Hochschule Rhein-Waal
Rhine-Waal University of Applied Sciences
Faculty of Technology and Bionics

Economic Freedom and Growth in the European Economic Area:
A Panel Analysis for the Period 2000-2019

Bachelor Thesis

By
Kasra Hashemi

Supervisors:
Prof. Dr. Gernot Müller
Prof. Dr. Dirk Berndsen

Hochschule Rhein-Waal

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Kasra Hashemi

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Prof. Dr. Gernot Müller

Prof. Dr. Dirk Berndsen

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Abstract

This thesis examines the relationship between economic freedom and economic growth in the European Economic Area (EEA) from 2000 to 2019. The study focuses on four components of The Heritage Foundation's Index of Economic Freedom (IEF): Rule of Law (RL), Government Size (GS), Regulatory Efficiency (RE), and Market Openness (MO). Using the Common Correlated Effects Mean Groups (CCEMG) estimation technique with Driscoll-Kraay robust standard errors, the analysis finds that all components significantly impact GDP growth. RL and RE are negatively associated with growth, while GS and MO are positively correlated. Additionally, increases in capital and labor stocks significantly enhance growth, with capital having a stronger effect.

The findings challenge the blanket advocacy for libertarian policies by The Heritage Foundation and the Fraser Institute. The relationship between economic freedom and growth is complex, with some measures potentially hindering growth. This highlights the importance of considering external factors and the diminishing returns of economic freedom measures beyond certain thresholds.

In the context of a global shift from globalization to fragmentation, EEA members need to adopt new growth models to sustain economic growth. Economic fragmentation typically reduces trade and capital movement, but the EEA can achieve higher growth rates through deeper integration. Future expansions must carefully consider new members' effects on current policies. The study underscores the need for a balanced policy approach, avoiding overly large public sectors and broad protectionist measures. A flexible regulatory approach is crucial for adapting to changes and ensuring sustained growth within the EEA.

Keywords: Economic Freedom, European Economic Area, Panel Analysis, Driscoll-Kraay Standard Errors, Common Correlated Effects Estimator

Contents

Table of Abbreviations

CCEMG	Common Correlated Effects Mean Groups
CCEP	Common Correlated Effects Pooled
CIPS	Cross-sectionally augmented IPS
ECB	European Central Bank
EEA	European Economic Area
EF	Economic Freedom
EFW	Economic Freedom of the World
FE Model	Fixed Effects Model
GDP	Gross Domestic Product
GDPPC	Gross Domestic Product Per Capita
GNI	Gross National Income
GS	Government Size
GVA	Gross Value Added
HDI	Human Development Index
IEF	Index of Economic Freedom
IHDI	Inequality-adjusted Human Development Index
IPS	Im, Pesaran, and Shin
LOWESS	Locally Weighted Scatter-plot Smoothing
MO	Market Openness
OLS	Ordinary Least Squares
PPP	Purchasing Power Parity
RE	Regulatory Efficiency
RE Model	Random Effects Model
RL	Rule of Law

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1 Introduction

Economic Freedom (EF), a concept with roots tracing back to Milton Freedman's Capitalism and Freedom and arguably even Adam Smith's *The Wealth of Nations*, has garnered significant attention in economic literature. The core principles of EF — secure private property rights, personal choice, voluntary exchange, and market entry freedom — are considered essential for economic growth. By fostering an environment where innovation, entrepreneurship, and prudent economic decision-making flourish, EF serves as the linchpin in the quest for both economic robustness and, by extension, higher Human Development Index (HDI) and national happiness index values [1]. The Fraser Institute's Economic Freedom of the World (EFW) index and the Heritage Foundation's Index of Economic Freedom (IEF) both aim to quantify EF across countries. These indexes measure "institutional success", with higher scores corresponding to higher economic freedom, implicitly suggesting that higher EF leads to free markets, fewer regulations, and minimal government.

Literature on EF and growth predominantly focuses on either a global scale [2]–[5] incorporating diverse countries, or specifically on developing nations [6]–[13]. This trend is understandable, as researchers are interested in exploring long-term macroeconomic impacts and mechanisms for sustained growth in developing countries, which typically exhibit lower EF scores. While empirical evidence often suggests a positive relationship between EF and growth, many studies overlook underlying empirical issues. Pooling together countries with unique characteristics offers limited insights for policy-making. Additionally, EF is often assessed as a whole rather than disaggregated, leading to a distorted view of its effects, as it is an aggregated index of various measures. Many studies also fail to adequately model heterogeneity and endogeneity, resulting in biased estimates and incorrect inferences.

This study focuses on the European Economic Area (EEA) due to its methodological suitability and the commonalities among EEA countries [14]. EEA members benefit from the EU's single market and the "four freedoms". There is regulatory homogeneity, shared commitments to human rights and democracy, environmental and sustainable development goals, as well as social and economic cohesion. EEA countries also share high investment in education and innovation, commitment to social welfare, high degrees of industrialization, significant service and tech sectors. However, the aging population due to increased life expectancy and low birth rates poses a challenge to economic growth, underscoring the necessity for ongoing economic development within the EEA.

This need for growth is amplified by the EEA's lag behind China and the US in terms of competitiveness, productivity, and investment. This lag is partly attributed to excessive regulations, fragmented financial markets, and insufficient public and private investments [15]. Structural and organizational issues, such as reliance on outdated economic structures and higher energy prices, further impact competitiveness. Radical changes in economic policies, increased investments, and greater market integration are necessary to keep pace with global competitors. Despite these challenges, the EEA's contribution to approximately 16% of the total global economic output highlights its pivotal role in global trade, research, and innovation [16].

Given the inherent homogeneity within this region [14], the EEA offers a unique opportunity to study the long-term relationship between EF and economic prosperity at a more granular level. Altman [17], [18], and Derbel, Abdelkafi, and Chkir [19] found that the EF-growth relationship is characterized by threshold effects and country-specific critical values. As EEA members generally have high EF scores, this study will explore the extent to which incremental increases in EF continue to influence economic growth and prosperity within the EEA, providing insights for policymakers on potential strategy shifts after achieving a certain level of EF. The findings of this research could guide policymakers in shaping economic policies that ensure sustainable and inclusive economic growth, helping the EEA address its competitiveness challenges and maintain its significant role in the global economy.

1.1 Background and Concepts

1.1.1 Economic Freedom

There is not a single official accepted definition of EF, however the definitions given all have a few key elements in common. Broadly speaking, EF refers to the degree to which individuals and businesses are free to conduct economic activities without undue interference from the government. Freedom to produce, consume, work ,and invest in any way individuals prefer all fall under the main definitions. Another important aspect referred to very often is the protection of individuals and business and their property by law. To this day, the exact way to measure the degree of EF has not been standardized, however, two indexes have predominantly been used by both researchers and policy-makers. Namely, the Economic Freedom of the World index (EFW) by the Fraser Institute[20] and the Index of Economic Freedom (IEF) by The Heritage Foundation [1]. Given the multifaceted nature of such a broad idea, it is certain that the definitions will continue to evolve over time. In fact, both the Fraser Institute and The Heritage Foundation made changes to their indexes in the recent years. So to summarize, the concept of EF at its core comprises several key aspects, namely:

- Personal choice to conduct economic affairs
- Freedom to enter and compete in markets
- Voluntary exchange and freedom to trade goods and services
- Protection of persons and property by the rule of law
- Minimal government intervention in the economy

In the next two sections, a more detailed description of each of the prominent EF indexes is given.

Fraser Institute's Economic Freedom of the World Index The Fraser Institute's EFW index consists of a total of five major "areas" which are broken down into 25 subcomponents, which in turn are broken down further into a total of 45 distinct measures. Each individual measure receives a score between 0-10 and an unweighted average is calculated to obtain the subcomponents and the main 5 components. For more details, the methodology and data sources are provided in the 2023 report [20]. The five main areas are:

1. **Size of Government:** focuses on how government expenditures and tax rates affect economic freedom. Taken together, the five components of Area 1 measure the degree to which a country relies on personal choice and markets rather than government budgets and political decision-making. Countries with lower levels of government spending, lower marginal tax rates, less government investment, and state ownership of assets earn the highest ratings in this area.

2. **Legal System and Property Rights:** focuses on the importance of the legal system as a determinant of EF. Protection of persons and their right- fully acquired property is a central element of economic freedom. Many would argue that it is the most important function of government. The key ingredients of a legal system consistent with economic freedom are rule of law, security of property rights, an independent and unbiased judiciary, and impartial and effective enforcement of the law. The eight components of Area 2 are indicators of how effectively the protective functions of government are performed. The rating for Area 2 is adjusted based on a gender-disparity index that reflects cross-country differences in legal rights based on gender.

3. **Sound Money:** focuses on the importance of money and general price stability in the exchange process. Sound money—money with relatively stable purchasing power across time—reduces transaction costs and facilitates exchange, thereby promoting economic freedom. The four components of this area provide a measure of the extent to which people in different countries have access to sound money. In order to earn a high rating in Area 3, a country must follow policies and adopt institutions that lead to low (and stable) rates of inflation and avoid regulations that limit the ability to use alternative currencies.

4. **Freedom to Trade Internationally:** focuses on exchange across national boundaries. In our modern world, freedom to trade with people in other countries is an important ingredient of economic freedom. When governments impose restrictions that reduce the ability of their residents to engage in voluntary exchange with people in other countries, economic freedom is diminished. The components in Area 4 are designed to measure a wide variety of trade restrictions: tariffs, quotas, hidden administrative restraints, and controls on exchange rates and the movement of capital. In order to get a high rating in this area, a country must have low tariffs, easy clearance and efficient administration of customs, a freely convertible currency, and few controls on the movement of physical and human capital.

5. **Regulations**: measures how regulations that restrict entry into markets and interfere with the freedom to engage in voluntary exchange reduce economic freedom. The components of Area 5 focus on regulatory restraints that limit the freedom of exchange in credit, labor, and product markets.

The Heritage Foundation's Index of Economic Freedom The Heritage Foundation's IEF is made up of four main "pillars", which are each divided up into subcomponents, of which there are a total of 12. The IEF is also an unweighted average of all the subcomponents and each one is scored 0-100. The main components and subcomponents are:

1. **Rule of law (property rights, judicial effectiveness, and government integrity)** Secure property rights motivate workers and investors, enabling them to accumulate wealth, engage in entrepreneurial activities, and make long-term plans without fear of unfair expropriation or theft. This security also facilitates the use of property as collateral for investment, preventing the "tragedy of the commons". Judicial effectiveness ensures that legal frameworks protect citizens' rights and uphold contracts, which is fundamental for economic specialization and international trade. An effective judiciary is especially critical for developing countries, providing a foundation for economic growth and preventing economic decline in advanced economies. Government integrity involves minimizing corruption, which can manifest as bribery,

nepotism, and other practices that undermine fair treatment and economic freedom. Excessive government intervention and regulations often create opportunities for corruption, hindering economic growth and transparency.

2. **Government size (tax burden, government spending, and fiscal health)**
   The tax burden reflects the extent to which governments allow individuals and businesses to retain their income and wealth. Higher taxes reduce economic incentives, limiting private sector activity. The overall tax burden, including various indirect taxes, is measured as a percentage of GDP. Government spending, while sometimes beneficial for infrastructure, research, and public goods, generally crowds out private economic activity. Excessive spending distorts market allocations and leads to inefficiencies and higher public debt. Fiscal health, indicated by budget management, is crucial for economic freedom. Poor fiscal health, marked by growing deficits and debt, destabilizes the economy, increasing uncertainty and reducing economic freedom. High public debt can crowd out private investment and limit government flexibility, often leading to economic stagnation rather than growth.

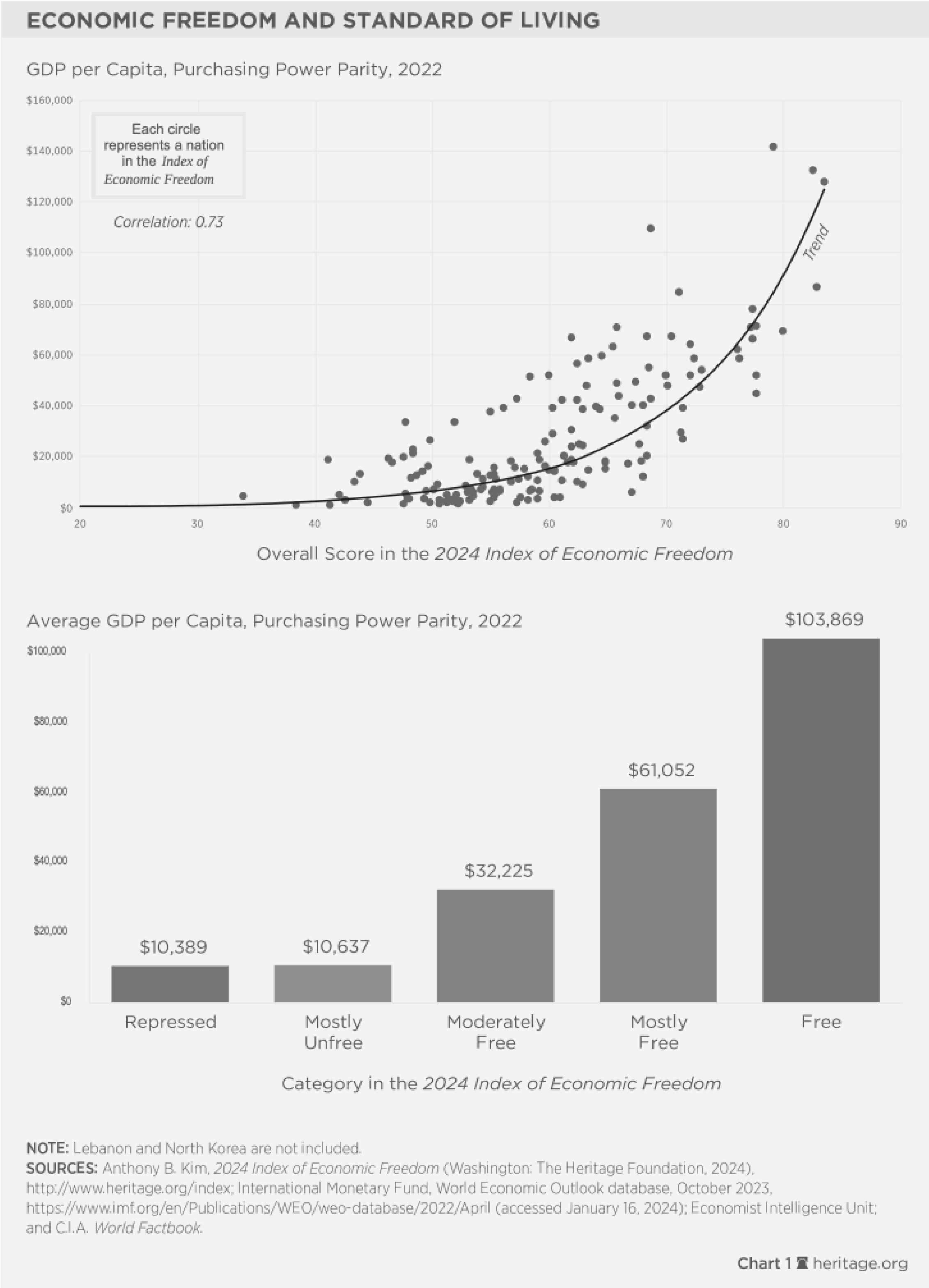
3. **Regulatory efficiency (business freedom, labor freedom, and monetary freedom)**
   Business freedom ensures that individuals can start and run businesses without excessive government interference, while labor freedom allows for flexible labor markets where businesses can hire and fire workers as needed. Monetary freedom requires a stable currency and market-determined prices, enabling individuals to plan and invest confidently. Excessive regulations and rigid labor laws hinder economic activity, while stable monetary policies combat inflation and preserve wealth.

