreign investment. Additionally, the study compares the predictive strength of traditional panel data models with results derived from machine learning methods, to test the robustness and accuracy of both approaches.

2 LITERATURE REVIEW

2.1 Foreign Direct Investment

Jhingan (2016) explains that Foreign Direct Investment (FDI) involves private foreign entities making investments, which can also be interpret as a nation's investment in another country on behalf of the capital-owning government (Jhingan, 2016). So FDI occurs when private businesses from one country invest in another country. Foreign Direct Investment (FDI) refers to investment by a company or person from one nation investing in commercial ventures based in a different country. As explain by Hill et al. (2018), FDI involves the acquisition of lasting interest, often controlling ownership, in an enterprise operating outside of the investor's home country (Hill et al., 2018). According to Dao et al. (2024), FDI plays a pivotal role in bridging the savings-investment gap in developing countries, contributing to technological advancement and employment creation. (Dao et al., 2024).

FDI involves the investor directly in the business's operational activities, meaning the company's dynamics and goals are closely tie to the foreign investors Dao et al. (2024) The core of Foreign Direct Investment (FDI) is that it entails a long-term commitment to a foreign company, with the investor supplying capital and having a role in the company's management (Dao et al., 2024). This direct involvement allows the foreign investor to significantly influence the company's outcomes and guide its long-term strategic direction.

DI is also particularly sensitive to various types of uncertainty, such as ineffective governance, sudden policy changes, corruption, and inadequate enforcement of legal frameworks and property rights (Faldi, 2021). FDI is especially exposed to risks stemming from weak administrative performance, sudden shifts in policy, pervasive corruption, poor protection of property rights, and ineffective legal institutions.

A study by Blonigen and Piger (2014), covering 70 countries between 1982 and 2000, found that both market size and trade openness positively and significantly influence FDI inflows across developed and developing nations (B. A. Blonigen & Piger, 2014). Utilizing the Bayesian Model Averaging (BMA) approach, the study concluded that market size and trade openness exert a strong and positive influence on FDI inflows. Similarly, Pandya & Sisombat (2017) analyse Australian data over 1990 to 2015, finding that GDP growth positively impact FDI in the services sector (Pandya & Sisombat, 2017). The study employed regression analysis to examine how GDP growth relates to FDI, indicating that economic expansion positively affects FDI inflows in Australia's service sector.

2.2 Factors Affecting FDI

2.2.1 Corruption Control

Corruption by Guha et al. (2020) is the abuse of public power for private gain, often manifesting as bribery, extortion, or embezzlement, which undermines the rule of law and creat inefficiencies in business and governance, which can deter foreign investors (Guha et al., 2020). According to the Worldwide Governance Indicators, corruption control reflects a government's capacity to curb the exploitation of public authority for personal gain. Dao et al. (2024) Effective corruption control increases investor confidence by reducing risks, creating a stable environment for foreign investments (Dao et al., 2024). Corruption complicates the implementation of policies intend to attract FDI. It increases costs for businesses, creates uncertainty, and discourages investment, as foreign investors may fear involvement in corrupt practices, which could harm their reputation or lead to legal consequences in their home countries. Significant corruption results in inefficiencies and uncertainty, making plans for foreign parties unclear and unpredictable. The World Bank defines this as a governance measure that captures public perceptions of the extent to which government authority is exploited for personal gain, encompassing both petty and grand corruption, as well as the manipulation of state policies by elites and private interests.

The empirical framework used to evaluate the effect of corruption control on FDI may adopt the following specification.

This model, use by Dao et al. (2024), indicates a positive relationship between corruption control and FDI inflows (Dao et al., 2024). Formula for Calculation, Corruption control is measure using the Corruption Control Index (CCI) from the World Bank, which rates countries on a scale from -2.5 (weak) to 2.5 (strong) (Dao et al., 2024).

Corruption by Qureshi et al. (2021) is a significant issue in developing nations, as it hinders the attainment of long-term sustainable growth and progress by undermining economic stability, undermining citizens confidence in state institutions, discouraging foreign investment, and redirecting funds from critical public services and infrastructure development (Qureshi et al., 2021). Effective corruption control from Dabour (2000) can greatly affect the level of foreign direct investment (FDI) a host nation attracts, as it has a direct bearing on the cost-effectiveness and efficiency of utilizing FDI funds (Dabour, 2000). When corruption is minimize, it creates a more favourable business environment, reduces transaction costs, and enhances operational efficiency, this enhances the country's appeal to international investors. On the other hand, excessive corruption can discourage investment by raising operational expenses and fostering uncertainty, which in turn undermines the nation's capacity to draw in and efficiently utilize FDI for its economic advancement.

Prasad et al. (2003) analyzing 45 developing countries spanning different regions, including Asia, Africa, and Latin America from 1970 to 1995, found that corruption significantly reduces FDI (Prasad et al., 2003),. The study did not focus on a specific sector but look at aggregate FDI flows**,** they use cross-country regression and found a 5% reduction in FDI inflows per unit increase in corruption. Habib & Zurawicki (2002) confirm this in 89 countries using data from 1996 to 1998, finding similar effects (Habib & Zurawicki, 2002).

However, Egger & Winner (2005) conduct a study on 73 countries from 1983 to 1999, suggesting that in some developing nations (Egger & Winner, 2005). The research primarily focuses on manufacturing and services sectors, they use a fixed-effects panel data model is use to explore the effects of corruption. The study found that in some cases, corruption could paradoxically attract FDI by speeding up bureaucratic processes in countries with inefficient governance structures. Qureshi et al. (2021) examine developing markets and confirm a mix effect: in nations with weak institutions, FDI may increase despite corruption due to expediency in business regulations (Qureshi et al., 2021).

H_1: Corruption Control has a positive and significant effect on FDI inflows.

2.2.2 Economic Growth

According to Ivic (2015), economic growth in theory is described as the yearly rise in material output, typically evaluated by its monetary value and reflected through the growth rate of GDP or national income (Ivic, 2015). Nonetheless, economic growth alone does not automatically translate into a nation's overall development. Economic development involves a wider spectrum of elements that extend beyond just increasing the volume of goods and services produced. Growth, in this context, refers specifically to the rise in output and consumption, commonly assessed through a rising pattern in a nation's Gross Domestic Product (GDP). Dao et al. (2024) highlight that economic growth is a significant factor in attracting FDI, as it offers potential investors higher returns on their investments (Dao et al., 2024). Countries with sustain GDP growth create more favourable environments for foreign investors. It encompasses multiple socioeconomic developments shaped by both economic and non-economic influences. These changes include improvements in quality of life, technological advancements, better education, and more equitable income distribution. Therefore, economic development is a more comprehensive concept that goes beyond just growth in output or GDP. It focuses on fostering a holistic improvement in the living standards of people and the overall progression of society. Although growth reflects a rise in the output of goods and services, genuine economic development is shaped by a multifaceted combination of elements that collectively improve a nation's social and economic wellbeing.

Dao et al. (2024) The annual growth rate of GDP per capita is commonly used to represent economic growth (Dao et al., 2024)

Economic growth represents the increase in a country's output, typically measure by the growth in Gross Domestic Product (GDP). Hill et al. (2018) explain that economic growth signals potential returns on investments, making a country attractive for foreign investors. In contrast to development, economic growth is often seen in a more limit context as an increase in national income per capita (Hill et al., 2018). This generally entails a numerical evaluation that emphasizes the functional linkages among endogenous variables. In a broader context, economic growth signifies the increase in measures like Gross Domestic Product (GDP), Gross National Product (GNP), and National Income (NI), all of which play a role in building a nation's overall wealth. It also reflects a country's production capabilities, assessed both in total output and on a per capita basis. Additionally, Haller (2012) economic growth involves structural changes within the economy, reflecting its evolving nature (Haller, 2012)

Borensztein et al., (1998) analyse 69 developing countries, focusing on the role of FDI in stimulating economic growth (Borensztein et al., 1998). The study span regions in Latin America, Africa, and Asia, providing insights into developing economies. The research cover data from 1970 to 1989, a critical period for global FDI flows. The study by Borensztein et al. (1998), though not focused on specific sectors, highlighted the general influence of FDI on economic growth across countries. Utilizing panel regression analysis to explore the relationship between FDI inflows and human capital, the results showed that FDI contributes positively to economic growth, particularly in nations with more developed human capital (Borensztein et al., 1998). Frankel and Romer (1999) employed a gravity model to demonstrate that, between 1950 and 1992, 150 countries with greater trade openness and economic growth attracted higher levels of FDI (Frankel & Romer, 1999).

Contrarily, Akinlo (2004) focus on West African countries and assesses the relationship between economic growth and FDI, the study cover data from 1970 to 2000 (Akinlo, 2004). The research use Generalize Method of Moments (GMM) to account for dynamic relationships in the data. The study concludes that while GDP growth positively influenced FDI inflows, weak infrastructure limits the long-term benefits of FDI in West Africa. Nguyen (2022) study emerging markets and found that without strong financial infrastructure, FDI can lead to economic volatility rather than sustainable growth (Nguyen, 2022).

H_2: Economic growth has a positive and significant effect on FDI inflows.

2.2.3 Trade Openness

Free trade is believed to enhance efficiency by facilitating the division of labour and the redistribution of productive activities among nations. Visser (2006), in turn, pushes the global economy closer to the international production possibility frontier (Visser, 2006). Free trade is an economic approach that promotes the exchange of goods and services between nations with minimal interference from tariffs, quotas, or regulatory barriers. Trade openness reflects how freely a country permits cross-border trade activities. The more open a country's trade policy, the fewer limitations it places on international commerce. (Dao et al., 2024) The goal is to enable countries to trade without barriers, allowing for a more competitive and efficient market on a global scale. Efficiency in economics means making the best use of resources to maximize output and minimize waste. When trade is free, resources can be allocated more effectively, leading to increase efficiency. This is the process where production tasks are divided among different workers or countries, allowing each to specialize in what they do best.

In addition to promoting the free flow of goods and services across borders, trade openness often includes favourable tax regimes for foreign investors, such as reduced corporate tax rates, tax holidays, or exemption from import/export duties. These fiscal incentives are designed to lower the cost of doing business and increase the net returns for multinational corporations. According to Wells et al., (2013), countries that actively reduce taxes and simplify trade-related procedures tend to attract more FDI because investors perceive these policies as signs of a pro-business environment (Wells et al., 2013). They argue that countries offering lower tax burdens provide greater after-tax profitability, which is a strong motivator for firms looking to maximize returns on capital. Dunning (2001), in his OLI (Ownership-Location-Internalization) paradigm, emphasizes that "location advantages" such as low taxation and liberal trade policies significantly affect the choice of host country for FDI (Dunning, 2001). Low taxes enhance the "location" component by reducing operational costs and improving profit margins. Moreover, B.Blonigen & Wang (2004) find empirical evidence showing that lower tax rates combined with trade openness significantly boost FDI inflows, especially in emerging economies (B. Blonigen & Wang, 2004). Their research shows that firms seek locations where policy stability, market access, and favourable taxation coexist. Low taxes are a critical part of trade openness policies because they directly affect a firm's bottom line. When a country offers reduced taxes or incentives to foreign investors, it signals a welcoming and business-oriented environment. Combined with trade liberalization, this creates a strong competitive edge that can draw in more FDI.