4. **Market openness (trade freedom, investment freedom, and financial freedom)**
   Trade freedom reduces barriers like tariffs and quotas, promoting efficient international commerce. Investment freedom allows capital to flow to its most productive uses, fostering entrepreneurship and innovation. Financial freedom ensures access to diverse financial services, encouraging competition and efficient capital allocation. Transparency and minimal government intervention in financial markets are crucial to maintaining integrity and efficiency. These components of market openness collectively enhance economic resilience and growth.

Refer to [1] for more detailed descriptions of each category.

Figure 1 has been taken from the latest report by The Heritage Foundation where the fitted line through the scatter plot seems to resemble an exponential trend. This will be investigated further in the methodology section.

Figure 1: Economic Freedom and Standard of Living [1]



Differences Between EFW and IEF Despite the fact that both indexes attempt to measure EF, each one measures it slightly differently(recall that the EFW uses five main measures while the IEF uses four). There are also minor scoring and methodological differences, such as the EFW having a scale of 0 to 10 and the IEF 0 to 100.

Ausloss and Bronlet [21] provided an in-depth comparison and further analysis of both indexes and found the IEF to be slightly more "conservative" than the EFW, meaning that the scores on average were lower in the IEF. The IEF is used in this paper for a few reasons:

- The EFW index is frequently and predominantly referenced in academic research. In an effort to diversify perspectives and potentially gain novel insights, the IEF is employed as a strategic counterbalance to the prevalent reliance on the EFW. This approach aims to broaden the analytical scope by incorporating a varied set of economic freedom indicators.
- The IEF is recognized for its more conservative stance relative to the EFW, which inherently reduces the likelihood of overestimating the influence of EF on economic growth.
- the IEF's four principal measures have a lower risk of multicollinearity compared to the EFW's five measures.
- compared to the EFW, the IEF is designed not only as an analytical tool but also as a policy advocacy tool, with clear policy recommendations accompanying the country analyses.

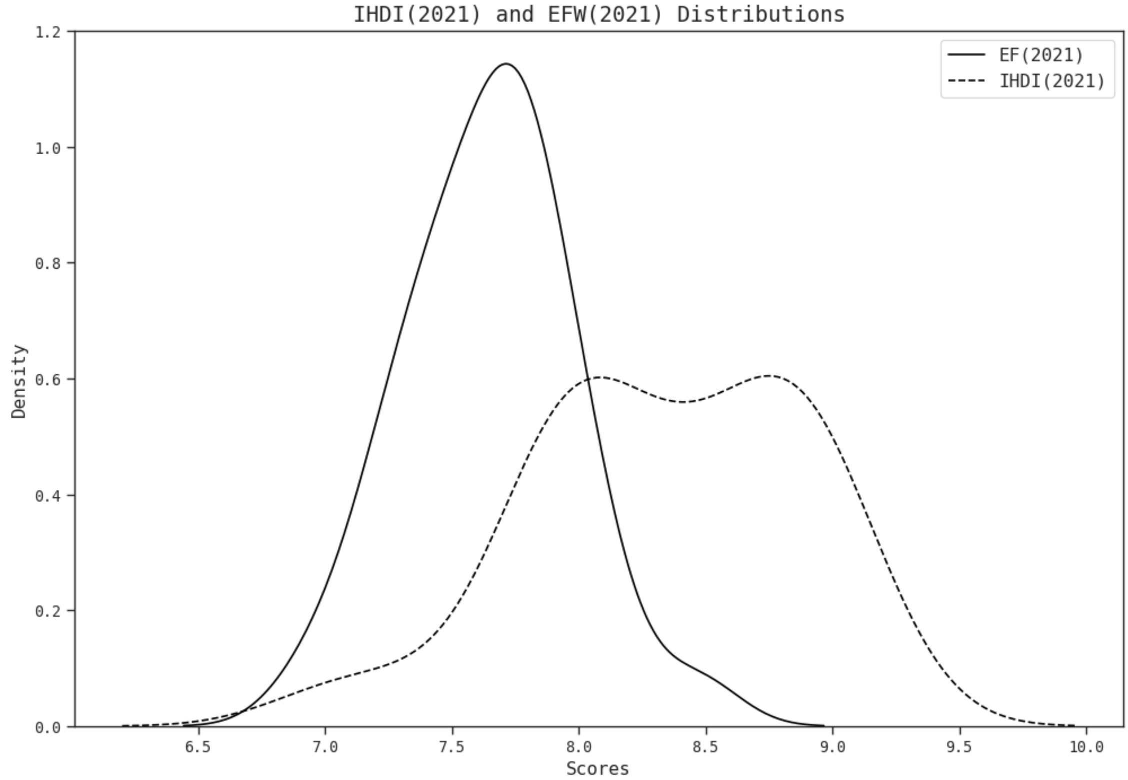
1.1.2 European Economic Area

Established in 1994, the EEA is a partnership between the countries of the European Union (EU) and the European Free Trade Association (EFTA) members. It extends the EU's free movement of goods, persons, services and capital within its market to EFTA members. Since, 1994, the EEA has continually expanded and adapted new regulations and policies to mirror the single market in the EU [14]. The main idea behind the EEA is to integrate the economies of European states into a single market, thereby facilitating economic cooperation and harmonizing legislations to try and minimize the social and economic disparities in the EEA. Table I and Figure 2 show the descriptive statistics as well as the spread of both the IHDI and the EFW scores of the EEA countries for the year 2021:

Table I: Summary Statistics for IHDI and EFW

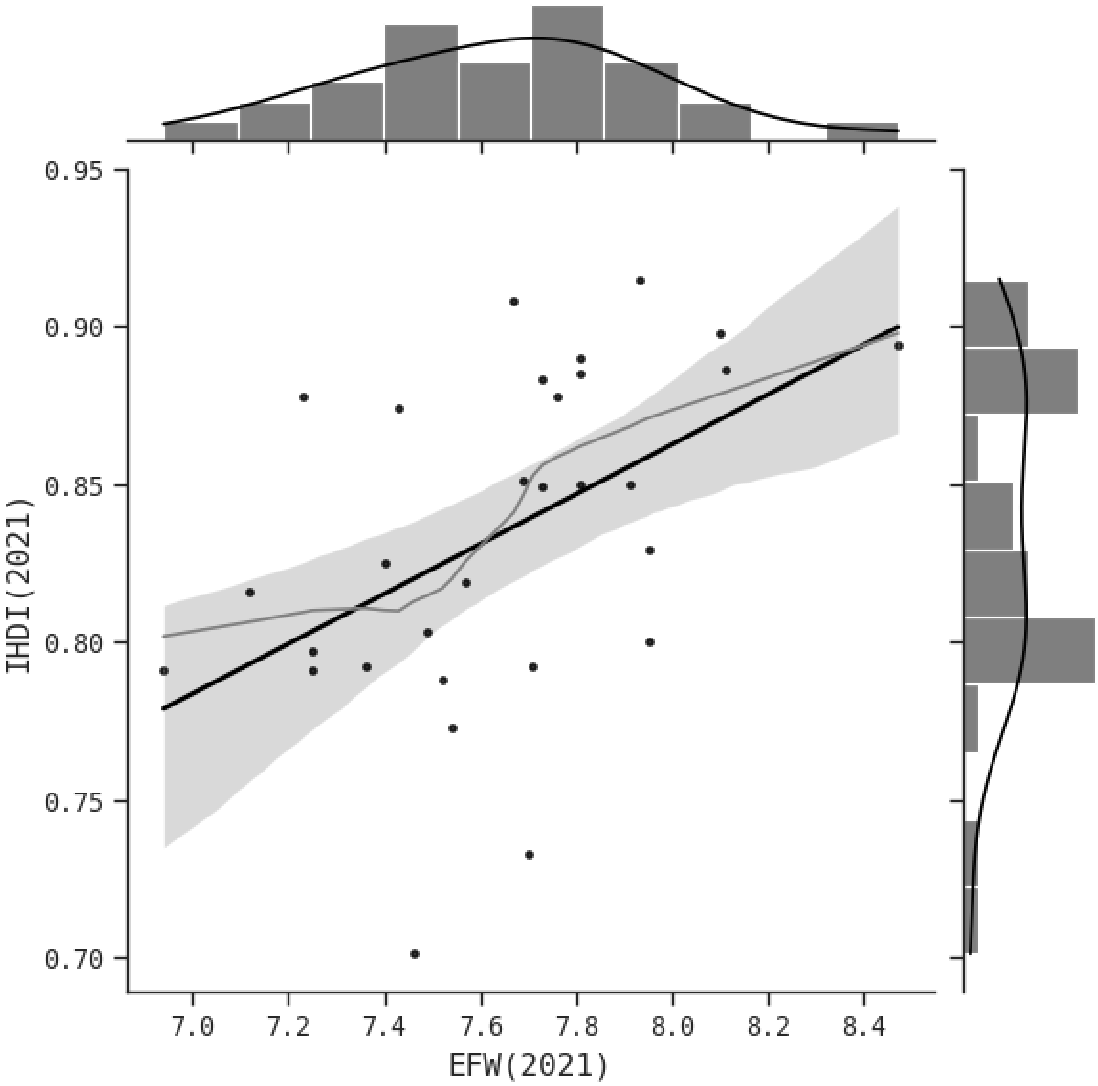
	IHDI(2021)	EFW(2021)
count	30.000	30.000
mean	0.835	7.647
std	0.053	0.327
min	0.701	6.940
25%	0.793	7.438
50%	0.839	7.695
75%	0.882	7.810
max	0.915	8.470

Figure 2: KDE Plots of IHDI (Rescaled) and EFW



As expected, the mean IHDI of 0.835 and mean EFW of 7.647 reflect the fact that the majority of the EEA countries possess high living standards and EF scores. The minimum and maximum IHDI scores are 0.701 (Bulgaria) and 0.915 (Iceland) respectively. Meanwhile the minimum and maximum EFW scores are 6.940 (Greece) and 8.470 (Switzerland) respectively. Additionally, Figure 3 is a regression plot of the IHDI and EFW that demonstrates a positive correlation between the two measures.

Figure 3: Regression Plot of IHDI and EFW



Overall, there is a general upward trend, meaning that countries with higher IHDI scores tend to also have higher EF scores. With regards to correlation, since the nature of the relationship between these variables is not known, several measures of correlation are calculated:

Table II: Correlation Between IHDI and EFW in 2021

	Correlation coefficient	P-value
Pearson r	0.485	0.007
Spearman ρ	0.562	0.001
Kendall Tau τ	0.388	0.003
Xi ξ_n	0.129	0.039

Likely a new correlation coefficient for most readers, the ξ_n correlation coefficient, introduced by Chatterjee [22], is designed to address some of the limitations of classical correlation coefficients, particularly in terms of detecting non-linear relationships and providing an equitable measure of association. The coefficient ranges from 0 to 1. It is 0 if and only if the two variables are independent, and it is 1 if and only if one variable is a measurable function of the other. Unlike most correlation coefficients, ξ_n is not symmetric.

This non-symmetry is intentional to reflect the direction of dependency. To test if a variable X is a function of Y, one would use $\xi_n(Y,X)$. A symmetric measure can be obtained by taking the maximum of $\xi_n(Y,X)$ and $\xi_n(X,Y)$, which is what has been done in Table II. ξ_n will be included in further computations as it is robust to outliers and it is particularly useful for detecting non-linear relationships which makes it relevant to this study.

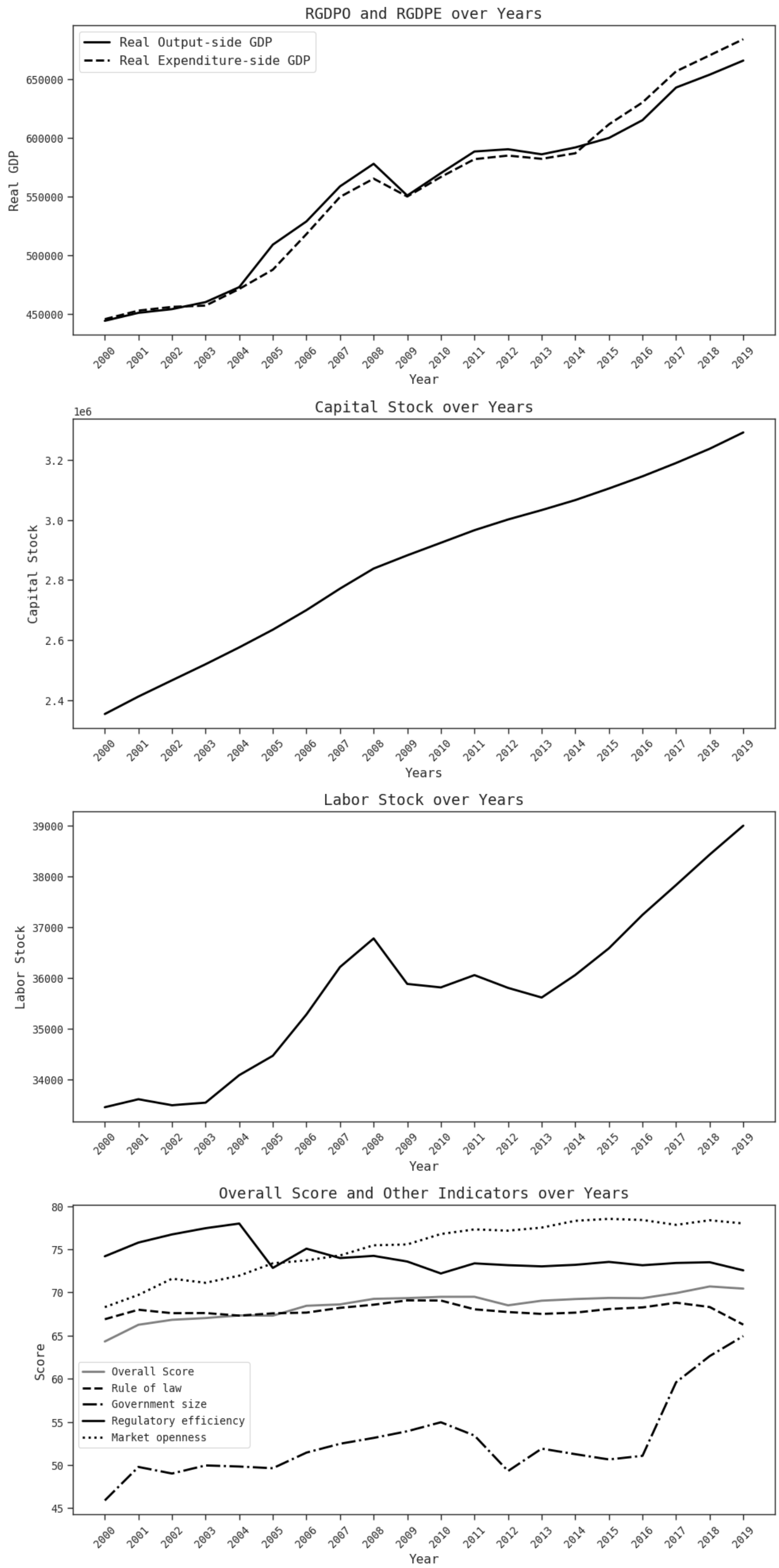
1.1.3 General Trends of Economic Freedom and Economic Growth