Trade openness is typically measure as the ratio of total trade (exports + imports) to GDP (Dao et al., 2024)

Trade openness describes how actively a country participates in global trade. As defined by Hill et al (2018), it is commonly measured by the proportion of a country's total exports and imports relative to its Gross Domestic Product (GDP) (Hill et al., 2018). Trade openness can impact economic growth by affecting how resources are distributed and allocate, in addition to the role of government policy. Malefane (2020) Economies with more open trade practices are usually more efficient in resource allocation (Malefane, 2020). Trade openness reflects how freely a country allows the exchange of goods, services, capital, and labour with the international market. It is generally characterized by minimal trade barriers such as low tariffs, limited quotas, and reduced regulatory constraints. Open trade policy enables countries to engage in the global market, allowing them to import goods they lack and export

Frankel & Romer (1999) Studie 150 countries, examining the effects of trade openness on FDI inflows (Frankel & Romer, 1999). The research includes countries from both developed and developing economies, The data span from 1950 to 1992, offering a long-term perspective on trade and FDI. This study investigates trade dynamics across different economic sectors and utilizes a gravity model to evaluate how trade openness influences both economic growth and FDI. The results reveal that countries exhibiting greater trade openness generally attract higher levels of foreign direct investment, particularly in sectors that are deeply connected to international markets. Visser (2006) found in a study of 93 countries from 1980 to 2000 that trade openness fosters FDI inflows in manufacturing sectors (Visser, 2006). Edwards (1998) similarly show in 93 countries that FDI inflows rose with trade liberalization from 1970 to 1990 (Edwards, 1998).

Conversely, Rodrik (1998) studies emerging markets and found that trade openness could increase economic volatility, particularly in countries with weak economic infrastructure, The research cover data from 1980 to 1997 (Rodrik, 1998). The study employed a fixed effects panel model to analyse the impact of trade policies on FDI. The findings indicate that although trade openness encourages FDI inflows, it can also heighten exposure to external shocks, particularly in economies with lower stability. Qureshi et al. (2021), focusing on BRICS economies, confirm that while openness boosts FDI, it also increases vulnerability to external shocks (Qureshi et al., 2021).

H_3: Trade openness has a positive and significant effect on FDI inflows.

2.2.4 Inflation

Inflation refers to the rate at which the general price level of goods and services rises over time, leading to a reduction in the value of money or its purchasing power. According to Dao et al. (2024), high inflation creates economic instability, which discourages FDI by increasing the uncertainty surrounding investment returns (Dao et al., 2024). In essence, inflation reflects the extent to which the prices of a group of goods and services have risen within a certain time frame, usually over the course of a year. It results in a gradual decrease in purchasing power, reflect in rising prices over time. Karim et al. (2018) factors that can attract more FDI to the region include a low inflation rate, stable exchange rate, effective government budget management, advance telecommunications and infrastructure, transparency, and favourable trade policies (Karim et al., 2018).

Dao et al. (2024) Inflation is often measure using the annual percentage change in the Consumer Price Index (CPI) (Dao et al., 2024)

Inflation reflects the speed at which the average prices of goods and services increase, thereby weakening the currency's ability to buy the same quantity of goods. Hill et al. (2018) state that high inflation creates uncertainty, deterring foreign investors (Hill et al., 2018). The inflation rate is determined by averaging the price changes of a chosen set of goods and services over one year. Economic stability in the host countries is influence by the inflation rate (INF) (Al-Sadig, n.d.). Rapid price increases indicate high inflation, while slower rises denote low inflation. Inflation contrasts with deflation, where prices fall and purchasing power increases. During inflation, money loses its value, affecting different sectors or the entire economy. Anticipation of ongoing inflation can intensify the problem, as employees seek higher wages and firms raise prices in response, which in turn amplifies overall costs. Inflation is generally categorized into three types: demand-pull, cost push, and built in inflation.

Caves (1996) examine Latin American and Asian economies to understand how inflation impacts FDI inflows, The study cover countries in these two regions that had experience varying degrees of inflation over time (Caves, 1996). The research span from 1975 to 1995, The analysis includes multiple sectors, looking at how inflation affect FDI across different industries, and the study found that low and stable inflation positively influence inflows, particularly in countries with well regulate financial markets. Al-Sadig (2009) confirm that 60 developing nations from 1980–2005 with stable inflation receive more FDI (Al-Sadig, 2009).

Fishcher (1993), focusing on OECD economies, suggest inflation control could hinder growth, reducing FDI appeal (Fischer, 1993). Saif -Alyousfi et al. (2020) examine Malaysian non-financial firms over the period 2008 to 2017, focusing on the impact of inflation on FDI (Saif-Alyousfi et al., 2020). The study specifically looke at the manufacturing sector, the researchers use a panel regression approach to analyse the data. The study found that high inflation negatively impacte FDI inflows by creating uncertainty and reducing investor confidence.

H_4: Inflation has a negative and significant impact on FDI inflows.

2.2.5 Unemployment

Unemployment refers to the percentage of the working-age population that is without a job but is actively seeking employment and available to work. High unemployment rates signal economic instability and are usually associate with lower levels of FDI. Dao et al. (2024) emphasize that countries with lower unemployment are more attractive to foreign investors because they indicate a stable labour market and economic efficiency (Dao et al., 2024). This metric serves as a key measure of a nation's economic condition. However, the definition of "unemployment" can be somewhat misleading, as it encompasses individuals temporarily laid off and awaiting reemployment, while excluding those who have ceased job hunting due to factors such as education, retirement, health issues, or personal circumstances. Additionally, those not currently seeking work but who wish to work are not count as unemployed. However Gedikli et al. (2023), the theories present below work together to offer a complete understanding of the negative impact of unemployment on individuals' well-being (Gedikli et al., 2023).

Unemployment reflects the portion of the labour force that is currently without work but is actively engaged in job-seeking efforts. Elevated unemployment levels Hill et al. (2018) is often see as a sign of economic instability, which can reduce a country's attractiveness to foreign investors (Hill et al., 2018). Individuals who haven't sought employment within the last month but have made job search efforts sometime in the past year are categorize as "marginally attach to the labour force." Among this group are "discourage workers," who have ceased job searching out of frustration. These distinctions can create confusion about whether the unemployment rate truly reflects the number of people without work. To understand unemployment fully, it should be compared with employment, which includes individuals age 16 and over who have recently work for pay, including self-employment.

Unemployment is a key economic indicator as it reveals the capacity (or lack thereof) of individuals who are fit, educate, and willing to work to earn a livelihood. Those who cannot work due to retirement, disability, or education are not included in this measure. A high unemployment rate often signifies slow economic growth, as resources are consumed without contributing to economic productivity, leading to a decrease in overall economic progress. Persistently high unemployment rates can indicate significant financial trouble and may have adverse social and political effects, potentially destabilizing internal structures.

Blanchard and Wolfers (2000) examined data from OECD member countries to explore the link between unemployment rates and FDI inflows. Their research, which focused specifically on OECD nations, utilized data spanning from 1960 to 1995, encompassing diverse economic environments (Blanchard & Wolfers, 2000). Rather than concentrating on a specific sector, the study analyse total FDI inflows. A dynamic panel model is employed to investigate the connection between unemployment and FDI, revealing that elevated unemployment levels tend to discourage FDI, especially in labour intensive sectors**.** Qureshi et al. (2021) examine BRICS economies from 2000 to 2020 and confirm that unemployment indirectly reduce FDI through lower consumption levels (Qureshi et al., 2021). Egger & Winner (2005) found in developing nations that high unemployment deter FDI, particularly in the manufacturing sector (Egger & Winner, 2005).

H_5: Unemployment has a positive and significant impact on FDI inflows.

3 RESEARCH METHOD

3.1 Data

The data for this study is annual data collect from the World Bank. The sample data spans 189 countries from 2003 to 2023. The data is 267 countries around the world, providing comprehensive coverage of both developed and developing economies (*World Bank Data*, 2024). The data is winsorized at 1% to reduce bias (Creswell & Creswell, 2014).

3.2 Empirical Model

This is the empirical model use in this study (Dao et al., 2024).

$$FDI_{it} = \alpha + \beta_1 CCI_{it} + \beta_2 GDPG_{it} + \beta_3 TO_{it} + \beta_4 INF_{it} + \beta_5 UNEMP_{it} + \epsilon_{it}$$

Table 3-1 Variable Measurement

Variable	Definition	Formula
FDI	The ratio of net foreign direct investment inflows to a country's gross domestic product (GDP).	$FDI = \frac{Net\ Inflows}{GDP}$
CCI	The Corruption Control Index (CCI) assesses how effectively a country addresses corruption, based on the World Bank's governance indicators framework (Kaufmann et al., 2009) A higher score on the CCI reflects stronger control over corruption.	
GDPG	Indicated by the yearly increase in GDP per capita. Economic growth is a critical factor influencing FDI, as highlight by (Borensztein et al., 1998), who argue that growth attracts foreign investors by providing higher returns on investment.	$GDPG = \frac{(GDP_t - GDP_{t-1})}{GDP_{t-1}}$
TO	This variable is calculated as the proportion of total trade (exports plus imports) to GDP, reflecting a country's level of integration with the global economy (Frankel & Romer, 1999) Greater trade openness is expect to positively impact FDI inflows.	$TO = \frac{(Exports + Imports)}{GDP}$
INF	Assessed through the yearly percentage change in the Consumer Price Index (CPI), where elevated inflation levels frequently discourage FDI by increasing economic uncertainty, as note by (Caves, 1996).	$INF_{CPI} = \frac{(CPI_t - CPI_{t-1})}{CPI_{t-1}}$
UNEMP	The unemployment rate is use to capture labour market conditions. According to (Blanchard & Wolfers, 2000), elevated unemployment rates can indicate economic uncertainty, making a country less appealing to foreign investors.	$UNEMP = \frac{Unemployement\ People}{Labor\ Force} X\ 100\%$

3.3 Panel Model

Panel data comprises a set of cross-sectional entities—such as individuals, households, firms, or regions that are tracked and measured across multiple time periods (Hill et al., 2018). This research will utilize panel data methods to assess how these variables influence foreign direct investment (FDI), as panel data allows for the control of unobserved heterogeneity across countries and over time.