There have been five significant economic phases in the EEA between 2000 and today, namely:

- 2000-2008: Pre-Financial Crisis
- 2008-2012: Financial Criss and Eurozone Debt Crisis
- 2013-2019: Recovery and Growth Stabilization
- 2020-2021: COVID-19 Pandemic Impact
- 2022-2024: Post-Pandemic Recovery and Challenges

In the early 2000s, the EEA experienced moderate growth, driven by the expansion of the EU and increased trade integration, as well as technological advancements. In the mid-2000s, growth accelerated due to favorable economic conditions, robust consumer and business confidence, and low interest rates. As can be seen in Figure 4, the global financial crisis in 2008 led to a severe economic downturn, with recovery being slow and uneven in the EEA. Despite countries implementing austerity measures to curb high public debt levels, several EEA countries particularly in southern Europe, faced sovereign debt crises, leading to bailouts and once again significant economic contraction. Between 2013 and 2020, economic recovery became more robust, aided by monetary easing from the European Central Bank (ECB). The EEA experienced moderate, albeit steady economic expansion. In 2020, the COVID-19 pandemic caused a sharp drop in economic activity. Lockdowns and restrictions led to significant GDP declines across the EEA. This drop was followed by a strong rebound due to large-scale fiscal stimulus, easing of restrictions, and vaccine rollouts. From 2022 onwards, growth rates across the EEA have been varied at best. Inflationary pressures due to the pandemic combined with extensive supply chain disruptions have so far hampered major growth. This has been further exacerbated by rising geopolitical tensions, including the Russia-Ukraine conflict, which has led to trade restrictions and higher energy prices.

Figure 4: Line Plots of GDP, Capital Stock, Labor Stock, and EF Scores



The Heritage Foundation’s 2024 report [1] notes that the global Economic Freedom (EF) score is the lowest it has been since 2001, indicating a deterioration in fiscal soundness worldwide. However, within the European Economic Area (EEA), the EF scores have remained relatively stable. Looking ahead, the World Bank projects growth rates of 0.7% in 2024, 1.4% in 2025, and 1.3% in 2026 [23]. While growth is expected to stabilize, the

World Bank report highlights several challenges, including tight credit conditions, weak exports, and high energy prices, which are leading to a loss of export competitiveness. Additionally, the national fiscal policies of some large euro area members are expected to impede economic growth in the near term. There is also considerable uncertainty surrounding trade policy, both within the EEA and globally.

Currently, the previous economic orthodoxy of liberalized trade, open markets, and maximizing efficiency through globalization is being challenged. Policies such as Germany's "Wandel durch Handel" (change through trade) have been discredited by Russia's invasion of Ukraine. The pandemic and periods of heightened geopolitical tensions exposed severe vulnerabilities and shortages due to complex global supply chains and interdependencies between countries. China, arguably the major beneficiary of globalization, has not embraced democratic values and its control over strategic supply chains poses significant challenges for EEA countries. Furthermore, globalization has led to increased emissions and environmental degradation, accelerating climate change. Advanced economies, such as those in the EEA, outsourced industrial jobs abroad, resulting in wage suppression and political discontent. Trade has become more difficult as more industrial policies and restrictions have been adopted. Policymaking is increasingly improvised, focusing on balancing efficiency, security, and self-reliance. According to the World Bank report, these combined factors suggest that growth in the EEA, and globally, is expected to remain modest.

1.2 Organization of the Paper

The rest of this paper is organized as follows: section 2 is a selected literature review of the most relevant papers. In section 3, the research framework is discussed which leads to the main research hypotheses. In section 4, the process of data collection and cleaning, EDA, model specification, alongside estimation and testing of the models are discussed. In section 5, model results are interpreted. Section 6 concludes the paper and in it, further lines of research are included, as well as policy suggestions based on the the research findings.

2 Literature Review

The concept of EF, its measurement and its effects on other macroeconomic indicators has generated a lot of interest since its introduction, with the amount of literature being rather large. In the next three sections, the most seminal and relevant papers are discussed to provide the background for the EF-growth relationship, as well as the current state of research on the topic. The papers discussed are broadly divided into three main topics: 2.1 are papers that discuss the importance of institutions and policies in ensuring economic stability and prosperity. This concept is actually older than EF, forming the foundations of EF as it is defined today. 2.2 is a review of the literature specifically looking at the EF-growth relationship, as well as some limitations of EF. 2.3 are selected papers that examine the effects of EF in the European context.

2.1 Institutions and Policies

Already in 1971, North [24] explored the impact of institutional changes on economic development. In it, he argued that institutional innovations were just as critical as technological advancements. Institutions have a profound impact in reducing transaction costs, spreading risk and helping with the management of externalities. More efficient institutions directly lead to more efficient economic organization and market function, driven by the pursuit of profit maximization. He advocated for a more integrated approach that considers both technological and institutional innovations, suggesting that the key to economic growth lies in creating an environment conducive to productive institutional arrangements. This environment includes stable property rights, efficient markets, and a legal system that encourages innovation and investment while discouraging unproductive rent-seeking behaviors.

Barro [25] concluded in his paper that while democracy has complex and sometimes even contradictory effects on economic growth, it still plays a crucial role in the development of a nation. He mentioned that once a certain level of freedom has been achieved, more democracy does not always catalyze growth, in fact having a slight negative correlation with growth past a certain point. He also mentioned the importance of both political and economic freedom in conjunction when analyzing growth trajectories. His conclusion was that, especially for developing economies, economic systems, notably property rights and free markets, contribute more toward growth and general welfare compared to political systems.

Pitlik [26] examined the impact of economic liberalization on growth, based on theories from classical liberalism and empirical data. He discussed measuring liberalization using indexes like the Fraser Institute's index and highlighted the negative effects of policy volatility on growth. He emphasized that gradual and steady liberalization correlates with better growth, contrasting with the detrimental impact of volatile policies. He supported his conclusion by theoretical frameworks and a cross-sectional regression study, presenting a comprehensive view of the relationship between policy stability and economic growth.

Abdiweli [27] hypothesized that institutional difference across countries were a significant factor in the observed differences in growth levels. His empirical results revealed that the 'institutional environment' of a nation is a key determinant of its economic growth. Specifically, he mentioned judicial efficiency, reducing corruption, enhancing bureaucratic efficiency and safeguarding private property. He also mentioned that economic freedom and good institutions go hand in hand, which means that long-term growth is only possible if the institutional quality of a country is good.

Acemoglu, Johnson and Robinson [28] also addressed institutional differences and how they lead to divergent economic outcomes using historical examples and quasi-natural experiments. They discussed how economic institutions determine the incentives and constraints on economic actors and are chosen based on their consequences for different groups. The distribution of political power, influenced by political institutions and resource distribution, plays a crucial role in shaping these economic institutions. Good economic institutions, which encourage investment, innovation, and efficient resource allocation, arise when political institutions distribute power broadly and create constraints on power-holders. According to them, economic growth is fostered by secure property rights and inclusive economic institutions. They concluded that understanding the development and impact of economic institutions requires a dynamic framework that considers the interplay between political institutions, political power, and economic outcomes.

Harrison and Rodríguez-Clare [29] did an extensive study of how non-neutral policies regarding trade, FDI, and resource allocation could affect growth in developing countries and across different industries. They identified key reasons why a country might deviate from policy neutrality, including learning externalities from exports, knowledge spillovers, industry-level rents, and sector-specific coordination failures. An extensive look at the empirical evidence on these so-called "industrial policies" showed mixed results in their effectiveness. They found that in a few instances infant-industry protection has led to higher growth, but necessary conditions (e.g. industry-level rents, large Marshallian externalities) are rarely met in practice. They associated liberalization of trade with higher growth in general, but mentioned that its success often depends on complementary policies such as reducing barriers to firm entry and improving infrastructure. After their extensive survey of empirical evidence, they concluded that while there are instances of successful industrial policy, these are not common. Broad protectionist measures were unlikely to yield results. They instead suggested policies that promote trade and FDI.

Haidar [30] investigated the relationship between business regulatory reforms and economic growth. He concluded the contribution of business regulatory reforms to economic growth was significant. His paper was unique in that he showed that while macroeconomic policies are crucial for growth, microeconomic reforms in business regulations are also catalysts for economic growth. He showed that there is robust evidence suggesting that after the global financial crisis, countries with more business regulatory reforms enjoyed higher economic growth rates.

In his 2022 paper, Lane [31] examined South Korea's Heavy and Chemical Industry (HCI) drive from 1973 to 1979, a pivotal industrial policy, and used newly assembled data ,covering South Korea's industrial outcomes from 1967 to 1986, found that HCI resulted in substantial growth in target industries. Crucially, he found that the benefits of the HCI drive persisted even after the policy ended, suggesting a durable industrial transformation. Furthermore, he found that downstream users of HCI products expanded their outputs and investments in intermediate capital goods. Similarly to his earlier study [32], Lane called for coherent and targeted industrial policies in achieving significant industrial growth and transformation. The success of such policies depends on the political will, bureaucratic capacity, and incentive compatibility within the implementing state or states.

More recently, and specifically regarding industrial policies, [33], [34] have revealed that contrary to skepticism from most economists, recent literature provides a more positive and nuanced understanding of industrial policy. They found that, perhaps somewhat surprisingly, industrial policy is more prevalent in high-income countries and typically involves subsidies and export promotion measures, rather than being protectionist. Using more modern statistical techniques, they found that industrial policy can produce significant long-term effects in specific settings, such as infant industry promotion and public R&D efforts. This validates the effectiveness of industrial policy as a significant tool for economic development and structural transformation, particularly in advanced economies, challenging the traditional skepticism.

2.2 Economic Freedom

Hanke and Walters [5] provided a comprehensive analysis of the relationship between economic freedom and multiple economic performance indicators. They were aware of and even addressed the difficulty in the methodology of quantifying such a metric (by referring to EFW and IEF). Their key findings were that natural resources, labor, and technologies were not sufficient conditions for sustained growth. Once agin, they emphasized economic liberty and its main tenets for growth. They also highlighted the importance of economic institutions and policies that foster economic freedom as a means to achieve greater prosperity and equality.

De Haan and Sturm [3] provided a rather detailed analysis of the freedom-growth relationship and found that while the level of economic freedom in a given country might not be directly correlated with growth rates, changes in economic freedom are robustly related to economic growth. Additionally, they discussed the limitations of measuring economic freedom through the EFW and IEF indexes. They called for a more nuanced and critical approach to measuring and understanding economic freedom, noting its fundamental role in economic development strategies.

Carlsson and Lundström [35] analyzed the disaggregated indexes and found differing levels of significance for various aspects of the index. They found unequal contribution of the individual components to growth and cautioned against using an aggregate index in policy-making. Namely, that the positive effect of some aspects of economic freedom on growth is robust, but this does not imply that increasing all forms of economic freedom will necessarily enhance growth. Certain dimensions have more profound impacts, and policy implications should consider the specific nature and interaction of these dimensions.

Similarly, Sturm, Leertouwer and de Haan [36] confirmed the difference in the relevance of different components and, as far as the author knows, were the first to come up with an alternative index to more accurately reflect these differences. Interestingly, they found that this new index was no longer robustly related to economic growth. Although later papers suggested that they were potentially being too strict in their statistical estimations [37]. They also cautioned against over-reliance on aggregated indexes and called for more nuanced approaches in understanding the EF-growth relationship.

Dawson [2] addressed causality in the EF-growth relationship. His paper underscored a crucial point: while many studies have shown correlations between EF and growth, establishing a causal relationship is more complex. His findings suggested that overall EF appears to cause growth, while changes in freedom and growth are often jointly determined. Specifically, he found that levels of freedom related to the use of markets and property right were significant in driving growth. Conversely, he found the size of the government is often a result of growth rather than a cause, and that changes in areas like international finance are also more likely a consequence of economic expansion. Dawson also explored the relationship between political and individual freedoms, and EF and found that political and civil liberties very often precede (Granger-cause) economic freedom, suggesting that institutional conditions determine how EF develops in a country. This is inline with previous findings mentioned in the literature review so far.

Possibly the first to address this issue, Doucouliagos [38] investigated publication bias in the EF-growth literature. He once again critiqued the methods used in previous studies, suggesting that the aggregation of various components of EF into a single measure might contribute to this bias. Overall, he found that while the EF-growth relationship is positive, the extent of it could not be accurately determined due to the bias. Furthermore, Doucouliagos and Ulubasoglu [4] found an overall positive association between EF and growth in a meta-analysis, as well as an indirect positive effect through the stimulation of physical capital. They once again emphasize disaggregating the index and also emphasized the need for careful specification of empirical models in studies of EF and growth.

Altman [17], [18] evaluated the disaggregated EFI. He discussed the significant limitations of using the index in its aggregate form and how it could lead to misleading results. Altman then went on to introduce an alternative index that better correlated with GDPPC. He highlighted the importance of good governance and the effective role of the government alongside the subcomponents that were found to be significant. Importantly, he pointed out the presence of threshold effects and diminishing returns at higher levels of economic freedom. This is a rather crucial finding, as it means that achieving moderate levels of EF to facilitate growth and prosperity are important, however there also needs to be a balanced approach to economic policy, where the focus is not solely on maximizing EF but rather on achieving an optimal level that supports sustainable growth.

Derbel, Abdelkafi, and Chkir [19] studied how the EF-growth relationship is affected by a country's level of development. They posited that the relationship between EF and growth is non-linear and can be significantly influenced by country-specific factors. Using their threshold model approach, they identified specific levels of GDP per capita and enrollment rates that change the impact of government size, legal systems, trade policies, and monetary policies on economic growth. For example, in countries with lower enrollment rates or lower initial GDP per capita, reducing the size of the government tends to have a positive impact on growth. Conversely, in more developed or higher enrollment countries, reducing government size can negatively affect growth. They suggested that policy implications for enhancing economic growth through EF are not universal and should be tailored to specific country conditions, cautioning against a one-size-fits-all approach to economic policy.

Similar to [19] , Dialga and Vallée [39] generated component- and country-specific weights for computing the EF scores, contrasting the equal weighting method typically used by The Heritage Foundation in calculating the IEF. They demonstrated how different weighting methods can lead to dramatically different and unstable results, notably identifying negative correlations between some components of the IEF, underlining the importance of methodological rigor and transparency in constructing the IEF and suggesting improvements to it.