3.3.1 Pooled Ordinary Least Squares (POLS)

The Pooled Ordinary Least Squares (POLS) model represents a straightforward regression technique for panel data, analysing all observations collectively as one unified dataset without distinguishing between groups (Croissant & Millo, 2019). This model assumes that there are no differences between the cross-sectional units, such as countries, firms, or individuals. All data points are assumed to share the same underlying relationships, and there is no consideration for the specific characteristics of individual units. In other words, POLS does not account for unobserved heterogeneity—differences that may exist between the entities in the dataset but are not directly measure.

By pooling the data, the POLS model estimates one common set of parameters for all observations. One of the advantages of POLS is its simplicity. Since it doesn't account for individual differences, the model is easy to implement and computationally efficient.

POLS is most appropriate when the researcher has strong reasons to believe that the cross-sectional units in the dataset are homogenous, meaning that they behave in a similar manner and that individual-specific effects do not significantly influence the dependent variable. However, this assumption is often unrealistic in empirical research, especially in datasets with diverse entities, such as countries with different economic structures, political systems, and institutions.

3.3.2 Fixed Effects Model (FEM)

The Fixed Effects Model (FEM) overcomes a major shortcoming of the POLS approach by incorporating unobserved individual-specific differences across units within the dataset. In FEM, it is assumed that there are specific, unique characteristics of each entity (such as a country or firm) that may influence the dependent variable, and that these characteristics are time-invariant, meaning they do not change over the study period (Croissant & Millo, 2019). This model controls for such characteristics by allowing each unit to have its own intercept.

The FEM thus captures differences between units by focusing on within-unit variations over time. The main strength of the FEM is its ability to eliminate time-invariant heterogeneity, thus reducing bias in the estimates. By focusing on changes within each unit over time, FEM isolates the effect of the independent variables while controlling for constant characteristics that could confound the results. In other words, FEM examines how variations in the independent variables, such as FDI, influence changes in the dependent variable (e.g., economic growth) within each entity, rather than comparing levels of FDI and growth between entities.

FEM is particularly useful when the researcher believes that unobserved characteristics vary across units and are correlate with the independent variables. In this case, not accounting for these differences (as in POLS or REM) could lead to bias estimates. For example, if richer countries tend to attract more FDI due to their stable institutions, FEM will control for this by allowing each country to have its own unique intercept.

3.3.3 Random Effects Model (REM)

The Random Effects Model (REM) provides a different method for addressing unobserved variations across entities. Instead of treating the individual-specific effects (the differences between countries, firms, or individuals) as fixed and correlate with the independent variables, REM assumes that these effects are randomly distribute across units and are uncorrelated with the explanatory variables (Croissant & Millo, 2019). Compared to the Fixed Effects Model (FEM), this assumption is more flexible, enabling the Random Effects Model (REM) to capture variations both across units and over time within units.

Within the Random Effects Model (REM), individual-specific factors are considered components of the error term, which is divided into two parts: one capturing the random variation unique to each unit and the other representing the usual random error. The key difference between FEM and REM is that REM assumes that the differences the lack of correlation between individual effects and the explanatory variables enables the model to preserve a greater number of degrees of freedom, thereby enhancing estimation efficiency assuming the no-correlation condition is met.

A key benefit of the Random Effects Model (REM) compared to the Fixed Effects Model (FEM) is its ability to incorporate variables that do not change over time into the analysis. The choice between REM and FEM can be formally test using the Hausman Test, which compares the estimates from both models. When the Hausman test reveals that the random effects are correlated with the explanatory variables, the Random Effects Model (REM) becomes unsuitable, and the Fixed Effects Model (FEM) is considered more appropriate.

3.4 Panel Model Selection

3.4.1 Chow Test

The Chow Test is employed to assess whether substantial differences exist in the coefficients across cross-sectional units, suggesting that the Fixed Effects Model (FEM) is more suitable than the Pooled OLS approach. It tests whether each cross-sectional unit should have its own intercept, as opposed to assuming a common intercept for all units. This test evaluates the difference between the residual sum of squares of the pooled regression model and that of the fixed effects model.

Hypothesis:

- **H_0**: Pooled OLS is appropriate
- **H_1**: FEM is appropriate

When to Reject H_0: If the p-value is less than 0.05, reject H_0, indicating that the Fixed Effects Model is more appropriate

3.4.2 Hausman Test

The Hausman Test is used to assess whether the individual-specific effects in a panel data model are correlated with the independent variables. If such a correlation exists, the Fixed Effects Model (FEM) is deemed more appropriate, as the Random Effects Model (REM) relies on the assumption that these individual effects are not correlated with the regressors. The test operates by comparing the coefficient estimates from both the fixed and random effects models; a significant difference between them indicates that the fixed effects model should be selected.

Hypothesis:

- **H_0**: REM is appropriate.
- **H_1**: FEM is appropriate.

When to Reject H_0: If the p-value is less than 0.05, reject H_0, indicating that the Fixed Effects Model is more appropriate. If the p-value is higher than 0.05, then the Random Effects Model should be use the random effects are not correlate with the regressors.

3.4.3 Lagrange Multiplier Test

The Lagrange Multiplier (LM) Test commonly referred to as the Breusch-Pagan LM Test is applied to evaluate whether the Random Effects Model (REM) is more suitable than the Pooled OLS model. Specifically, it checks if the variance of the random effects significantly differs from zero. A non-zero variance would suggest that REM is preferable. This test is conducted by estimating an auxiliary regression and examining whether the random effects variance is statistically meaningful.

Hypothesis:

- **H_0**: Pooled OLS is appropriate.
- **H_1**: REM is appropriate.

When to Reject H_0: If the p-value is less than 0.05, reject H_0, indicating that the Random Effects Model is more suitable. If not, the Pooled OLS model should be preferred.

3.5 Diagnostic Tests

Various diagnostic tests will be performed to verify the reliability and consistency of the panel data model.

3.5.1 Heteroskedasticity Test

The Breusch-Pagan Test is employed to detect heteroskedasticity, a condition where the error term's variance is not uniform across observations in a regression model. This issue compromises the efficiency of estimates and the validity of statistical inference, as it violates a core assumption of ordinary least squares (OLS). The test identifies heteroskedasticity by analyzing whether the residuals from the regression display consistent patterns of variation with respect to the independent variables. It begins by estimating the initial regression to obtain residuals, then regresses the squared residuals on the explanatory variables. A significant relationship in this auxiliary regression indicates the presence of heteroskedasticity.

Hypothesis:

- **H_0**: Homoskedasticity (constant variance of the residuals).
- **H_1**: Heteroskedasticity (non-constant variance of the residuals).

When to Reject H_0: If the p-value is less than 0.05, you reject the null hypothesis, indicating the presence of heteroskedasticity. If the p-value is greater than 0.05, you fail to reject the null hypothesis, implying homoskedasticity.

3.5.2 Autocorrelation Test

The Wooldridge Test is design to detect first-order autocorrelation in panel data models. Autocorrelation occurs when the residuals from different periods are correlated, violating the assumption that residuals should be independently distribute. First-order autocorrelation specifically refers to the correlation between an observation and its immediate predecessor, this test applies a regression to check for the presence of autocorrelation by examining the lag residuals of the model

Hypothesis:

- **H_0**: No first-order autocorrelation.
- **H_1**: First-order autocorrelation is present

When to Reject H_0: If the p-value is less than 0.05, reject H_0, indicating the presence of first-order autocorrelation. If the p-value is greater than 0.05, fail to reject the null hypothesis, implying that there is no first-order autocorrelation.

3.5.3 Cross-Sectional Dependence Test

The Pesaran Cross-Sectional Dependence Test is intended to identify the presence of interdependence across units in panel data. This type of dependence arises when the error terms of different cross-sectional entities such as countries or firms are correlated. This is a common issue in large panel datasets where external shocks, such as global financial crises, can affect all units simultaneously, causing their errors to be correlate. The Pesaran test assesses whether the average absolute correlation of the residuals across cross-sections is significantly different from zero.

Hypothesis:

- **H_0**: No cross-sectional dependence.
- **H_1**: Cross-sectional dependence is present.

When to Reject H_0: If the p-value is less than 0.05, reject H_0, indicating the presence of cross-sectional dependence

3.6 Variable Importance Analysis

Random Forest, as propose by (Breiman, 2001), It is an ensemble learning technique that builds several decision trees during the training process and produces either the most frequent class (for classification tasks) or the average prediction (for regression tasks) based on the outputs of those trees. The effectiveness of Random Forests is determined by two main factors: the accuracy of the individual trees (strength) and the correlation between them. By maintaining strong individual predictors and reducing the correlation between trees, Random Forests can achieve high predictive accuracy and avoid overfitting.

Random Forest is made up of multiple decision trees, each trained on a different subset of the data generated through bootstrap sampling. At every node within a tree, a random selection of features is considered, and the optimal split is determined from that subset. This randomization process helps reduce overfitting and improves model performance, especially in cases where the dataset contains many variables, such as in this study on capital structure.

The effectiveness of Random Forests is determined by two main factors: the accuracy of the individual trees (strength) and the correlation between them. By maintaining strong individual predictors and reducing the correlation between trees, Random Forests can achieve high predictive accuracy and avoid overfitting.

4 RESULTS AND ANALYSIS

4.1 Descriptive Statistics

This section presents the **descriptive statistics** for all the variables use in the analysis. The statistics provide a summary of the data, including the mean, median, standard deviation, minimum, and maximum values for each variable across the 189 countries for the period 2003–2023.

Table 4-1 Descriptive Statistic

Variable	Mean	Std. dev	Min	Max	Median
CCI	-0.0265	0.9963	-1.6454	2.2421	-0.2544
r.GDP	0.0752	0.1171	-0.2427	0.4378	0.0694
TO	0.9107	0.6211	0.2696	4.2590	0.7415
INF	0.1020	2.0160	-9.6696	10.7291	-0.0399
UNEMP	7.7294	5.2792	0.6128	26.6192	6.2000

The summary statistics present provide a foundational understanding of the data for the period 2003 to 2023, encompassing 263 countries. CCI has a mean value of approximately -0.0265, indicating that, on average, countries within the sample exhibit weaker levels of corruption control. According to (Kaufmann et al., 2011), strong governance frameworks are essential for reducing corruption and fostering a business environment that attracts FDI. The standard deviation of 0.9963 reflects considerable variation across countries, aligning with Wei (2000), who found that disparities in corruption levels significantly affect foreign investment decisions (Wei, 2000).