In 2020, Lawson, Murphy, and Powell [40] attempted to breakdown the EFW and did a detailed study of the different factors of the EFW affecting growth across the world across 69 empirical studies. They found a positive correlations between EF and desirable outcomes like faster growth and better living standards and negative correlations between EF and undesirable outcomes like increased income inequality. Democracies and countries with political freedom tend to have higher EF as well, however EF is harder to improve in already freer countries. In general, the following trends were observed:

- Foreign Aid and Intergovernmental Organizations: Mixed results; some studies show aid improves economic freedom, others show the opposite.
- Crises: Economic crises often reduce economic freedom, but some studies show long-term liberalizing effects.
- Democracy: Generally positive relationship with economic freedom, especially when constitutional constraints are present.
- Political Rights, Human Rights, and Civil Liberties: Strong positive correlation with economic freedom.
- Historical and Cultural Factors: Deep historical measures and cultural factors significantly affect current levels of economic freedom.
- Inequality: Higher inequality tends to reduce economic freedom.
- Ideology: Pro-market ideology positively affects economic freedom.
- Migration: Immigration generally does not harm and may improve economic freedom.
- Natural Resources and Geography: Mixed results; resource-rich countries may suffer from a 'resource curse' affecting economic freedom.
- Income and Growth: Mixed evidence on whether higher income leads to greater economic freedom.
- Lagged Economic Freedom: Strongly predictive of current levels, with some evidence of convergence among countries.

They concluded by suggesting that EF persists over time, evidencing institutional inertia. They also acknowledged the complexity and context-dependent relationship between EF and its determinants.

Ausloos and Bronlet [21] did a detailed analysis of both the EFW and the IEF. They used as many data points as possible from both indexes in an effort to understand the empirical relationship between the EF indexes and various economic indicators, including GDP. They pointed to the widespread belief in empirical studies that EF fosters growth, notably even in countries with limited political freedoms, but emphasized that these claims need to be better substantiated with more research. Importantly, they discussed the behaviors of the EFW and IEF indexes in terms of rank-size distribution in an effort to identify the functional form relating economic growth and EF. They investigated whether the indexes follow an exponential or a power law behavior in relation to GDP, finding evidence that both EFW and IEF follow slightly different power laws. They also normalized both indexes and compared them, finding that IEF is more conservative, meaning that the IEF generally has lower values compared to the EFW for the same country.

2.3 European Context

Šeputienė [41] looked at the development of EFW and IEF within the EU and its impacts on economic growth. She looked at both old and new EU member states, assessing the strength of the relationship between various components of EF and growth and finding that the strength of the relationship depends on the country sample and the specific variable used to reflect economic growth, such as real GDP growth rate or real GDP per capita growth rate. She concluded that while the EF-growth relationship is well-established, the degree and nature of this relationship can vary significantly between different country samples and economic indicators.

Kacprzyk [42] investigated the EF-economic growth relationship in the EU. He used the EFW as his index of choice and he used averaged values of five-year periods from 1985 to 2009. His empirical results revealed four of the five subcomponents of the EFW to have a positive and significant impact on economic growth. He concluded that EF is a significant driver of economic growth in the EU. Similarly to other researchers, he suggested that policies enhancing security of property rights are most likely to boost economic growth. He also highlighted the importance of choosing an appropriate estimation procedure, as neglecting endogeneity leads to misleading estimates. In his concluding remarks, he also discussed the implications of the EU's expansions and the tensions between increasing member states versus policy centralization in the EU. He called for careful consideration and a balanced approach toward expansions plans and policies aimed at economic growth within the bloc.

In 2017, Ivanović and Stanišić [43] analyzed the relationship between monetary freedom(a subcomponent of the IEF) and economic growth in the 11 newest EU members and found positive effects on real GDP growth, while also discovering complexities during economic shocks. They suggested that policies aimed at maintaining and enhancing monetary freedom could positively impact growth. However, they also highlighted that this relationship is more complicated and changing global economic conditions could potentially affect this relationship.

Sayari, Sari ,and Hammoudeh [44] looked at the long-term relationship between the IEF, FDI, and the value-added components of GDP in 30 European countries. They found that service and industry valued-added components positively affected IEF, while the agricultural value-added component had a negative relationship between IEF and FDI. Interestingly, they also found a negative relationship between the IEF and FDI, positing that FDI may not have adequate linkages with the business establishments and institutions in the host countries. They suggest a further line of research looking specifically at the relationship between EF and FDI. They also suggested that European governments and institutions seeking higher levels of EF might benefit from strategies that foster industrial and service growth while placing less emphasis on agricultural development.

Brkic, Gradojevic and Ignjatijevic [45] used more recent data from the last two decades to examine the EF-growth relationship and found changes in the level of EF to be robustly related to growth, as opposed to the static level of economic freedom, pointing toward the dynamic and potentially non-linear nature of the EF-growth relationship. They suggest further research could focus on measuring the individual impact of the sub-indexes of the IEF on growth and examining this relationship in different clusters of countries.

2.4 Summary

As one can see from the literature review, the EF indexes are complex, multifaceted and potentially flawed in their methodologies. As the Fraser Institute's 2023 EFW report puts it [20]:

> Economic Freedom of the World is an ongoing research project. As Milton Friedman stated in his foreword to the initial report, Economic Freedom of the World: 1975–1995 (Gwartney, Lawson, and Block, 1996), additional work would be necessary to "bring the indexes of economic freedom up to date and to incorporate the additional understanding that will be generated".

Overall, the freedom-growth literature has a few key recurring points that any researcher needs to keep in mind, namely that:

- the disaggregation of the index when doing an analysis is of utmost importance.
- certain components in the indexes are more significant than others for economic growth, with certain subcomponents even having shown negative relationships
- there is plenty of evidence that the freedom-growth relationship is non-linear and that threshold effects are present and significant. Namely, that EF generally follows either a power law or an exponential law with relation to GDP.
- it makes more sense to look at countries individually as this provides a much more meaningful and nuanced view of the EF-growth relationship.
- the specific indicator of economic growth that is used to assess the EF-growth relationship can significantly alter the results.
- with regards to policy implications, EF should be viewed as a potential tool in stimulating growth as on its own, EF can not cause sustained long-term growth.

Table III summarizes the selected papers' details and where applicable, the study's sample size, time periods, methodology and direction of EF-growth relationship.

Table III: Summary of Selected Papers

Paper	Number of Countries	Time Periods	Methodology	Direction of Effect on Growth
[25]	100	1960-1990	Panel model	Positive
[5]	172	1975-1990	Cross-sectional model	Positive
[3]	80	1975-1990	Multiple regression model	ΔEF positive
[35]	74	1975-1995	Panel model	Mixed effects
[36]	49	1980-1990	Cross-sectional model and PCA	Not significant
[26]	80	1975-1995	Cross-sectional model and PCA	Positive
[27]	48-100	1974-1994	Cross-sectional model	Positive
[2]	103	1975-1995	Cross-sectional model	Positive
[38]	N/A	N/A	Meta-analysis	Positive
[4]	82	1970-1999	Meta-analysis, panel model	Positive
[17]	133	1990-2005	Cross-sectional model	Positive with threshold effects
[41]	27	1996-2007	Multiple linear model	Positive
[19]	100	1972-2003	Threshold model	Mixed
[30]	172	2006-2010	Multiple linear model	Positive
[18]	133	2004	Cross-sectional model	Positive with threshold effects
[42]	28	1985-2009	Panel model	Mixed
[43]	11	1997-2015	Panel model	Mixed
[44]	30	1997-2014	Panel model	Mixed
[45]	43	1995-2014	Dynamic panel model	ΔEF positive

3 Research Framework

Referring back to Table III, the effects of EF on growth can be estimated using many different techniques. Moreover, economic growth itself can be specified in different ways, such as in terms of GDP, GVA, GNI, etc. The often-used GDP has been criticized as not being reflective of the actual wellbeing and living standards in a country, and there are perfectly valid reasons for this. Put succinctly [46]:

> the gaps between what we mean by wellbeing, and what GDP per capita measures, should make us cautious about the literal use of GDP per capita to measure how well off people are.

Many factors such as inequality, environmental degradation, people's wellbeing and happiness, and general health and education are not measured [47], [48]. On the other hand, Altman [17] points out the very tight relationship between higher GDPPC and HDI scores with an R^2 of 0.92 and [46, Unit 1.2]:

> ...GDP per capita is undoubtedly telling us something about the differences in the availability of goods and services.

Given that the relationship being studied is particularly between EF and economic growth, considering other factors such as wellbeing, environmental degradation, etc. is outside the scope of this study and thus the study opts for GDP as the measure of economic activity.

Based on the reviewed literature, higher EF is generally associated with higher growth. However, different subindexes of both the IEF and EFW can have varying, and sometimes negative, effects on growth. Both the EFW and IEF are composite indexes comprising many complex subcomponents, making it challenging to draw certain and concrete conclusions even with robust econometric methods. De Haan and Sturm [49] have discussed the complexities of incorporating government taxation into the index and advocated for a nuanced understanding of EF's composition. Additionally, the equal weighting of the subindexes and other statistical properties of these indexes have been questioned. Dialga and Vallée [39] suggested using more robust methods for estimating the IEF, which would ultimately affect the policy and research implications derived from it. Currently, both indexes still use unweighted averages across all components and subcomponents. Ausloos and Bronlet [21] found similar results, emphasizing the need for country-specific calculations of the subcomponents of EFW and IEF.

3.1 Theoretical Framework

The discussions in this section are informed by the perspectives and insights from *The Economy 1.0* by the CORE team [46], *Macroeconomics: Institutions, Instability, and Inequality* by Wendy Carlin and David Soskice [50], and *Why Nations Fail: The Origins of Power, Prosperity, and Poverty* by Daron Acemoglu and James Robinson [51].

An examination of the successes and failures of planned and capitalist economic systems suggests that the immediate sources of growth in living standards are primarily the accumulation of capital—both physical and human—and the development and diffusion of new technology. Unlike earlier economic systems, both planned and capitalist systems successfully mobilized resources to increase the human and physical capital intensity required for industrialization. With enhanced infrastructure, such as electrification, and improved skills, higher output per worker became achievable. However, the capitalist system demonstrated a superior ability to generate continuous technological progress, introducing new methods of production and new products that elevated living standards.

The fundamental causes of growth delve into the underlying factors driving the accumulation of capital and technological advancements that transform human lives. These causes are categorized into broad hypotheses concerning the roles of geography, culture, and institutions. Recent research increasingly questions the significance of geography and culture as primary drivers of long-term economic growth, highlighting the pivotal role of institutions. While geography and culture may influence long-term development, this study focuses primarily on the institutional framework within a nation.

Several economic growth models exist, each based on specific assumptions and aimed at explaining core mechanisms behind growth. For the purposes of this study, the focus is on three key models:

- Harrod-Domar model (Keynesian growth model)
- Solow-Swan model (Exogenous growth model)
- Romer-Lucas model (Endogenous growth model)

Harrod-Domar Model: Developed in the 1930s and 1940s, the Harrod-Domar model builds on Keynesian principles and emphasizes the role of investment in economic growth and highlights the potential for economic instability and cycles due to imbalances between savings and investment.

The growth rate is described as

$$\frac{dY}{Y} = \frac{S}{v}$$

where

$$\frac{dY}{Y} \text{ is the growth rate of output,}$$
$$S \text{ is the savings rate,}$$
$$v \text{ is the capital-output ratio.}$$

The model posits that economic growth depends on the level of savings and the efficiency of capital use. It also predicts potential instability, as deviation from the warranted growth rate can lead to either cyclical fluctuations or economic stagnation. While a perfectly valid model for explaining short-term dynamics and potential instability such as business cycles, it has limited utility in explaining long-term economic growth. It also assumes fixed capital-output and savings rates, ignoring technological progress and other factors that can influence growth.

Solow-Swan Model: Developed in the 1950s, this model focuses on long-term economic growth driven by capital accumulation, labor or population growth, and technological progress. It emphasizes the role of diminishing returns to capital and the impact of technological advancements on growth. By modeling technological progress as an exogenous factor, it addresses the limitations of the Harrod-Domar model to some extent.

The Solow-Swan model uses a Cobb-Douglas production function to model growth

$$Y = K^{\alpha}(AL)^{1-\alpha}$$

where

Y is output,
K is capital,
A is technology level (augmenting labor),
L is labor,
α is output elasticity of capital.

As mentioned before, the model incorporates diminishing returns to capital and labor, leading to a steady-state equilibrium. As a consequence, the exogenous technological level drives long-term growth. The steady-state output per worker depends on the savings rate, population growth, and technological progress. Additionally, the Solow-Swan model explains the convergence hypothesis, suggesting that poorer economies will catch up to richer ones if they have similar savings rates, population growth, and access to technology. However, the fundamental limitation of this model is the exogeneity of technological progress. How technological progress is achieved is left unexplained which is a significant factor in long-term economic growth. It also does not consider the role of human capital and innovation in growth.

Romer-Lucas Model: Developed in the 1980s, the Romer-Lucas model incorporates factors such as innovation, knowledge spillovers, and human capital into the growth process to address the limitations of the Solow-Swan model. It suggests that policy measures, such as investments in education and research, can have a significant impact on long-term economic growth. In this model, technological progress is an outcome of economic activities.

The production function is similar to the Solow-Swan model

$$Y = AK^{\alpha}L^{1-\alpha} \tag{1}$$

where this time A is knowledge stock or level of technology (also called multi-factor productivity). Knowledge accumulation then occurs by

$$\frac{dA}{dt} = \phi A L_A$$

where

ϕ is productivity of labor in R&D,
L_A is labor in R&D.

In this model, technological progress results from intentional investment in R&D and human capital and policies that promote innovation, education, and knowledge dissemination can sustain long-term economic growth. Additionally, the Romer-Lucas model predicts increasing returns to scale due to knowledge spillovers and the non-rival nature of knowledge. Unlike the Solow-Swan model, the Romer-Lucas model does not necessarily predict convergence, as growth rates can differ based on policy choices and institutional quality. According to the Romer-Lucas model, the role of government and institutions in fostering an environment conducive to innovation (Schumpeterian "creative destruction") and human capital development is absolutely crucial and investments in education, R&D, and infrastructure can have lasting impacts on economic growth.

As can be seen, each successive model builds on its predecessor to offer a more comprehensive understanding of economic growth. The progression begins with the Harrod-Domar model, which emphasizes capital accumulation as the primary driver of growth. This is followed by the Solow-Swan model, which introduces exogenous technological progress as a key factor in long-term growth. Finally, the Romer-Lucas model advances the theory by incorporating endogenous factors such as innovation, human capital, and knowledge spillovers.

To adequately describe long-term economic growth, a model must encompass both the immediate drivers, like capital accumulation, and the fundamental drivers, such as technological progress and innovation. Upon review, it becomes evident that while the Harrod-Domar and Solow-Swan models provide valuable insights, they do not fully address the endogenous factors that fundamentally drive long-term growth. Consequently, the Romer-Lucas model is selected as the primary theoretical framework for this research, as it offers a more complete and nuanced understanding of the mechanisms that sustain economic growth over time.