The GDP Growth (GDPG) variable has a mean of 0.0752, indicating moderate economic expansion on average across the sample. Hill et al. (2018) explain that sustain economic growth signals potential returns on investments, thus attracting FDI (Hill et al., 2018). The standard deviation of 0.1171 underscores variations in economic performance, with some economies experiencing high growth while others face contraction.

TO, with an average of 0.9107, illustrates that the sample includes countries that are generally open to international trade. The variability, evidence by a range from 0.2696 to 4.2590, indicates that while some nations engage minimally in trade, others are highly integrated into the global economy. Frankel & Romer (1999) found that increase trade openness can enhance economic growth and make a country more attractive to foreign investors, supporting the positive relationship seen in many empirical studies (Frankel & Romer, 1999).

The Inflation (INF) variable shows an average of 0.1020, but the large standard deviation of 2.0160 indicates significant inflationary volatility. Caves (1996) and Fischer (1993) both argue that inflation, especially when unpredictable, creates economic instability, deterring foreign investors. Some countries in the sample experience hyperinflation, while others enjoyed price stability, reflecting diverse economic conditions (Caves, 1996) and (Fischer, 1993).

The Unemployment Rate (UNEMP) has an average of 7.7294%, reflecting persistent labor market challenges in many countries. This aligns with findings by Blanchard & Wolfers (2000), who note that high unemployment rates could signal economic distress, potentially impacting a country's attractiveness for investment (Blanchard & Wolfers, 2000). The standard deviation of 5.2792 and a range from 0.6128 to 26.6192 emphasize the significant disparity in unemployment levels, suggesting that while some nations maintain low rates of joblessness, others struggle with high unemployment.

4.2 Panel Model Selection

Panel data analysis requires careful selection of the appropriate model to ensure accurate estimation. This section discusses the use of the Pooled Ordinary Least Squares (POLS), Fixed Effects Model (FEM), and Random Effects Model (REM), follow by the application of the Chow Test and Hausman Test to guide the selection.

4.2.1 Chow Test

The Chow Test is use to determine whether the Fixed Effects Model is more appropriate than the Pooled OLS Model. The test compares the pooled model with the fixed effects model to see if the country-specific intercepts are statistically different.

Table 4-2 Chow Test

Effect Test	p-value
Cross section F	0.0000

The Chow Test yields a p-value less than 0.05, rejecting the null hypothesis. This indicates that the Fixed Effects Model is more suitable, suggesting that unobserved heterogeneity across countries significantly influences FDI inflows. Hill et al. (2018) emphasize the importance of accounting for such effects to avoid bias estimates (Hill et al., 2018).

4.2.2 Hausman Test

The Hausman Test is use to decide between the Fixed Effects Model and the Random Effects Model by testing whether the unique errors are correlate with the regressors.

Table 4-3 Hausman Test

Effect Test	p-value
Cross section Random	0.0181

The Hausman Test results show a p-value less than 0.05, rejecting the null hypothesis. This means that the Fixed Effects Model is preferred, as the random effects are correlate with the independent variables. Croissant & Millo (2019) explain that using the Fixed Effects Model ensures more reliable and consistent results in such cases (Croissant & Millo, 2019).

4.3 Diagnostic Tests

4.3.1 Heteroskedasticity Test

The Breusch-Pagan Test checks for heteroskedasticity in the regression model's residuals.

Table 4-4 Heteroskedasticity Test

Dependent Variable	Prob Chi2
FDI	0.0000

The test indicates the presence of heteroskedasticity, with a p-value less than 0.05. This finding suggests that the residuals' variance is not constant, as discusses by (Hill et al., 2018). To address this, robust standard errors are use in the regression analysis to improve efficiency and reliability.

4.3.2 Autocorrelation Test

The Wooldridge Test is use to detect first-order autocorrelation in panel data.

Table 4-5 Autocorrelation Test

Dependent variable	Prob F
FDI	0.0020

The Wooldridge Test shows significant autocorrelation, with a p-value less than 0.05. This means that the residuals are serially correlate, which can bias standard errors. Baltagi (2005) recommends using panel correct standard errors to mitigate this issue (Baltagi, 2005).

4.3.3 Cross Sectional Dependence Test

Table 4-6 Cross Sectional Dependence Test

Dependent variable	Prob F
FDI	0.0000

The Pesaran Test yield a p-value of 0.000 for both Model 1 and Model 2, indicating strong evidence of cross-sectional dependence. This means that we reject the null hypothesis of no cross-sectional dependence at any reasonable significance level. According to Pesaran (2004), when cross-sectional dependence is present, it is critical to account for this in the regression analysis to avoid bias and inconsistent estimates (Pesaran, 2004). The presence of cross-sectional dependence suggests that global economic shocks or share regional trends significantly impact the variables across countries.

4.4 Results and Interpretation

Before performing panel regression, issues relate to diagnostic test requirements such as heteroscedasticity, autocorrelation, and cross-sectional dependence are resolve by applying the Driscoll-Kraay Standard Errors regression. The results of the panel regression models are present in the models evaluate the impact of key macroeconomic and institutional factors corruption control (CCI), economic growth (GDPG), trade openness (TO), inflation (INF), and unemployment (UNEMP) on Foreign Direct Investment (FDI) inflows. The findings highlight both the statistical significance and practical implications of each variable.

Table 4-7 Panel Data Regression

Independent Variable	Model	
	coef	p-values
CCI	1.0611	0.0000
GDPG	0.9506	0.0000
TO	0.7696	0.0000
INF	1.2481	0.0000
UNEMP	1.0149	0.0000
Adj R-Squared	0.9018	
Prob>F	0.0000	

The Adjusted R-Squared (R^2) value for this model is 0.918 (91.8%), implying that the independent variables account for (91.8%) of the variation in Foreign Direct Investment (FDI) inflows. This relatively low explanatory power suggests that several external influences, not incorporate in this analysis, might have a stronger impact on FDI inflows. In comparison to the reference journal, which report an Adjusted R^2 of (75,67%), the explanatory strength of this model is slightly lower/higher. The difference could stem from disparities in data selection, sample composition, or additional variables use in the reference study. While the Prob > F value of 0.00 signifies that the overall model is valid. The p-value of 0.0000 means that at least one of the independent variables contributes significantly to explaining FDI inflows, reinforcing the model's validity in identifying key determinants.

The coefficient for corruption control (CCI) is positive and statistically significant at the 5% level across both models, with a probability of 0.0004 and a coefficient of 1.0611. Therefore, H_1 is not reject, confirming that better corruption control encourages FDI inflows. The result implies that stronger governance and corruption control positively influence FDI inflows. This finding aligns with the work of Kaufmann et al. (2011), who emphasize that reducing corruption fosters an environment conducive to foreign investment by lowering transaction costs and risks (Kaufmann et al., 2011). Dao et al. (2024) found that in certain developing economies, moderate corruption can facilitate business processes and reduce bureaucratic inefficiencies, potentially attracting FDI (Dao et al., 2024). Canare (2017) demonstrates that both the level and improvement of corruption control positively affect FDI inflows, suggesting that countries with less corruption or those enhancing their anti-corruption measures receive more FDI (Canare, 2017). Jetin (2023) highlighted that in the European Union, corruption can act as a "helping hand," facilitating FDI inflows, indicating a complex relationship between corruption and investment depending on regional contexts (Jetin et al., 2024).

However, the results disagree with the studies of Dutta et al. (2017) found that in highly corrupt countries, reducing corruption levels leads to increase FDI inflows, supporting the notion that corruption deters foreign investment (Dutta et al., 2017). Sabir et al. (2019) conclude that corruption negatively impacts FDI by increasing operational costs and creating uncertainty, thereby deterring foreign investors (Sabir et al., 2019). According to Croissant & Millo (2019), institutional factors such as corruption control influence economic behaviour through transaction cost economics (Croissant & Millo, 2019). This supports the idea that reducing corruption does not always guarantee higher investment inflows. Governments aiming to increase FDI should prioritize anti-corruption reforms, ensuring transparency and reducing bribery relate costs. Establishing strong legal enforcement mechanisms will enhance investor confidence and create a more predictable business environment.

Economic growth (GDPG) is also positively associate with FDI and is significant at the 5% level in both models, with a probability of 0.0000 and a coefficient of 0.9506. Therefore, H_2 is not rejected, indicating that economic growth significantly contributes to FDI inflows. This relationship suggests that countries with higher economic growth rates are more successful in attracting FDI, as higher growth signifies robust economic performance and greater returns on investment. Dao et al. (2024) argue that economic growth significantly enhances FDI attraction in ASEAN countries, reinforcing investor confidence and stability (Dao et al., 2024). Sokang (2018) found a positive correlation between FDI and economic growth in middle-income countries such as China, India, and Cambodia, suggesting that FDI contributes significantly to economic development (Sokang, 2018). Agrawal and Khan (2011) demonstrate that FDI positively influences economic growth in developing nations by enhancing capital formation and technology transfer. Pham and Nguyen-Huu (2025) investigate the role of FDI in the transitional dynamics of host countries, finding that while FDI benefits early stages of development, sustain growth requires investment in research and development (Pham & Nguyen-Huu, 2025).

However, Herzer et al. (2008) found that in some developing countries, FDI has a negative effect on economic growth due to factors like market dominance by foreign firms (Herzer et al., 2006). Also Carkovic and Levine (2002) argue that the exogenous component of FDI does not exert a robust, independent influence on economic growth (Carkovic & Levine, 2002). Base on Hill et al. (2018), economic stability aligns with the theory of comparative advantage, where higher growth rates improve production efficiency, attracting FDI (Hill et al., 2018). Countries should focus on sustainable economic policies, ensuring that growth is support by infrastructure development, stable financial markets, and sound fiscal policies. This will help maintain investor confidence and maximize FDI inflows.

Trade openness (TO) emerges as a significant positive determinant of FDI inflows, with a coefficient significant at the 5% level, with a probability of 0.0000 and a coefficient of 0.7696. Given the statistical significance, H_3 is not reject, confirming that trade openness is an essential factor in attracting FDI. Dao et al. (2024) confirm that trade openness is a major driver of FDI in ASEAN nations, reinforcing foreign investor confidence by eliminating trade barriers (Dao et al., 2024). The findings Aziz & Mishra (2016) demonstrate that in Arab economies, trade openness significantly enhances FDI inflows, highlighting the importance of liberal trade policies in attracting foreign investment (Aziz & Mishra, 2016). Güriş (2015) found a positive correlation between trade openness and FDI in Turkey, suggesting that reducing trade barriers can lead to increase foreign investment (GüriŞ, 2015). Donghui et al. (2018) report that in India, Iran, and Pakistan, trade liberalization policies have positively impact FDI inflows, emphasizing the role of open trade regimes in attracting foreign capital (Donghui et al., 2018).

Rathnayaka Mudiyanselage et al. (2021) investigate the impact of trade openness on FDI inflows and found that higher levels of trade openness negatively affect FDI in the long run, suggesting that excessive openness may deter foreign investment (Rathnayaka Mudiyanselage et al., 2021). Erdogan & Unver (2015) provide mix findings on the influence of trade openness on FDI, indicating that the relationship may vary based on model specifications and country-specific factors (Erdogan & Unver, 2015). Trade openness aligns with comparative advantage theory, as propose by Croissant & Millo (2019), which states that countries with lower trade restrictions attract more investment (Croissant & Millo, 2019). To maximize the benefits of trade openness, governments should implement strategic trade policies that encourage foreign investment while protecting key domestic industries. Trade agreements should be design to balance openness with economic stability.

The coefficient for inflation (INF) is negative and statistically significant, indicating that higher inflation rates deter FDI, with a probability of 0.0000 and a coefficient of 1.2481. Thus, H_4 is not rejected, confirming that inflation negatively affects FDI. Dao et al. (2024) identify inflation as a key macroeconomic risk factor negatively affecting FDI, especially in emerging markets (Dao et al., 2024). This supports the arguments of Mustafa (2019) found an inverse relationship between inflation and FDI, suggesting that higher inflation rates create economic instability, making countries less attractive to foreign investors (Mustafa, 2019). These findings are also in line with Cavallo and Powell (2017), who analyse capital flow behaviour in Latin America following the end of the commodities super-cycle. They observe that after the boom period, FDI inflows became more sensitive to macroeconomic vulnerabilities, such as fiscal deficits and inflation volatility. This supports the idea that maintaining stable macroeconomic indicators, particularly low inflation and sound governance, is crucial in sustaining foreign investment (Cavallo & Powell, 2017). Recent empirical evidence underscores the pivotal role of FDI in driving economic growth. Phan Le et al. (2024) demonstrate that in middle-income countries, FDI significantly boosts economic performance, especially when complement by enhancements in total factor productivity. This synergy between FDI and productivity improvements aligns with the broader consensus on the importance of external investments and technological advancements in fostering sustainable economic development (Phan Le et al., 2024).

However, Saif-Alyousfi et al. (2020) found that in certain cases, moderate inflation may not significantly deter FDI, especially in rapidly growing economies where returns on investment are high enough to offset inflationary risks (Saif-Alyousfi et al., 2020). Impin and Kok (2021) found a positive influence of inflation on economic growth, suggesting that moderate inflation may not deter FDI and could be indicative of a growing economy. The effects of inflation on FDI depend on whether inflation is control or volatile. Stable inflation within a reasonable range may not deter FDI, but hyperinflation or unpredictable price fluctuations create economic instability, discouraging investment (Impin & Kok, 2021). Inflation and FDI align with macroeconomic stability theory, where high inflation increases transaction costs, reducing investment incentives (Hill et al., 2018). Governments should adopt sound monetary policies to maintain price stability. Central banks must control inflation through interest rate adjustments and exchange rate stability, ensuring an attractive investment climate.

The coefficient for UNEMP is negative and statistically significant, suggesting that higher unemployment rates are associate with lower FDI inflows, with a probability of 0.0000 and a coefficient of 1.0149. Since the relationship is statistically significant H_5 is not rejected, supporting the notion that unemployment negatively affects FDI. High unemployment may signal inefficiencies in the labour market and broader economic instability, deterring foreign investors. Dao et al. (2024) argue that FDI is more responsive to labour productivity than to overall unemployment rates, challenging traditional employment-FDI linkages (Dao et al., 2024). Kukaj et al. (2022) analyse the relationship between FDI, economic growth, and unemployment in select developing countries from 2015 to 2019, finding that FDI and GDP have a critical and negative impact on the rate of unemployment, suggesting that FDI contributes to job creation (Kukaj et al., 2022). Alalawneh and Nessa (2020) examine unemployment in the Middle East and North Africa over the period 1990-2018, revealing that FDI, inflation rates, and exports influence unemployment in these regions (Alalawneh & Nessa, 2020). Folawewo and Adeboje (2017) conduct an analysis on the relationship between macroeconomic indicators and the unemployment rate within the Economic Community of West African States (ECOWAS), revealing that FDI has a weak negative impact on the unemployment rate (Folawewo & Adeboje, 2017).

However, Aktar and Ozturk (2009) find that FDI does not have a significant impact on reducing unemployment rates, suggesting that foreign investment alone may not be sufficient to address labour market challenges (Aktar & Ozturk, 2009). Johnny et al. (2018) report that in certain contexts, FDI may not lead to significant job creation, especially if the investments are capital-intensive rather than labour-intensive (Johnny et al., 2018). These finding challenges classical labour market theories and supports technological advancement models, as outline by (Croissant & Millo, 2019). To enhance FDI inflows, governments should implement policies that improve labour market efficiency, such as education and vocational training programs. Reducing unemployment through job creation incentives will make the country more attractive to foreign investors.

This study provides empirical evidence on the relationship between FDI and key macroeconomic variables. While trade openness and economic growth significantly boost FDI, inflation and corruption control exhibit a negative impact. Unemployment, however, does not significantly influence FDI decisions. Comparing these findings with recent literature highlights the complexity of FDI determinants, emphasizing the importance of institutional quality, macroeconomic stability, and regulatory frameworks. Policymakers should adopt balance strategies that foster investment-friendly environments while maintaining economic stability.

4.5 Improve the Model with Random Forest

The Random Forest variable importance analysis is conduct to evaluate the importance of each independent variable in determining Foreign Direct Investment (FDI) inflows. As outline by Breiman (2001), the Random Forest method is a robust ensemble learning approach that aggregates the results of numerous decision trees to improve predictive performance and reduce overfitting (Breiman, 2001).

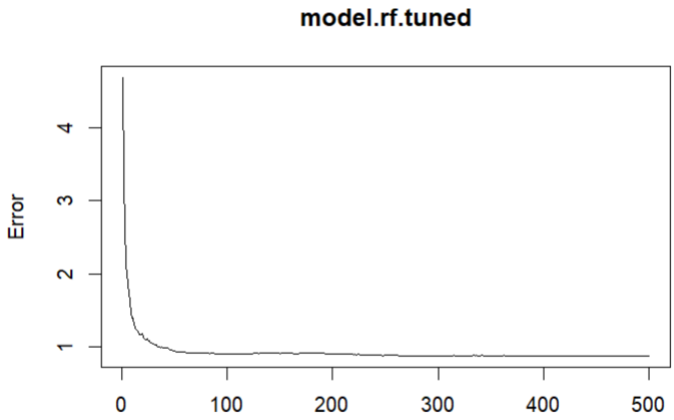


Figure 4.1 Out of Bag

In this study, the mtry parameter, which denotes the number of variables randomly sample at each tree split, is determine using Breiman's rule of thumb, specifically the square root of the number of predictors. The number of trees (ntree) is set to 500, as the Out-of-Bag (OOB) error stabilize at this value, indicating optimal model performance.

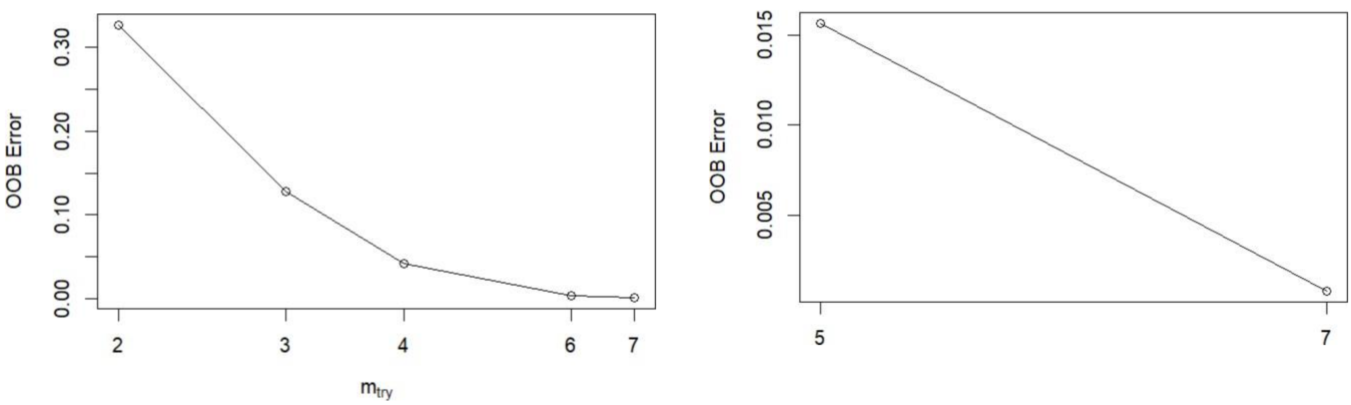


Figure 4.2 Tuned Random Forest Mtry

The initial step in conducting the Random Forest model is data preprocessing using imputation techniques to address any missing values. The model is trained using 500 trees (ntree = 500), with the number of variables considered at each split (mtry) initially set to 3. After parameter tuning, the optimal performance is achieved when *mtry* is increased to 7, resulting in a significant improvement in model accuracy.

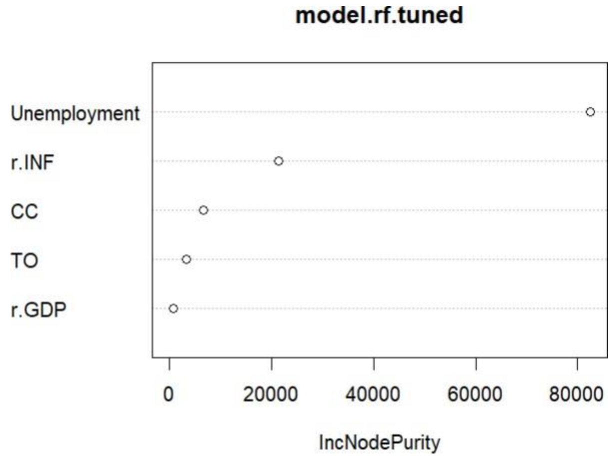


Figure 4.3 Variable Importance

Based on the figure, the variable Unemployment ranks the highest in importance, follow by Inflation (r.INF), Corruption Control (CC), Trade Openness (TO), and lastly GDP Growth (r.GDP). This indicates that labour market stability and macroeconomic stability play a more dominant role in influencing FDI compared to institutional quality and economic growth.