Both Fraser Institute's EFW and The Heritage Foundation's IEF aim to measure the institutional success of a country at maintaining EF. In the context of the Romer-Lucas growth model (1), EF can potentially have a multi-channel effect on the total output of an economy. Namely, EF can cause an increase in K by

- creating a better and more secure investment environment (e.g. higher FDI)
- allocating capital more efficiently in markets
- a general increase in market efficiency leading to lower transaction costs and thereby higher saving rates

EF can also cause an increase in L by

- lowering barriers to mobility across countries which in turn results in an easier flow of labor
- increasing labor market efficiency, i.e. increased labor market flexibility means it is easier for worker to find suitable jobs

and perhaps most importantly, EF can bring about an increase in A by:

- more efficient use of scarce resources (i.e. both capital and labor) which increases per capita productivity
- creating more competitive markets in which firms have to continually improve to stay afloat
- allowing more entrepreneurial activity, thereby bringing about "creative destruction"

3.2 Research Hypothesis

Building upon the reviewed literature and the concepts explored in the preceding sections, the following research hypothesis is stated:

Null hypothesis H_0 : Economic freedom (EF), as measured by the four principal components of the Index of Economic Freedom (IEF), does not have a statistically significant impact on the economic growth of the European Economic Area (EEA) nations.

Alternative hypothesis H_1: Economic freedom (EF), as measured by the four principal components of the Index of Economic Freedom (IEF), has a statistically significant and positive impact on the economic growth of the European Economic Area (EEA) nations.

4 Methodology

Table III outlines two primary methods for estimating the effects of EF on economic growth: cross-sectional models and panel models. Although cross-sectional models have often been used due to missing data, panel models generally offer significant advantages that make them more suitable for this study.

The data used in this study has a panel structure, comprising several entities (countries) measured over multiple time periods (years), which aligns well with the panel model approach. Using a panel model allows for the control of unobserved heterogeneity, which is crucial for a macroeconomic study of this nature. Furthermore, panel models enable more complex model specifications that can capture nuanced relationships between variables. The use of panel models also increases the statistical power of tests due to the higher number of data points. Additionally, analyzing data over a long period enhances the estimation of long-term trends and effects, which might not be detectable with cross-sectional models.

It is for these reasons that a panel model is used for this study. Specifically, one derived from the Romer-Lucas model as will be discussed in section 4.1.

4.1 Econometric Model Specification

Recalling equation (1), Economic Freedom (EF) is modeled as the multi-factor productivity term A:

$$A = e^{\beta \times EF} \quad \Longrightarrow \quad GDP = e^{\beta \times EF} K^{\beta_1} L^{\beta_2}$$

where

$$\begin{aligned} GDP &\text{ is the gross domestic product (i.e. total output),} \\ K &\text{ is the total stock of capital,} \\ L &\text{ is the total stock of labor,} \\ EF &\text{ is the economic freedom score.} \end{aligned}$$

Note the change from α being the exponent of K and L to β_1 and β_2. This is to help differentiate these two coefficients later when formulating the econometric model.

Additionally, as of now, the exact functional form of the EF-GDP relationship has not been robustly shown. Ausloos and Bronlet [21] found evidence for a power law relationship

$$GDP \propto EF^{\alpha}$$

however, graphically examining the relationships (Figure 1) seems to suggest an exponential relationship

$$GDP \propto e^{EF}$$

the exponential relationship has been used in empirical research before as well [13], [52]. This is mainly because the exponential functional form, especially when used in a Cobb-Douglas function, can conveniently be linearized. Additionally, if the effects of EF on GDP are insignificant (i.e. estimated coefficient of EF is zero), equation (1) remains valid. For the purposes of this research, the exponential law is used and is to be taken as the correct functional specification. It should be noted that due to this uncertainty regarding the exact functional form of the EF-GDP relationship, while the signs of the estimated relationships will be significant, the exact effect sizes are not to be taken literally.

Recalling the previous equation

$$GDP = K^{\beta_1} L^{\beta_2} e^{\beta \times EF}$$

it can be linearized by taking the natural logarithms of both sides

$$ln(GDP) = \beta_1 ln(K) + \beta_2 ln(L) + \beta EF$$

EF is now disaggregated into its four principal components as

$$EF = \frac{RL + GS + RE + MO}{4}$$

where

$$\begin{aligned} RL &\text{ is Rule of Law} \\ GS &\text{ is Government Size} \\ RE &\text{ is Regulatory Efficiency} \\ MO &\text{ is Market Openness} \end{aligned}$$

thus getting

$$ln(GDP) = \beta_1 ln(K) + \beta_2 ln(L) + \beta \frac{RL + GS + RE + MO}{4}$$

The general panel model specification is now

$$ln(GDP)_{i,t} \sim ln(K)_{i,t} + ln(L)_{i,t} + RL_{i,t} + GS_{i,t} + RE_{i,t} + MO_{i,t} \tag{2}$$

where the indexes i and t each represent individual entities (i.e. country) and time periods (i.e. year) respectively.

4.2 Data Collection and Cleaning

The study focuses on the countries within the EEA and spans from the year 2000 until the year 2019. The included countries are [14], [53]:

Table IV: Countries Table

Austria	Belgium	Bulgaria
Croatia	Republic of Cyprus	Czech Republic
Denmark	Estonia	Finland
France	Germany	Greece
Hungary	Ireland	Italy
Latvia	Lithuania	Luxembourg
Malta	Netherlands	Poland
Portugal	Romania	Slovakia
Slovenia	Spain	Sweden
Iceland	Norway	Switzerland

Annual data has been collected for all variables. Due to missing data points, Liechtenstein was excluded from the list of countries. This led to a balanced panel with 30 countries and 20 time periods, totalling 600 data points.

The EF data, including *RL*, *GS*, *RE*, and *MO* (each one being a score from 0-100) have been taken from The Heritage Foundation [1]. *GDP*, capital stock (*K*), and labor stock (*L*) data have been taken from the Penn World Table 10.01 [54]:

GDP: The output-side real GDP at chained Purchasing Power Parities (PPPs) (in millions of 2017 US$) was used to deflate the nominal GDP, enabling direct comparisons between different countries and years. Although the output-side and expenditure-side GDP figures are practically the same (Figure 4), the output-side GDP was preferred. This preference is due to the output-side GDP's focus on the sum of the gross value added in various economic sectors such as agriculture, manufacturing, and services. In the Penn World Table, this measure is referred to as "rgdpo".

K: the total capital stock of a country is calculated by taking each country's capital stock at constant 2017 national prices (in mil. 2017US$) ("rnna") and multiplying it by the average depreciation rate of the capital stock for each year ("delta").

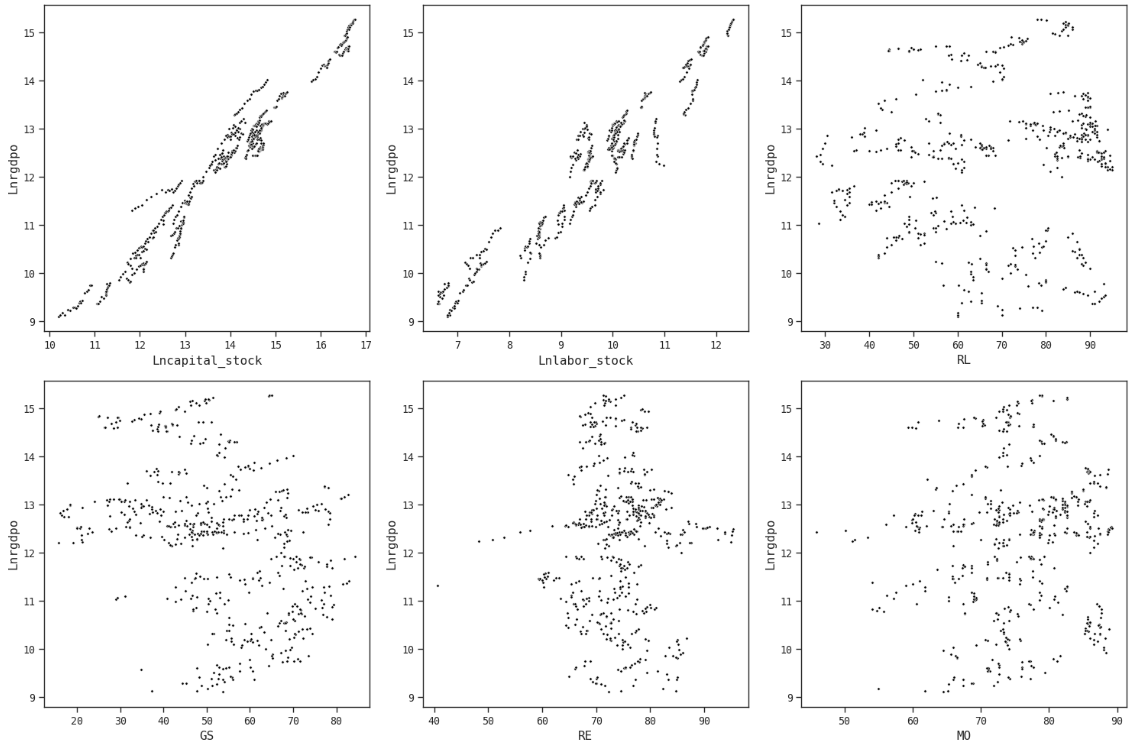
L: the total labor stock of a country is calculated by multiplying each country's number of persons engaged (in millions) ("emp") by the average annual hours worked by persons engaged ("avh"), and by the human capital index, based on years of schooling and returns to education ("hc").

Data cleaning, preparation, and visualization was done using Python 3.12. Estimations and diagnostic/statistical tests were done using R 4.3.3. See Appendix A for more details.

4.3 Exploratory Data Analysis

Before moving on to the estimation of the econometric model, some basic EDA steps are performed to inform the next steps. Starting off with pairwise scatter plots of the dependent variable versus the independent variables:

Figure 5: Scatter Plots of ln(GDP) (Lnrgdpo) vs. Independent Variables



There is a clear positive relationship between Lnrgdpo, Lncapital_stock, and Lnlabor_stock. However, the relationship between Lnrgdpo and RL, GS, RE, and MO is not immediately obvious. Upon closer examination of these scatter plots, more complex patterns and clusters become apparent. This is very likely due to individual-specific and time-specific effects. To test this hypothesis, scatter plots of single entities and time periods need to be examined. The following scatter plots are for a single entity (Finland) and all time periods (Figure 6) and for a single time period (2018) and all countries (Figure 7):

Figure 6: Scatter Plots of ln(GDP) (`Lnrgdpo`) vs. Independent Variables for Finland

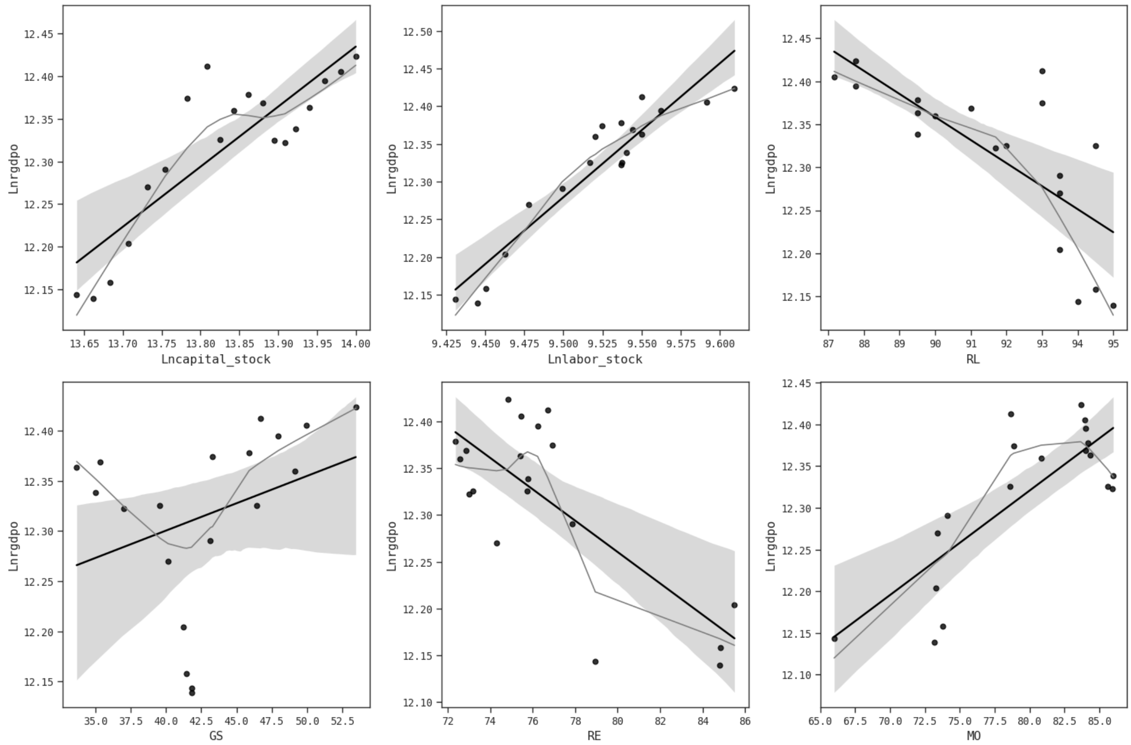
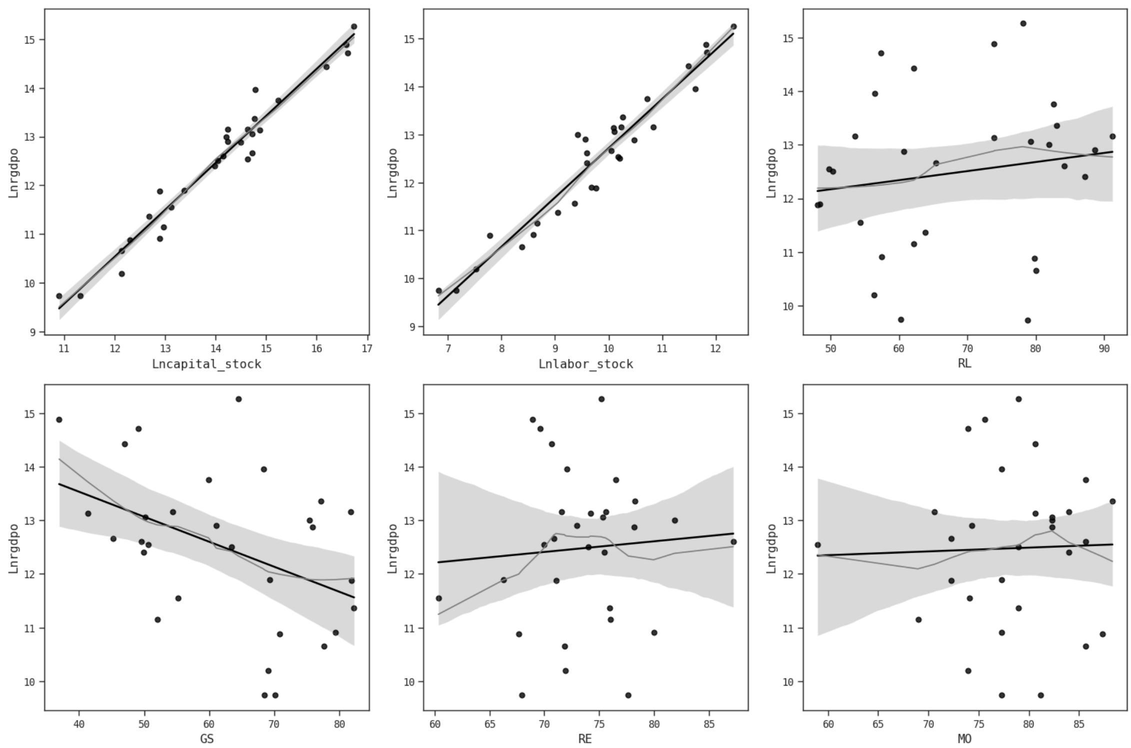


Figure 7: Scatter Plots of ln(GDP) (`Lnrgdpo`) vs. Independent Variables for 2018



Looking at the figures above, both entity and time effects seem to be significant and will likely need to be considered in the model specification and estimation. A formal test for the entity and time effects should also be performed to rigorously check for their significance.