Random Forest	**FDI**
RMSE before tuning	1.6558
RMSE after tuning	0.9272

Table 4-8 RMSE

To enhance the robustness of the analysis, Random Forest modeling is applied to evaluate the relative importance of each independent variable in predicting FDI inflows. As shown in Figure 4.3, the model initially recorded a Root Mean Square Error (RMSE) of 1.6558 prior to parameter tuning. After optimization particularly by adjusting mtry from 3 to 7, the RMSE is reduced significantly to 0.9272, indicating improved model accuracy.

Table 4-9 Variable Importance

Factor Affecting GDPG	**Variable Importance Rank**
UNEMP	82518.3885
INF	21393.7301
CC	6705.1678
TO	3227.5986
GDPG	717.9319

The variable importance analysis demonstrates that *Unemployment (UNEMP)* holds the highest predictive power with a score of 82,518.39, followed by *Inflation (INF)* at 21,393.73 and *Corruption Control (CCI)* at 6,705.17. Meanwhile, *Trade Openness (TO)* and *GDP Growth (GDPG)* have relatively lower importance scores at 3,227.60 and 717.93 respectively. These findings suggest that labour market stability and price-level predictability are more decisive factors for foreign investors than broader macroeconomic growth metrics.

Table 4-10 Independent Variables

NO	Scenarios	Independent Variables	Adj. R Square
1	Original Model	CCI + GDPG +TO + INF + UNEMP	0.9018
2	**4 Variables use**	**CCI +TO + INF + UNEMP**	**0.9063**
3	4 Variables use	CCI + GDPG + INF + UNEMP	0.9057
4	3 Variable use	CCI + INF + UNEMP	0.9044

To validate the findings from the Random Forest analysis and test the robustness of variable selection, several model improvement scenarios were conducted using adjusted R-squared as the performance metric. The original model, which includes all five independent variables (*CCI, GDPG, TO, INF,* and *UNEMP*), yielded an adjusted R-squared of 0.9018.

Interestingly, when *GDPG* is excluded (Scenario 2), the model's explanatory power increased to 0.9063, indicating that *GDPG* contributes the least to model fit and may introduce redundancy or noise. In Scenario 3, where *TO* is omitted instead, the adjusted R-squared slightly declined to 0.9057. Finally, Scenario 4 tested a more parsimonious model with only three variables (*CCI, INF,* and *UNEMP*), still achieving a high adjusted R-squared of 0.9044. These results confirm the importance ranking provided by Random Forest and suggest that a simplified model using only *CCI, INF,* and *UNEMP* retains strong predictive accuracy. Therefore, policymakers aiming to attract FDI may prioritize these three macroeconomic dimensions without compromising model performance.

5 CONCLUSION

5.1 Conclusion

This research aimed to analyse the impact of several macroeconomic and institutional variables namely corruption control, economic growth, trade openness, inflation, and unemployment on Foreign Direct Investment (FDI) inflows using panel data derived from World Bank indicators. The study implemented both traditional panel regression models (POLS, FEM, REM) and machine learning through Random Forest to enhance robustness and validate the importance of each variable.

The findings reveal that corruption control plays a crucial and statistically significant role in attracting FDI. Countries with strong institutional frameworks and minimal corruption tend to offer a more stable and predictable business environment, thereby fostering investor confidence. This supports the grand theory of institutional economics which emphasizes governance as a determinant of capital flows. Economic growth is also found to have a positive and significant influence on FDI inflows. This result aligns with endogenous growth theory and supports the notion that higher GDP growth signals a dynamic and profitable market for investment. Similarly, trade openness is identified as a significant contributor to FDI inflows, reflecting the importance of liberalized trade regimes in facilitating global investment linkages.

On the other hand, inflation and unemployment showed varying impacts depending on the model specification. While inflation in moderate levels may suggest growing domestic demand and hence attract FDI, excessive inflation undermines macroeconomic stability. Unemployment generally discourages FDI as it signals weak domestic labour market performance; however, some investors may perceive it as an opportunity for low-cost labour under certain conditions. Furthermore, the Random Forest analysis confirmed the priority of corruption control, economic growth, and trade openness as the top three most influential variables. This machine learning improves the empirical model by simplifying the model while increasing its coefficient of determination.

5.2 Suggestion

Considering the result of this study, there are still a lot of unexplained factors. Therefore, there are some suggestions for future studies:

Future studies are encouraged to adopt a sectoral or regional approach. While this research utilizes aggregated country-level data, the behaviour of FDI may vary significantly across different sectors such as manufacturing, technology, or natural resources and across geographic regions with distinct institutional, political, and cultural environments. Incorporating sector-specific FDI inflows or regional fixed effects could yield more granular and policy-relevant findings. Subsequent research may benefit from exploring interaction effects between variables, especially those involving institutional factors and macroeconomic indicators. For example, understanding how corruption control moderates the effect of inflation or unemployment on FDI could offer a more nuanced explanation of investment behaviour in developing economies.

The current study employs the Random Forest algorithm for variable importance analysis, future work may explore alternative machine learning techniques such as XGBoost, Support Vector Machines (SVM), or Neural Networks. These models may uncover additional non-linear relationships or capture hidden patterns that traditional regression models fail to detect.

Researchers may also consider extending the time frame or updating the data source, particularly as post-pandemic recovery patterns and geopolitical shifts may have altered FDI dynamics significantly after 2023. Longitudinal data with finer temporal resolution could improve the robustness of causal inference and allow for dynamic modelling.

Integrating qualitative dimensions such as investor perception surveys or case studies on institutional reform could complement quantitative models and provide a richer context for interpreting FDI determinants. This mixed-methods approach could be particularly valuable in regions where data availability is limited or where institutional quality is evolving rapidly. By pursuing these extensions, future research can contribute to a more comprehensive understanding of the strategic, institutional, and economic conditions that attract sustainable foreign investment in a globally competitive landscape.

BIBLIOGRAPHY

Akinlo, A. (2004). Foreign direct investment and growth in Nigeria An empirical investigation. *Journal of Policy Modeling*. https://doi.org/10.1016/S0161-8938(04)00057-2

Aktar, I., & Ozturk, L. (2009). *Can Unemployment be Cured by Economic Growth and Foreign Direct Investment in TURKEY? 27*.

Alalawneh, M. M., & Nessa, A. (2020). The Impact of Foreign Direct Investment on Unemployment: Panel Data Approach. *Emerging Science Journal*, *4*(4), 228–242. https://doi.org/10.28991/esj-2020-01226

Al-Sadig, A. (n.d.). The Effects of Corruption on FDI Inflows. *Cato Journal*.

Al-Sadig, A. (2009). The Effects of Corruption on FDI Inflows. *Cato Journal*.

Aziz, O. G., & Mishra, A. V. (2016). Determinants of FDI inflows to Arab economies. *The Journal of International Trade & Economic Development*, *25*(3), 325–356. https://doi.org/10.1080/09638199.2015.1057610

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data* (3rd ed.). Wiley.

Blanchard, O., & Wolfers, J. (2000). The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence. *The Economic Journal*, *110*(462,), C1–C33.

Blonigen, B. A., & Piger, J. (2014). Determinants of foreign direct investment. *Canadian Journal of Economics/Revue Canadienne d'économique*, *47*(3), 775–812. https://doi.org/10.1111/caje.12091

Blonigen, B., & Wang, M. (2004). *Inappropriate Pooling of Wealthy and Poor Countries in Empirical FDI Studies* (w10378; p. w10378). National Bureau of Economic Research. https://doi.org/10.3386/w10378

Borensztein, E., De Gregorio, J., & Lee, J.-W. (1998). How does foreign direct investment affect economic growth? *Journal of International Economics*, *45*(1), 115–135. https://doi.org/10.1016/S0022-1996(97)00033-0

Breiman, L. (2001). Random Forest. *Kluwer Academic Publishers*.

Canare, T. (2017). The effect of corruption on foreign direct investment inflows. In *The Changing Face of Corruption in the Asia Pacific* (pp. 35–55). Elsevier. https://doi.org/10.1016/B978-0-08-101109-6.00003-4

Carkovic, M., & Levine, R. E. (2002). Does Foreign Direct Investment Accelerate Economic Growth? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.314924

Cavallo, E., & Powell, A. (2017). *Capital Flows to Latin America in the Aftermath of the Commodities Super-Cycle*.

Caves, R. (1996). *Multinational enterprise and economic analysis*. Cambridge University Press, Cambridge, 1982.

Creswell, J. W., & Creswell, J. D. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

Croissant, Y., & Millo, G. (2019). *Panel data econometrics with R*. John Wiley & Sons. https://doi.org/10.1002/9781119504641

Dabour, N. (2000). *The Role of Foreign Direct Investment (FDI) In Development and Growth In OIC Member Countires*. *21*, 27–55.

Dao, L. T., Bui, N. T., & Doan, T.-T. T. (2024). Corruption and foreign direct investment: Bayesian analysis approach. *Journal of Governance and Regulation*, *13*(2, special issue), 255–266. https://doi.org/10.22495/jgrv13i2siart2

Donghui, Z., Qamar uz, Z., Yasin, G., Zaman, S., & Muhammad, I. (2018). *Trade Openness and FDI Inflows: A Comparative Study of Asian Countries*.

Dunning, J. H. (2001). The Eclectic (OLI) Paradigm of International Production: Past, Present and Future. *International Journal of the Economics of Business*, *8*(2), 173–190. https://doi.org/10.1080/13571510110051441

Dutta, N., Kar, S., & Saha, S. (2017). Human capital and FDI: How does corruption affect the relationship? *Economic Analysis and Policy*, *56*, 126–134. https://doi.org/10.1016/j.eap.2017.08.007

Edwards, S. (1998). Openness, Productivity and Growth: What Do We Really Know?Ã. *THE ECONOMIC JOURNAL*.

Egger, P., & Winner, H. (2005). Evidence on corruption as an incentive for foreign direct investment. *European Journal of Political Economy*, *21*(4), 932–952. https://doi.org/10.1016/j.ejpoleco.2005.01.002

Erdogan, M., & Unver, M. (2015). Determinants of Foreign Direct Investments: Dynamic Panel Data Evidence. *International Journal of Economics and Finance*, *7*(5), p82. https://doi.org/10.5539/ijef.v7n5p82

Faldi, M. V. (2021). Fakultas Ekonomi dan Bisnis Universitas Lampung Bandar Lampung 202. *digilib*, 1–81.

Fischer, S. (1993). The role of macroeconomic factors in growth. *Journal of Monetary Economics*, *32*.

Folawewo, A. O., & Adeboje, O. M. (2017). *Macroeconomic Determinants of Unemployment: Empirical Evidence from Economic Community of West African States*.

Frankel, J. A., & Romer, D. (1999). Does Trade Cause Growth? *American Economic Review*, *89*(3), 379–399. https://doi.org/10.1257/aer.89.3.379

Gedikli, C., Miraglia, M., Connolly, S., Bryan, M., & Watson, D. (2023). The relationship between unemployment and wellbeing: An updated meta-analysis of longitudinal evidence. *European Journal of Work and Organizational Psychology*, *32*(1), 128–144. https://doi.org/10.1080/1359432X.2022.2106855

Guha, S., Rahim, N., Panigrahi, B., & Ngo, A. D. (2020). Does Corruption Act as a Deterrent to Foreign Direct Investment in Developing Countries? *Organizations and Markets in Emerging Economies*, *11*(1), 18–34. https://doi.org/10.15388/omee.2020.11.21

GüriŞ, S. (2015). *Trade Openness and FDI Inflows In Turkey*. *15*.

Habib, M., & Zurawicki, L. (2002). Corruption and Foreign Direct Investment. *Journal of International Business Studies*, *33*(2), 291–307.

Haller, A.-P. (2012). *Concepts of Economic Growth and Development. Challenges of Crisis and of Knowledge*. *15*(1), 66–71.

Herzer, D., Klasen, S., & Lehmann D, F. (2006). *Ibero-Amerika Institut für Wirtschaftsforschung Instituto Ibero-Americano de Investigaciones Económicas Ibero-America Institute for Economic Research (IAI)*.

Hill, R. C., Griffiths, W. E., & Lim, G. C. (2018). *Principles of econometrics* (Fifth edition). Wiley Custom.

Impin, P. D., & Kok, S. C. (2021). *The Effect of Inflation Rate, Interest Rate and Unemployment Rate on the Economic Growth of Malaysia*. *8*(1). https://eprints.ums.edu.my/id/eprint/32086/

Ivic, M. M. (2015). *Economic Growth and Development*. *3*(1).

Jetin, B., Saadaoui, J., & Ratiarison, H. (2024). The Effect of Corruption on Foreign Direct Investment at the Regional Level: A Positive or Negative Relationship? In N. Teramura, L. Nottage, & B. Jetin (Eds.), *Corruption and Illegality in Asian Investment Arbitration* (Vol. 22, pp. 69–86). Springer Nature Singapore. https://doi.org/10.1007/978-981-99-9303-1_3

Jhingan, M. L. (2016). *Ekonomi Pembangunan dan Perencanaan* (17th ed.). RajaGrafindo Persada.

Johnny, N., Timipere, E. T., & Krokeme, O. (2018). Impact of Foreign Direct Investment on Unemployment rate in Nigeria (1980-2015). *International Journal of Academic Research in Business and Social Sciences*, *8*(3), Pages 57-69. https://doi.org/10.6007/IJARBSS/v8-i3/3905

Karim, B. A., Karim, Z. A., & Nasharuddin, M. N. (2018). *Corruption and Foreign Direct Investment (FDI) in ASEAN-5: A Panel Evidence*. *64*(2).

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2009). *Governance Matters VIII: Aggregate And Individual Governance Indicators 1996-2008*. The World Bank. https://doi.org/10.1596/1813-9450-4978

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2011). The Worldwide Governance Indicators: Methodology and Analytical Issues. *Hague Journal on the Rule of Law*, *3*(02), 220–246. https://doi.org/10.1017/S1876404511200046

Kukaj, H., Nimani, A., & Usaj, V. (2022). Foreign direct investment, economic growth, and unemployment: Evidence from developing countries. *Journal of Governance and Regulation*, *11*(2, special issue), 293–300. https://doi.org/10.22495/jgrv11i2siart8

Malefane, M. R. (2020). Trade openness and economic growth in Botswana: Evidence from cointegration and error-correction modelling. *Cogent Economics & Finance*, *8*(1), 1783878. https://doi.org/10.1080/23322039.2020.1783878

Mustafa, A. M. M. (2019). The Relationship between Foreign Direct Investment and Inflation: Econometric Analysis and Forecasts in the Case of Sri Lanka. *Journal of Politics and Law*, *12*(2), 44. https://doi.org/10.5539/jpl.v12n2p44

Nguyen, M.-L. T. (2022). Foreign direct investment and economic growth: The role of financial development. *Cogent Business & Management*, *9*(1), 2127193. https://doi.org/10.1080/23311975.2022.2127193

Pandya, V., & Sisombat, S. (2017). Impacts of Foreign Direct Investment on Economic Growth: Empirical Evidence from Australian Economy. *International Journal of Economics and Finance*, *9*(5), 121. https://doi.org/10.5539/ijef.v9n5p121

Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.572504

Pham, N.-S., & Nguyen-Huu, T. T. (2025). *The role of FDI along transitional dynamics of the host country in an endogenous growth model*.

Phan Le, H. T., Pham, H., Thu Do, N. T., & Dang Duong, K. (2024). *Foreign direct investment, total factor productivity, and economic growth: Evidence in middle-income countries*. *11*. https://doi.org/10.1057/s41599-024-03462-y

Prasad, E., Rogoff, K., Wei, S.-J., & Kose, A. (2003). *International Monetary Fund*.

Qureshi, F., Qureshi, S., Vinh Vo, X., & Junejo, I. (2021). Revisiting the nexus among foreign direct investment, corruption and growth in developing and developed markets. *Borsa Istanbul Review*, *21*(1), 80–91. https://doi.org/10.1016/j.bir.2020.08.001

Rathnayaka Mudiyanselage, M. M., Epuran, G., & Tescașiu, B. (2021). Causal Links between Trade Openness and Foreign Direct Investment in Romania. *Journal of Risk and Financial Management*, *14*(3), 90. https://doi.org/10.3390/jrfm14030090

Rodrik, D. (1998). Why do More Open Economies Have Bigger Governments? *Journal of Political Economy*, *106*(5), 997–1032. https://doi.org/10.1086/250038

Sabir, S., Rafique, A., & Abbas, K. (2019). Institutions and FDI: Evidence from developed and developing countries. *Financial Innovation*, *5*(1), 8. https://doi.org/10.1186/s40854-019-0123-7

Saif-Alyousfi, A. Y. H., Md-Rus, R., Taufil-Mohd, K. N., Mohd Taib, H., & Shahar, H. K. (2020). Determinants of capital structure: Evidence from Malaysian firms. *Asia-Pacific Journal of Business Administration*, *12*(3/4), 283–326. https://doi.org/10.1108/APJBA-09-2019-0202

Sokang, K. (2018). The Impact of Foreign Direct Investment on the Economic Growth in Cambodia: Empirical Evidence. *INTERNATIONAL JOURNAL OF INNOVATION AND ECONOMIC DEVELOPMENT*, *4*(5), 31–38. https://doi.org/10.18775/ijied.1849-7551-7020.2015.45.2003

Visser, R. (2006). *Sistani, the United States and politics in Iran: From quietism to machiavellianism?* Norsk utenrikspolitisk institutt/Norwegian Institute of International Affairs.

Wei, S.-J. (2000). HOW TAXING IS CORRUPTION ON INTERNATIONAL INVESTORS? *THE REVIEW OF ECONOMICS AND STATISTICS*.

Wells, L. T., Allen, N. J., Morisset, J., & Pirnia, N. (2013). *Using Tax Incentives to Compete for Foreign Investment: Are They Worth the Costs?* World Bank and the International Finance Corporation.

World Bank Data. (2024). https://databank.worldbank.org/home.aspx

ATTACHMENT

Descriptive Statistic

Name	Type	Value
data.mean	double [6]	-0.0266 0.0753 7.7294 0.1021 0.9107 9.0221
CC	double [1]	-0.02657245
r.GDP	double [1]	0.0752592
Unemployment	double [1]	7.729447
r.INF	double [1]	0.1020807
TO	double [1]	0.9107077
FDInew	double [1]	9.022116

Name	Type	Value
data.sd	double [6]	0.996 0.117 5.279 2.016 0.621 6.316
CC	double [1]	0.9963777
r.GDP	double [1]	0.1171761
Unemployment	double [1]	5.279233
r.INF	double [1]	2.016082
TO	double [1]	0.6211122
FDInew	double [1]	6.315692

Name	Type	Value
data.min	double [6]	-1.645 -0.243 0.613 -9.670 0.270 -3.572
CC	double [1]	-1.645401
r.GDP	double [1]	-0.2427155
Unemployment	double [1]	0.61286
r.INF	double [1]	-9.669677
TO	double [1]	0.26967
FDInew	double [1]	-3.572115

Name	Type	Value
data.max	double [6]	2.242 0.438 26.619 10.729 4.259 30.001
CC	double [1]	2.242162
r.GDP	double [1]	0.4378999
Unemployment	double [1]	26.61928
r.INF	double [1]	10.72917
TO	double [1]	4.259028
FDInew	double [1]	30.00103

Name	Type	Value
data.median	double [6]	-0.2544 0.0695 6.2000 -0.0399 0.7415 7.9765
CC	double [1]	-0.2544256
r.GDP	double [1]	0.06945994
Unemployment	double [1]	6.2
r.INF	double [1]	-0.03992795
TO	double [1]	0.7415351
FDInew	double [1]	7.976511

Uji Chow

```
> pooltest(cem, fem) #Chow test

        F statistic

data:  FDI ~ CC + CPI + Export + GDP + Import
F = 3380385128218408517662, df1 = 496, df2 = 2722, p-value < 0.00000000000000022
alternative hypothesis: unstability
```

Uji Hausman

```
> phtest(fem, rem)

        Hausman Test

data:  FDInew ~ CC + Unemployment + r.GDP + TO + r.INF
chisq = 13.635, df = 5, p-value = 0.0181
alternative hypothesis: one model is inconsistent
```

Heteroskedasticity Test

Autocorrelation Test

```
        Breusch-Godfrey/Wooldridge test for serial correlation in panel models

data:  FDInew ~ CC + Unemployment + r.GDP + TO + r.INF
chisq = 12.399, df = 2, p-value = 0.002031
alternative hypothesis: serial correlation in idiosyncratic errors
```