Next, a check for potential multicollinearity is performed by computing correlation matrices using the previously mentioned correlation coefficients:

Table V: Pearson r Correlation Matrix

	Lnrgdpo	Lnlabor_stock	Lncapital_stock	RL	GS	RE	MO
Lnrgdpo	1.000000						
Lnlabor_stock	0.956389	1.000000					
Lncapital_stock	0.976470	0.926098	1.000000				
RL	0.113939	-0.121872	0.121792	1.000000			
GS	-0.365095	-0.253234	-0.413025	-0.425313	1.000000		
RE	0.006256	-0.119088	0.034385	0.545178	-0.218661	1.000000	
MO	0.090852	-0.025742	0.089682	0.522296	-0.003266	0.379515	1.000000

Table VI: Spearman ρ Correlation Matrix

	Lnrgdpo	Lnlabor_stock	Lncapital_stock	RL	GS	RE	MO
Lnrgdpo	1.000000						
Lnlabor_stock	0.922490	1.000000					
Lncapital_stock	0.957170	0.896567	1.000000				
RL	0.150225	-0.097854	0.145957	1.000000			
GS	-0.389184	-0.271534	-0.461431	-0.426157	1.000000		
RE	0.023650	-0.110470	0.033426	0.529365	-0.157345	1.000000	
MO	0.115403	-0.012648	0.115690	0.490307	0.026028	0.318345	1.000000

Table VII: Kendall τ Correlation Matrix

	Lnrgdpo	Lnlabor_stock	Lncapital_stock	RL	GS	RE	MO
Lnrgdpo	1.000000						
Lnlabor_stock	0.788414	1.000000					
Lncapital_stock	0.843829	0.739421	1.000000				
RL	0.083838	-0.067784	0.083358	1.000000			
GS	-0.246080	-0.164208	-0.288921	-0.293008	1.000000		
RE	0.012912	-0.075917	0.017188	0.369746	-0.110009	1.000000	
MO	0.081785	-0.003827	0.081528	0.344999	0.017928	0.223574	1.000000

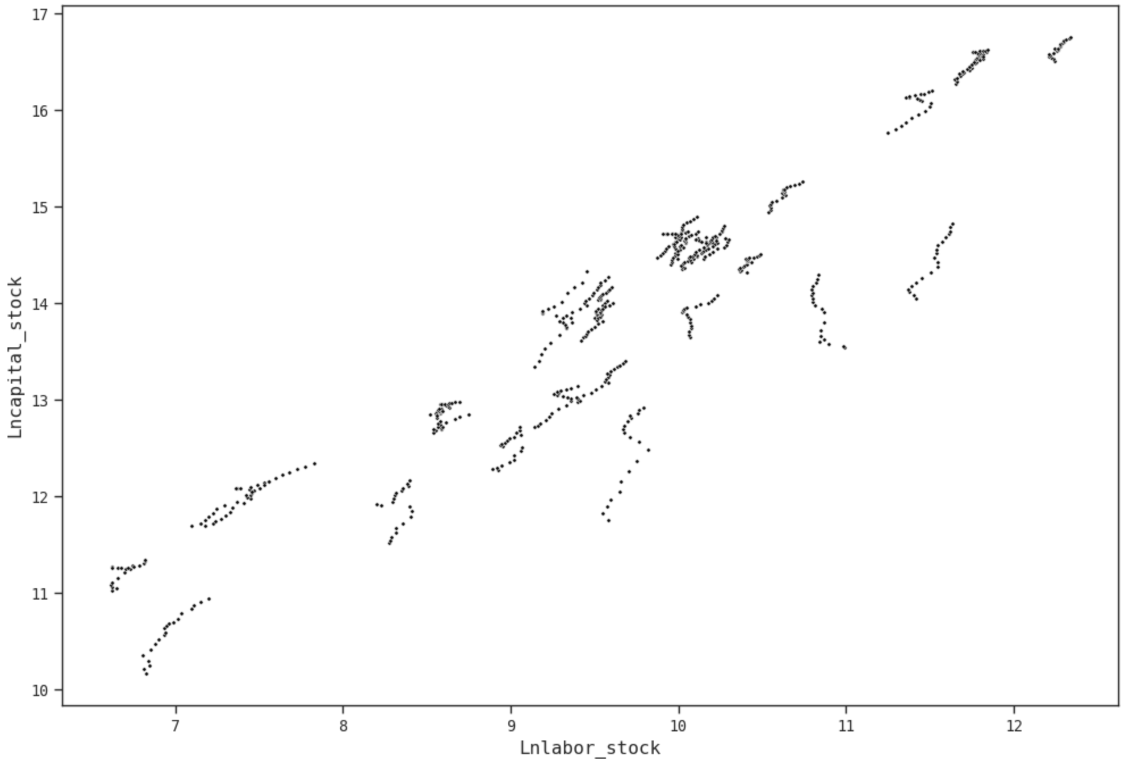
Table VIII: ξ_n Correlation Matrix

	Lnrgdpo	Lnlabor_stock	Lncapital_stock	RL	GS	RE	MO
Lnrgdpo	0.995008	0.740541	0.810449	0.325896	0.345552	0.240963	0.220765
Lnlabor_stock	0.769108	0.995008	0.785766	0.387629	0.456577	0.180516	0.296589
Lncapital_stock	0.792024	0.657207	0.995008	0.223502	0.277878	0.147174	0.196824
RL	0.157006	0.144973	0.179256	0.994987	0.223570	0.253149	0.267497
GS	0.135364	0.112048	0.178431	0.151494	0.995008	0.144474	0.067815
RE	0.132431	0.137031	0.101814	0.218657	0.121695	0.995007	0.128287
MO	0.076572	0.065297	0.081697	0.276373	0.119978	0.192935	0.995000

Note the asymmetry and the diagonal values in Table VIII. The fact that the diagonal values are not equal to 1 is due to floating-point inaccuracies in the calculation of the ξ_n coefficients and should be disregarded.

Looking at the correlation matrices, it is evident that `Lnlabor_stock` and `Lncapital_stock` are highly correlated and might cause issues if ignored in the estimations. The following scatter plot between the two variables confirms this:

Figure 8: Scatter Plot of $\ln(K)$ (`Lncapital_stock`) and $\ln(L)$ (`Lnlabor_stock`)



This poses a rather significant issue in estimating the model as one cannot simply drop either of these variables nor can one calculate their ratio in a meaningful way. Based on the theoretical framework (1), both the capital stock and the labor stock need to be controlled for in estimating the true effects of EF on growth. Therefore both `Lnlabor_stock` and `Lncapital_stock` are kept in the model. It is crucial, however, to fully understand and account for this known multicollinearity between the model variables when interpreting the estimation results. More details are discussed in the next section.

Finally, besides the relationship between `Lnlabor_stock` and `Lncapital_stock`, a much clearer set of cluster are observed in Figure 8. This once again hints at the presence of significant entity and time effects.

4.4 Model Estimation and Testing

Recall the general model specification (2)

$$ln(GDP)_{i,t} \sim ln(K)_{i,t} + ln(L)_{i,t} + RL_{i,t} + GS_{i,t} + RE_{i,t} + MO_{i,t}$$

The approach to modeling and estimation follows the principle of "Occam's Razor", meaning the models are kept as simple as necessary. Similarly, the Ordinary Least Squares (OLS) estimator is chosen for estimation because it is the simplest and most commonly used technique. In addition, OLS estimation has useful characteristics that make it convenient for analysis, such as the sum of the residuals being equal to zero, and the coefficient of determination R^2 having a very intuitive interpretation. In discussing the formal aspects of the estimation technique, model diagnostic testing, and hypothesis testing, the textbooks *Using Econometrics: A Practical Guide* by Arnold H. Studenmund [55] and *Introductory Econometrics for Finance* by Chris Brooks [56] were frequently referenced.

The OLS estimator relies on a set of assumptions, the so-called "Classical Assumptions", that need to hold for it to be the Best Linear Unbiased Estimator (BLUE). When estimating a panel model consisting of time series (as is the case for this study), two more assumptions need to hold as well. In total, these assumptions are:

I. **Linearity**: The relationship between the dependent variable and the independent variables should be linear in parameters.

II. **Strict Exogeneity**: The residual terms should be uncorrelated with the explanatory variables for all i and t.

III. **Homoskedasticity**: The variance of the error terms should be constant across all observations.

IV. **No Autocorrelation**: The residuals should not be correlated across time for a given entity i.

V. **Normality of Residuals**: For hypothesis testing and constructing confidence intervals, it is often assumed that the error terms are normally distributed.

VI. **Stationarity**: The variables are assumed to be stationary. Non-stationarity results in spurious regression results.

VII. **Cross-Sectional Independence**: It is assumed that the cross-sectional units are independent of each other.

To get a baseline estimation and for diagnostic testing, a pooled OLS model is estimated:

$$ln(GDP)_{i,t} = \mu + \beta_1 ln(L)_{i,t} + \beta_2 ln(K)_{i,t} + \beta_3 RL_{i,t} + \beta_4 GS_{i,t} + \beta_5 RE_{i,t} + \beta_6 MO_{i,t} + \varepsilon_{i,t} \quad (3)$$

Table IX: Pooled Model

	Estimate	**Std. Error**	**t-value**	**Pr(>|t|)**
(Intercept)	-0.21966340	0.13935532	-1.5763	0.115494
`Lnlabor_stock`	0.61688880	0.01929922	31.9644	< 2.2e-16 ***
`Lncapital_stock`	0.42677620	0.01814490	23.5205	< 2.2e-16 ***
`RL`	0.01238889	0.00068722	18.0276	< 2.2e-16 ***
`GS`	0.00210547	0.00065029	3.2377	0.001272 **
`RE`	-0.00336711	0.00132353	-2.5440	0.011211 *
`MO`	-0.00123813	0.00115872	-1.0685	0.285717

Signif. codes: '***' 0.001 , '**' 0.01 , '*' 0.05 , '.' 0.1

Balanced Panel: n = 30, T = 20, N = 600
Residuals:
Min: -0.5145065 1st Qu.: -0.1233690 Median: 0.0035411 3rd Qu.: 0.1169332 Max: 0.6451859

Total Sum of Squares: 1319.8
Residual Sum of Squares: 21.171
R-Squared: 0.98396
Adj. R-Squared: 0.9838
F-statistic: 6062.24 on 6 and 593 DF, p-value: < 2.22e-16

The model as a whole is statistically significant and all variables except `MO` are statistically significant as well with a p-value of 5% or lower. However, the unusually high R^2 suggests there are issues and potential violations of the OLS assumptions. Recall from before that one issue detected so far was high imperfect multicollinearity between `Lnlabor_stock` and `Lncapital_stock`. Multicollinearity usually results in inflated standard errors and unstable coefficient estimates, making the OLS estimator inefficient. However, the OLS estimator remains unbiased even in the presence of high multicollinearity.

Checks for I, III, and V: To check for assumptions of linearity (I), homoskedasticity (III), and normality (V), the residual plot, the quantile-quantile (QQ) plot, and the violin plot of the residuals are shown below:

Figure 9: Pooled Model Residual Plot

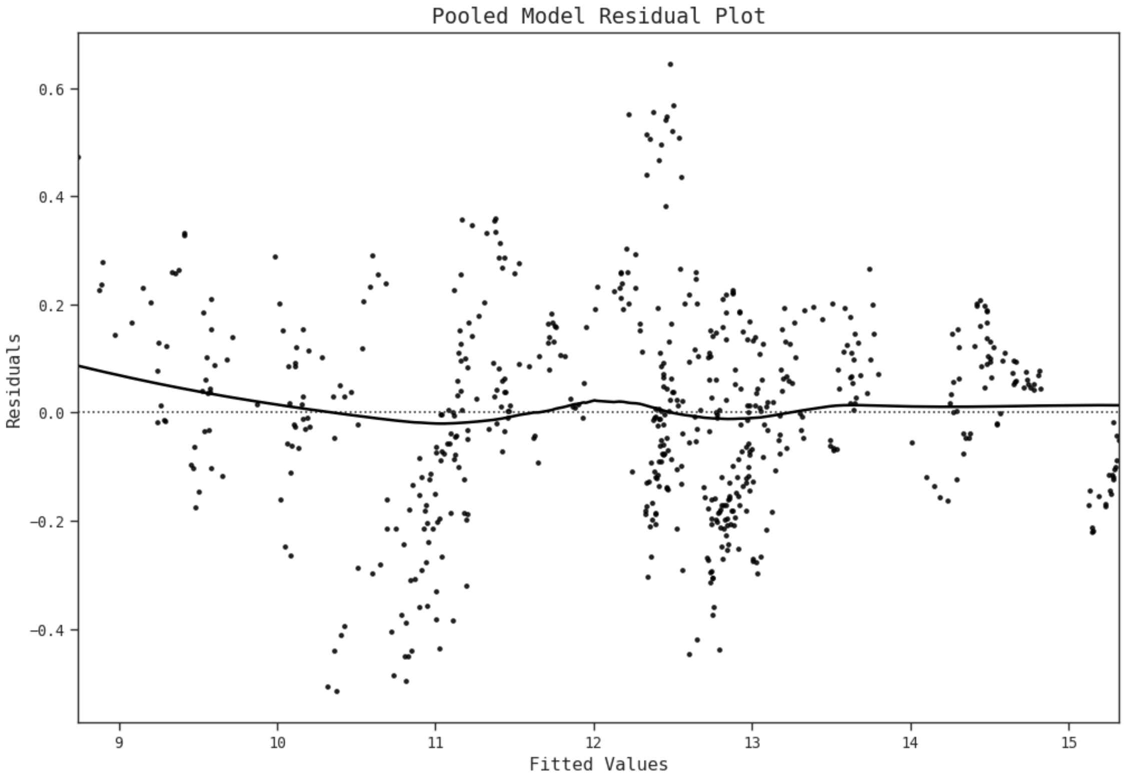


Figure 10: Pooled Model QQ Plot

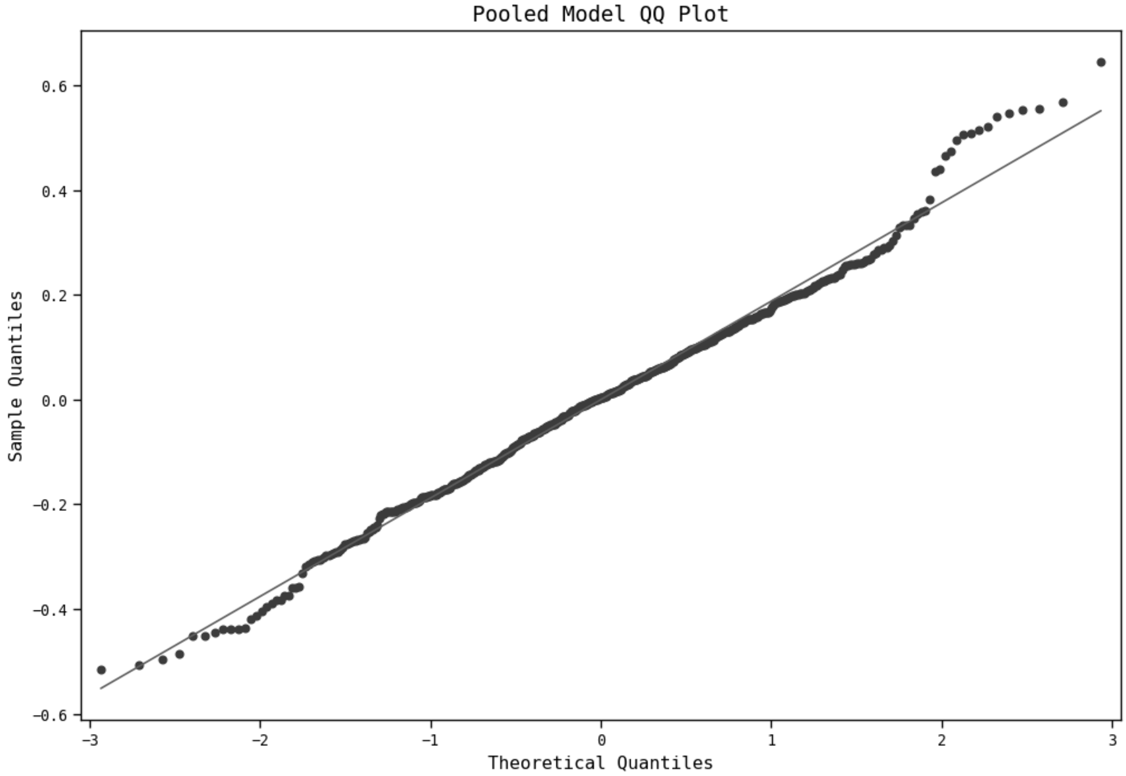
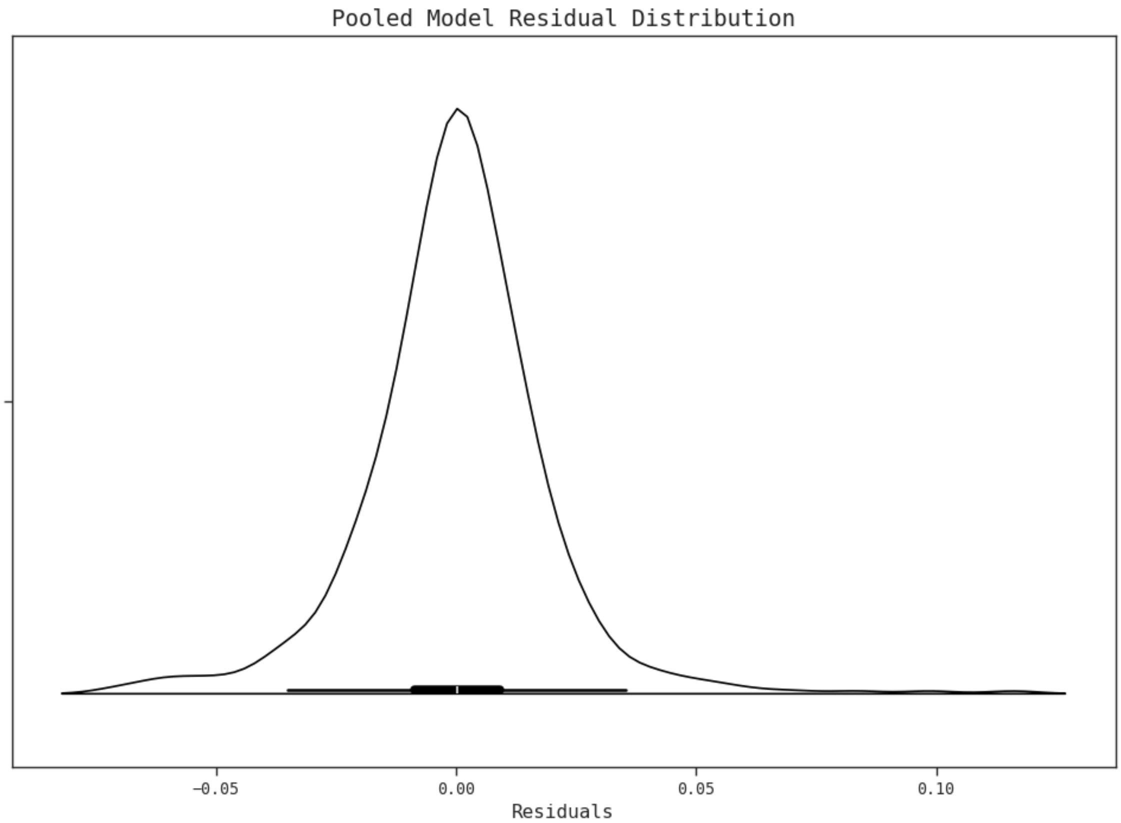


Figure 11: Pooled Model Violin Plot



As can be seen in Figure 9 and Figure 10, there are signs of heteroskedasticity and deviations from normality in residuals. Linearity for the most part seems to not have been violated. To confirm the presence of heteroskedasticity, as well as to test for the presence of autocorrelation, non-stationarity, and cross-sectional dependence, formal diagnostic tests are performed below.

III: Homoskedasticity (III) is tested for using the Breusch-Pagan test [57]

$$H_0 : \sigma_i^2 = \sigma^2 \quad \forall i$$

$$H_1 : \sigma_i^2 = \sigma^2 h(i)$$

where σ_i^2 is the variance of entity i and $h(i)$ is a function of the predictors, indicating that the variance changes with the predictors.

Table X: Studentized Breusch-Pagan Test Results

Studentized Breusch-Pagan Test	
Data	Pooled
BP	41.8
df	6
p-value	2.013e-07

The Breusch-Pagan test clearly rejects H_0 of homoskedasticity, indicating the presence of heteroskedasticity.

IV: Next, autocorrelation (IV) is tested for using the Breusch-Godfrey/Wooldridge test [58]

$$H_0 : Cov(\varepsilon_{it}, \varepsilon_{is}) = 0 \quad \forall t \neq s$$

where ε_{it} and ε_{is} are the idiosyncratic errors at different time points t and s for the same individual i .

$$H_1 : Cov(\varepsilon_{it}, \varepsilon_{is}) \neq 0 \quad \text{for some } t \neq s$$

Table XI: Breusch-Godfrey/Wooldridge Test Results

Breusch-Godfrey/Wooldridge Test for Serial Correlation	
Data	`Lnrgdpo` ~ `Lnlabor_stock` + `Lncapital_stock` + `RL` + `GS` + `RE` + `MO`
Chi-sq	479.32
df	20
p-value	< 2.2e-16
Alternative Hypothesis	Serial correlation in idiosyncratic errors

The Breusch-Godfrey/Wooldridge test clearly rejects H_0 of no serial correlation, indicating the presence of autocorrelation.

VII: Next, cross-sectional dependence (VII) is tested using Pesaran's CD test [58]

$$H_0 : Cov(\varepsilon_{it}, \varepsilon_{jt}) = 0 \quad \forall i \neq j$$

where ε_{it} and ε_{jt} are the idiosyncratic errors for different cross-sectional units i and j at the same time period t.

$$H_1 : Cov(\varepsilon_{it}, \varepsilon_{jt}) \neq 0 \quad \text{for some } i \neq j$$

Table XII: Pesaran CD Test Results

Pesaran CD Test for Cross-Sectional Dependence	
Data	`Lnrgdpo` ∼ `Lnlabor_stock` + `Lncapital_stock` + `RL` + `GS` + `RE` + `MO`
z	34.211
p-value	< 2.2e-16
Alternative Hypothesis	Cross-sectional dependence

The Pesaran CD test rejects the null hypothesis of cross-sectional independence, which means cross-sectional dependence is also present.

VI: The test for stationarity (VI) of the variables is influenced by the presence of cross-sectional dependence. Pesaran [59] suggested augmenting the Im, Pesaran, and Shin (IPS) test for unit roots in panel models with cross-sectional averages of lagged levels and first differences of the individual series. This makes the augmented IPS test robust to cross-sectional dependence. The Cross-sectionally augmented IPS (CIPS) test for unit roots in panel models has the null hypothesis [58]:

$$H_0 : \rho_i = 1 \quad \forall i$$

and the alternate hypothesis:

$$H_1 : \rho_i < 1$$

where ρ_i is the autoregressive parameter for the $i-$th individual time series in the panel. Specifically, it is the coefficient in the autoregressive process that characterizes the persistence of shocks in the series. For an individual time series $y_{i,t}$ in the panel, the autoregressive model with the first lag order can be written as

$$y_{i,t} = \rho_i y_{i,t-1} + \varepsilon_{i,t}$$

Table XIII: Pesaran's CIPS Test for Unit Roots

Variable	**CIPS test**	**Lag Order**	**p-value**
`Lnrgdpo`	-2.8644	1	0.01231
`Lnlabor_stock`	-2.6343	1	0.08016
`Lncapital_stock`	-2.4035	1	0.1
`RL`	-1.2065	1	0.1
`GS`	-2.4953	1	0.1
`RE`	-2.2975	1	0.1
`MO`	-2.5472	1	0.1
Alternative Hypothesis: Stationarity			

The Pesaran CIPS test results show that only `Lnrgdpo` is stationary, and for the rest of the variables the null-hypothesis fails to be rejected at the 5% significance level. Therefore it is concluded that all variables except `Lnrgdpo` are non-stationary. This is an important finding, as non-stationarity in variables can cause spurious correlation, very likely resulting in the overstated R^2 seen before. The standard approach to dealing with non-stationarity, especially in economic data, is to use first differences to estimate the model. This approach is also used in this study.

II: However, before changing the functional form of the model to first differences, one last set of tests are run to test for the significance of entity and time effects and how best to account for these. Recall that by estimating a pooled model (3), all entities (countries) and times (years) were "pooled" together and therefore not distinguished from each other. The most common ways to account for entity and time effects are by using the fixed effects (FE) model or the random effects (RE) model, where the RE model has the functional form

$$ln(GDP)_{i,t} = \mu + \beta_1 ln(L)_{i,t} + \beta_2 ln(K)_{i,t} + \beta_3 RL_{i,t} + \beta_4 GS_{i,t} + \beta_5 RE_{i,t} + \beta_6 MO_{i,t} + \alpha_i + \eta_t + \varepsilon_{i,t}$$

where α_i and η_t are the entity-specific and time-specific random effects respectively, and

$$Cov(\alpha_i, X_{i,t}) = 0 \quad \text{and} \quad Cov(\eta_t, X_{i,t}) = 0$$

where $X_{i,t}$ is a vector of the explanatory variables.

The FE model has the functional form

$$ln(GDP)_{i,t} = \mu_i + \lambda_t + \beta_1 ln(L)_{i,t} + \beta_2 ln(K)_{i,t} + \beta_3 RL_{i,t} + \beta_4 GS_{i,t} + \beta_5 RE_{i,t} + \beta_6 MO_{i,t} + \varepsilon_{i,t} \tag{4}$$

where μ_i and λ_t are entity-specific and time-specific fixed effects.

As can be seen, the RE and the FE models account for unobserved heterogeneity (i.e. entity- and time-specific effects) in different ways. Generally, the RE model is preferred to the FE model as it makes use of more information (within and between variations) leading to more efficient estimates and requires estimating fewer parameters, preserving degrees of freedom. However, for the RE model to be used, the no correlation assumption between individual-specific effects and regressors must hold.

Testing for the significance of entity effects

$$H_0 : \mu_i = \mu \quad \forall i$$

$$H_1 : \mu_i \neq \mu \quad \text{for some } i$$

And testing for the significance of time effects

$$H_0 : \lambda_t = \lambda \quad \forall t$$

$$H_1 : \lambda_t \neq \lambda \quad \text{for some } t$$

Table XIV: F-Test for Individual Effects Results

F-Test for Individual Effects	
Data	`Lnrgdpo` ~ `Lnlabor_stock` + `Lncapital_stock` + `RL` + `GS` + `RE` + `MO`
F	96.805
df1	29
df2	564
p-value	< 2.2e-16
Alternative Hypothesis	Significant effects

Table XV: F-Test for Time Effects Results

F-Test for Time Effects	
Data	`Lnrgdpo ~ Lnlabor_stock + Lncapital_stock + RL + GS + RE + MO`
F	5.5282
df1	19
df2	574
p-value	1.304e-12
Alternative Hypothesis	Significant effects

Both F-tests clearly reject the null-hypothesis of no significant entity/time effects. Therefore it is concluded that both entity and time effects are significant.

Whether the RE or the FE model is more appropriate is decided by using the Hausman test, where

$$H_0 : \beta_{RE} = \beta_{FE}$$

$$H_1 : \beta_{RE} \neq \beta_{FE}$$

where β_{RE} and β_{FE} are vectors of the coefficients in the RE and the FE model respectively.

Importantly, since the earlier violations of homoskedasticity, no autocorrelation, and cross-sectional independence are known, a robust Hausman test needs to be performed for proper inference. There are multiple methods of estimating the covariance matrix of regression models in the presence of violations of the OLS assumptions, however a full discussion of these methods would be out of the scope of this study. Based on analyses and suggestions made by Hoechle [60] , Peterson [61] , and Reed [62], the Driscoll-Kraay standard errors [63] are used in this study. The Driscoll-Kraay standard errors are robust to heteroskedasticity, autocorrelation, as well as cross-sectional dependence, making statistical inference possible despite these violations.

Table XVI: Regression-based Hausman Test Results

Regression-based Hausman Test	
Data	form
Chi-sq	127.2
df	6
p-value	< 2.2e-16
Alternative Hypothesis	One model is inconsistent

The results of the robust Hausman test clearly reject the null-hypothesis, suggesting that the FE model is more appropriate for use. An FE model with both entity and time effects is also to referred to as a two-way FE model.

Summary of Tests: Before moving on, let's summarize all test results and see which assumptions were violated:

I. **Linearity**: Not explicitly violated.

II. **Strict Exogeneity**: Endogeneity detected. Addressed by using the FE model to account for endogeneity and unobserved heterogeneity.

III. **Homoskedasticity**: Heteroskedasticity detected. OLS estimator remains unbiased. Robust standard error estimation using Driscoll-Kraay standard errors.

IV. **No Autocorrelation**: Autocorrelation detected. OLS estimator remains unbiased. Robust standard error estimation using Driscoll-Kraay standard errors.

V. **Normality of Residuals**: Non-normality detected. Will likely be solved by using the FE model. Needs to be checked again.

VI. **Stationarity**: Non-stationarity detected. Addressed through changing the model specification to first differences.