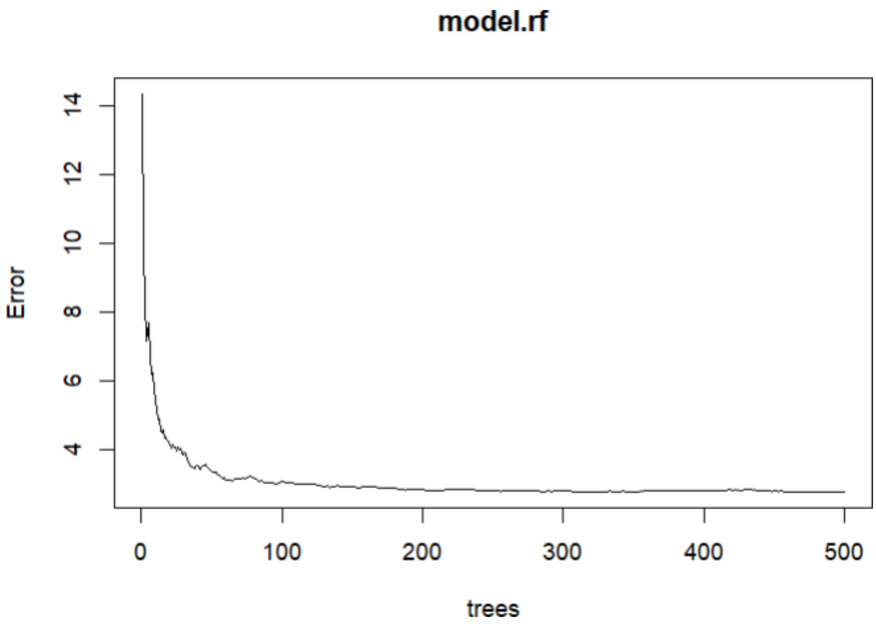
Cross Sectional Dependence Test

```
        Breusch-Pagan LM test for cross-sectional dependence in panels

data:  FDInew ~ CC + Unemployment + r.GDP + TO + r.INF
chisq = 19084, df = 12627, p-value < 0.00000000000000022
alternative hypothesis: cross-sectional dependence
```

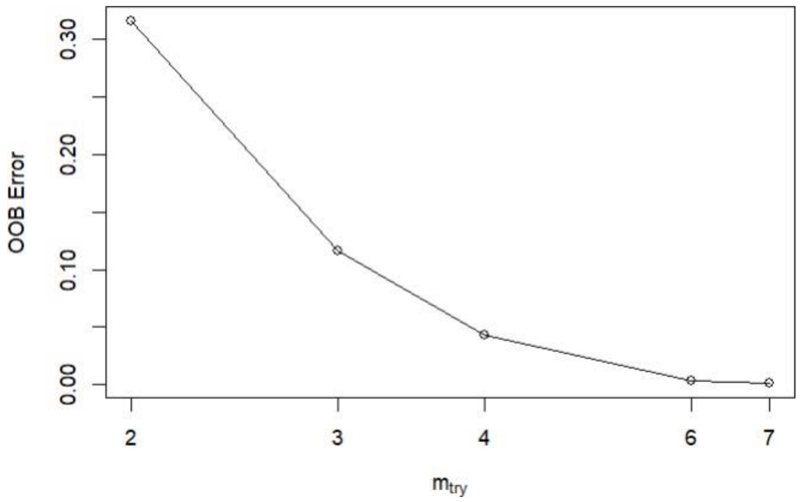
Result and Interpretation Discroll Kray

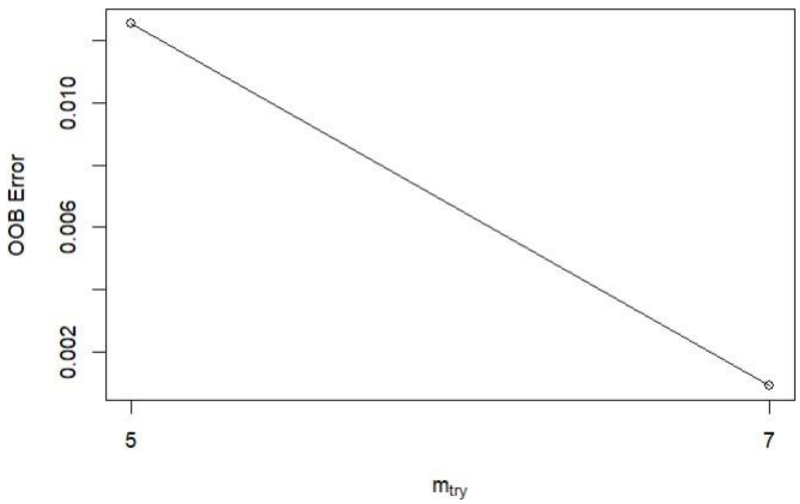
```
Coefficients:
            Estimate Std. Error t-value            Pr(>|t|)
CC          1.061131   0.083467 12.7132 < 0.00000000000000022 ***
Unemployment 1.014935   0.010719 94.6891 < 0.00000000000000022 ***
r.GDP       0.950669   0.119906  7.9284   0.000000000000003209 ***
TO          0.769666   0.072573 10.6055 < 0.00000000000000022 ***
r.INF       1.248186   0.020304 61.4749 < 0.00000000000000022 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    31643
Residual Sum of Squares: 2929.5
R-Squared:      0.90742
Adj. R-Squared: 0.90184
F-statistic: 2423.65 on 5 and 19 DF, p-value: < 0.000000000000000222
```

Plot Model rf before and after tuned

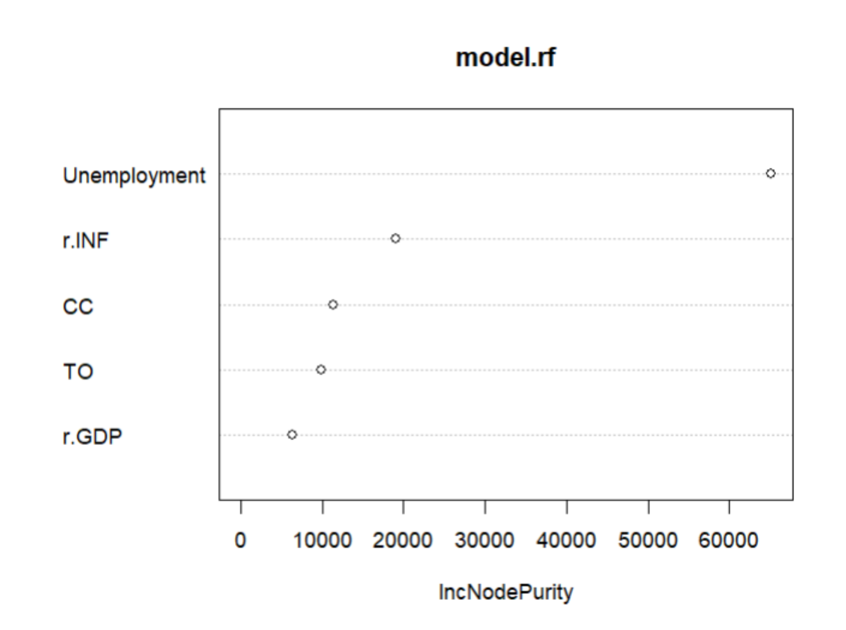


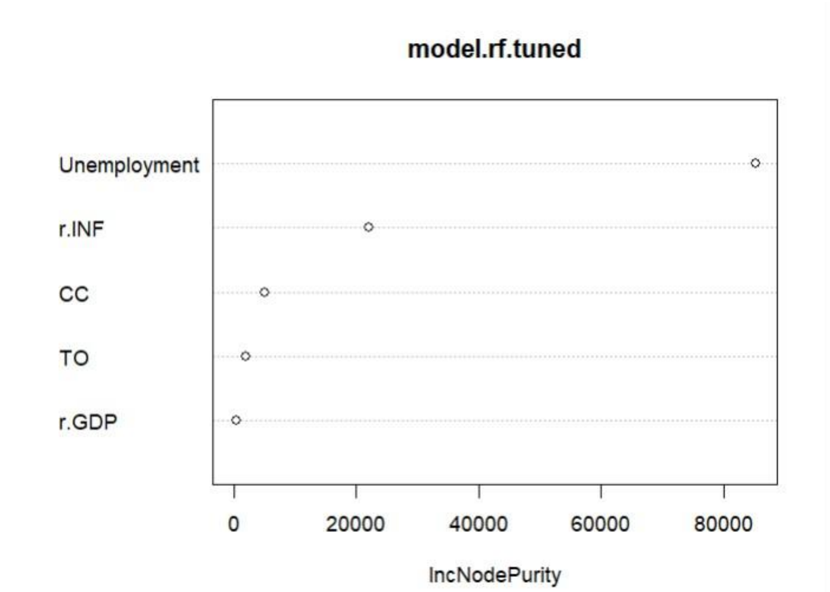
Mtry 3 and 7


OOB Error
0.00
0.10
0.20
0.30
2
3
4
6
7
mtry


OOB Error
0.002
0.006
0.010
5
7
mtry

Model rf tuned before and after tuned





RMSE before and after tuned

```
> sqrt.rf
[1] 1.655843
> sqrt.rf.tuned
[1] 0.9345702
>
```

Variable Importance before and after

```
> importance(model.rf.tuned)
              IncNodePurity
CC                5082.5185
r.GDP              373.4625
Unemployment     85322.6980
r.INF            22104.5763
TO                1972.4312
> importance(model.rf)
              IncNodePurity
CC                11364.482
r.GDP              6314.065
Unemployment      65198.134
r.INF             19120.317
TO                 9989.279
>
```

Scenarios Independent variable

```
Coefficients:
             Estimate Std. Error t-value             Pr(>|t|)
CC           1.080407   0.080964  13.344 < 0.00000000000000022 ***
Unemployment 1.010538   0.011821  85.484 < 0.00000000000000022 ***
TO           0.807821   0.079405  10.174 < 0.00000000000000022 ***
r.INF        1.250698   0.020335  61.504 < 0.00000000000000022 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    31643
Residual Sum of Squares: 2964.1
R-Squared:      0.90633
Adj. R-Squared: 0.90072
F-statistic: 2677 on 4 and 19 DF, p-value: < 0.000000000000000222
```

```
Coefficients:
             Estimate Std. Error t-value             Pr(>|t|)
CC           1.011863   0.087274 11.5942 < 0.00000000000000022 ***
Unemployment 1.009115   0.011060 91.2370 < 0.00000000000000022 ***
r.GDP        1.023846   0.111404  9.1904 < 0.00000000000000022 ***
r.INF        1.252981   0.021219 59.0490 < 0.00000000000000022 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    31643
Residual Sum of Squares: 2983.2
R-Squared:      0.90572
Adj. R-Squared: 0.90008
F-statistic: 2521.23 on 4 and 19 DF, p-value: < 0.000000000000000222
```

```
Coefficients:
             Estimate Std. Error t-value             Pr(>|t|)
CC           1.030061   0.084803  12.147 < 0.00000000000000022 ***
Unemployment 1.004050   0.012296  81.654 < 0.00000000000000022 ***
r.INF        1.255954   0.021305  58.950 < 0.00000000000000022 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    31643
Residual Sum of Squares: 3023.5
R-Squared:      0.90445
Adj. R-Squared: 0.89877
F-statistic: 2983.73 on 3 and 19 DF, p-value: < 0.000000000000000222
```