VII. **Cross-Sectional Independence**: Cross-sectional dependence detected. OLS estimator remains unbiased. Robust standard error estimation using Driscoll-Kraay standard errors.

To address these violations, a two-way FE model of the first differences of the variables is estimated. Using first differences of the variables reduces the degrees of freedom, however it is a compromise worth making to avoid non-stationarity in the variables. This model has the specification

$$\Delta \ln(GDP)_{i,t} = \mu_i + \lambda_t + \beta_1 \Delta \ln(L)_{i,t} + \beta_2 \Delta \ln(K)_{i,t} + \beta_3 \Delta RL_{i,t} + \beta_4 \Delta GS_{i,t} + \beta_5 \Delta RE_{i,t} + \beta_6 \Delta MO_{i,t} + \varepsilon_{i,t} \tag{5}$$

Table XVII: Differenced Two-way Fixed Effects Model

	Estimate	**Std. Error**	**t-value**	**Pr(>|t|)**
(Intercept)	-	-	-	-
ΔLnlabor_stock	0.53297869	0.09126483	5.8399	9.249e-09 ***
ΔLncapital_stock	0.54551106	0.12082168	4.5150	7.852e-06 ***
ΔRL	-0.00061515	0.00064102	-0.9596	0.3376835
ΔGS	0.00084452	0.00021709	3.8902	0.0001133 ***
ΔRE	-0.00034349	0.00072746	-0.4722	0.6369994
ΔMO	-0.00071769	0.00048845	-1.4693	0.1423596

Signif. codes: '***' 0.001 , '**' 0.01 , '*' 0.05 , '.' 0.1

Balanced Panel: n = 30, T = 19, N = 570
Residuals:
Min: -0.1929489 1st Qu.: -0.0159077 Median: -0.0002493 3rd Qu.: 0.0159833 Max: 0.1897883

Total Sum of Squares: 0.75959
Residual Sum of Squares: 0.64773
R-Squared: 0.14727
Adj. R-Squared: 0.05968
F-statistic: 21.2478 on 6 and 18 DF, p-value: 2.9508e-07

The model is overall statistically significant with ΔLnlabor_stock, ΔLncapital_stock, and ΔGS being statistically significant and the rest of the variables being insignificant. The Total Sum of Squares (TSS) and the Residual Sum of Squares (RSS) have both decreased by quite a margin compared to the pooled model, mainly due to first differencing and also due to the model specification addressing individual and time-specific heterogeneity. The R^2 values of the model suggest a very small amount of the variation is explained by the model which points to a potentially important omitted factor that needs to be considered. Below are the model diagnostic plots, as well as tests to cofirm the stationarity of the variables:

Figure 12: Differenced Two-way Fixed Effects Model Residual Plot

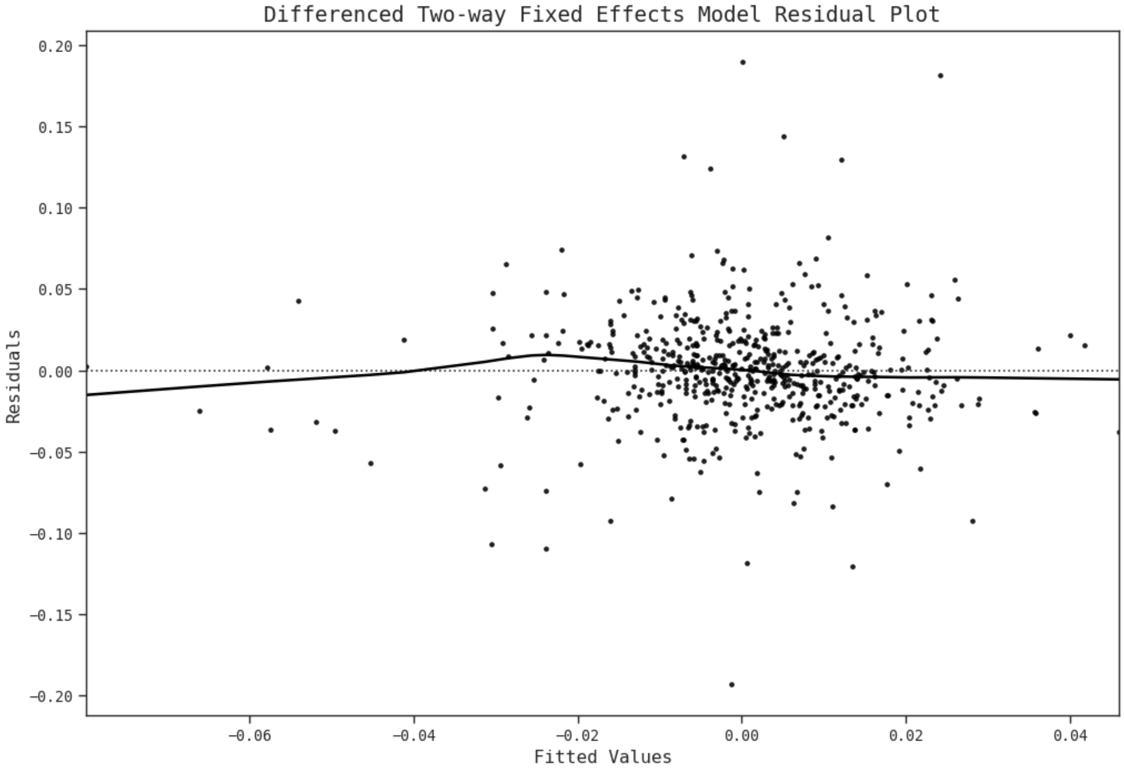


Figure 13: Differenced Two-way Fixed Effects Model QQ Plot

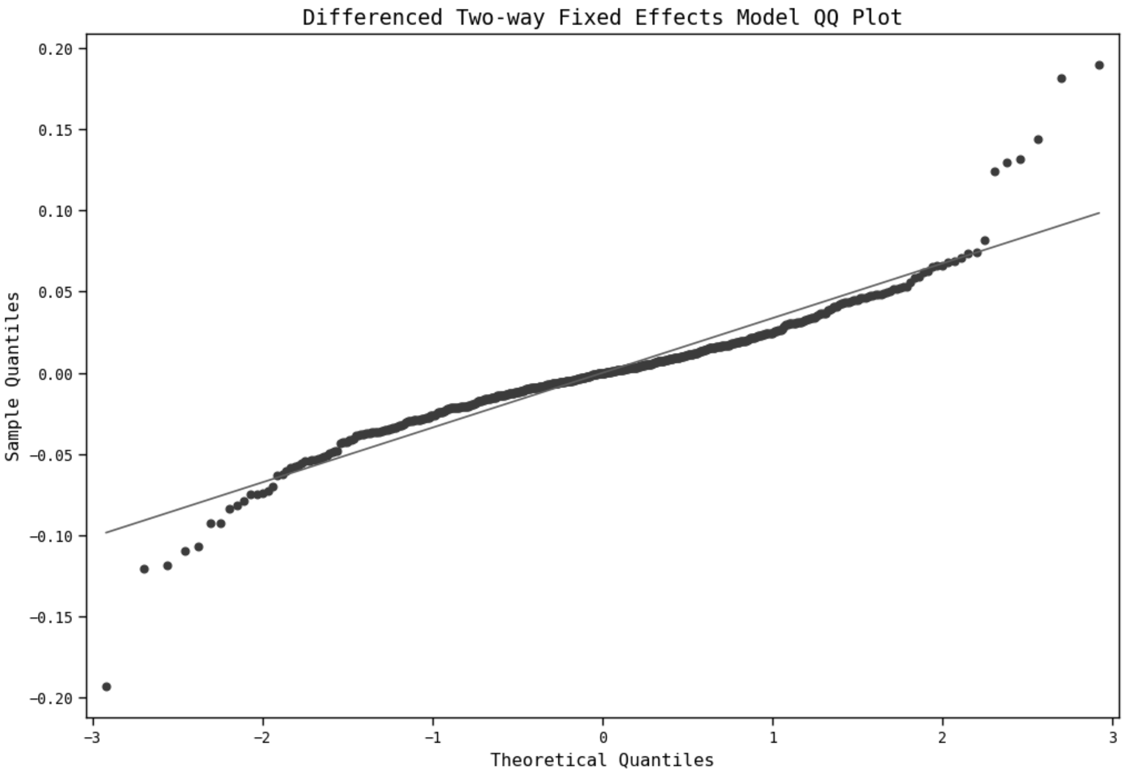


Figure 14: Differenced Two-way Fixed Effects Model Violin Plot

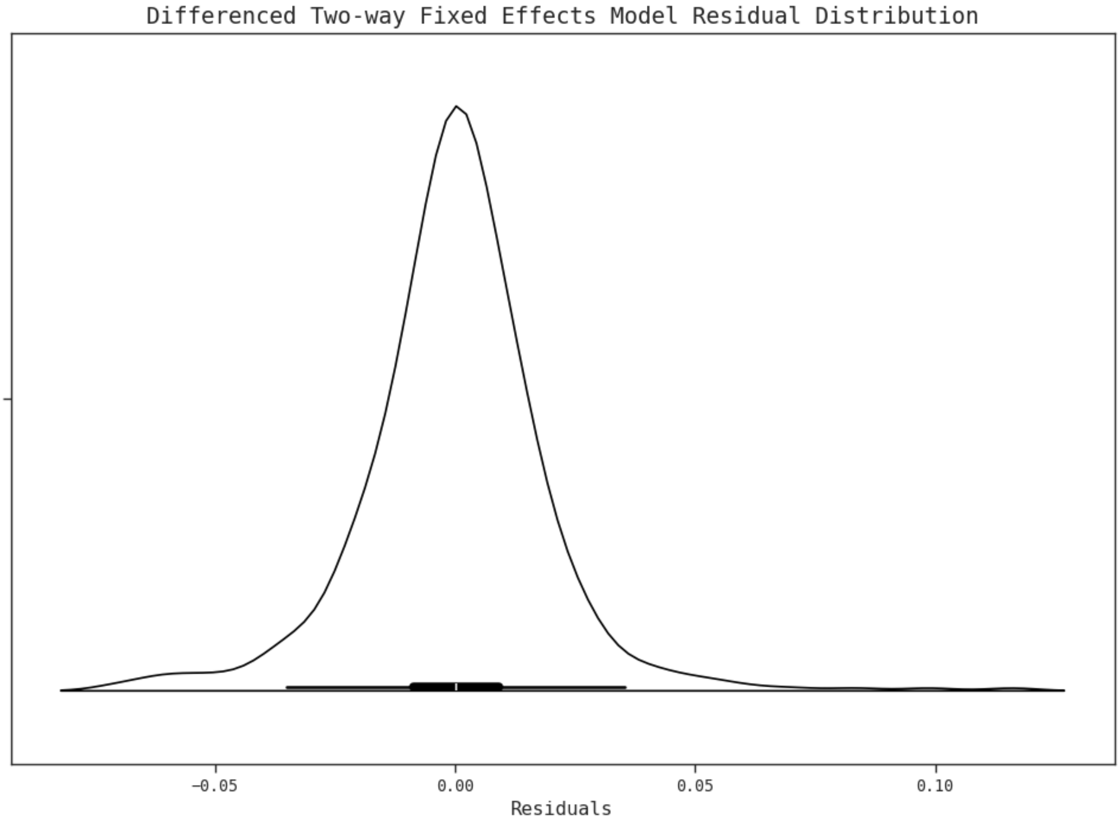


Table XVIII: Pesaran's CIPS Test for Unit Roots

Variable	**CIPS test**	**Lag Order**	**p-value**
ΔLnrgdpo	-3.2089	1	0.01
ΔLnlabor_stock	-2.7646	1	0.03421
ΔLncapital_stock	-2.6650	1	0.06428
ΔRL	-2.8567	1	0.01416
ΔGS	-3.3983	1	0.01
ΔRE	-3.1064	1	0.01
ΔMO	-3.2233	1	0.01
Alternative Hypothesis: Stationarity			

As can be seen in the plots, the differenced two-way FE model is a substantial improvement over the pooled model. Normality of residuals has been improved significantly and linearity seems to be even more present compared to the pooled model. The CIPS tests also show that all variables are now stationary at or below the 5% significance level, with the exception of ΔLncapital_stock which has a p-value of 0.06428. This is marginally higher than the required 5% significance level, however it is accepted as it does not seem to cause spurious correlation given the low R^2 value.

Recalling the previous question of whether an important factor is still missing in the model, let's consider what precisely the differenced two-way FE model is accounting for: The model accounts for entity and time effects, thereby accounting for unobserved heterogeneity, and it does this by having separated constants for every entity and time period in the dataset (i.e. slope heterogeneity). Two crucial factors hint at what is potentially missing from this model, namely: **i)** there is a significant shock in the time period under study (2007-2008 financial crisis) , and **ii)** there is significant cross-sectional dependence. These two factors are likely behind the low explanatory power of the model. Therefore, addressing these two issues should theoretically improve the model's explanatory power.

The two factors mentioned above are addressed using a technique introduced by Pesaran [64], whereby the model specification explicitly addresses the cross-sectional dependence and idiosyncratic factor loadings by augmenting the model by cross-sectional averages of the dependent and independent variables in order to account for the common factors, and adding individual intercepts and possibly trends [58]. Pesaran introduced two approaches: the Common Correlated Effects Pooled estimator (CCEP) and the Common Correlated Effects Mean Groups estimator (CCEMG). In the case of the model used for this study, the corresponding CCEP and CCEMG specifications are:

CCEP

$$\Delta ln(GDP)_{i,t} = \mu + \lambda_t + \beta_1 \Delta ln(L)_{i,t} + \beta_2 \Delta ln(K)_{i,t} + \beta_3 \Delta RL_{i,t} + \beta_4 \Delta GS_{i,t} + \beta_5 \Delta RE_{i,t} + \beta_6 \Delta MO_{i,t} + \gamma f_t + \varepsilon_{i,t} \tag{6}$$

where

$$\gamma f_t = \gamma_1 \overline{\Delta ln(GDP)_t} + \gamma_2 \overline{\Delta ln(L)_t} + \gamma_3 \overline{\Delta ln(K)_t} + \gamma_4 \overline{\Delta RL_t} + \gamma_5 \overline{\Delta GS_t} + \gamma_6 \overline{\Delta RE_t} + \gamma_7 \overline{\Delta MO_t}$$

and

CCEMG

for each cross-section *i*:

$$\Delta ln(GDP)_{i,t} = \mu_i + \lambda_t + \beta_{1,i} \Delta ln(L)_{i,t} + \beta_{2,i} \Delta ln(K)_{i,t} + \beta_{3,i} \Delta RL_{i,t} + \beta_{4,i} \Delta GS_{i,t} + \beta_{5,i} \Delta RE_{i,t} + \beta_{6,i} \Delta MO_{i,t} + \gamma_i f_t + \varepsilon_{i,t} \tag{7}$$

where

$$\gamma_i f_t = \gamma_{1,i} \overline{\Delta ln(GDP)_t} + \gamma_{2,i} \overline{\Delta ln(L)_t} + \gamma_{3,i} \overline{\Delta ln(K)_t} + \gamma_{4,i} \overline{\Delta RL_t} + \gamma_{5,i} \overline{\Delta GS_t} + \gamma_{6,i} \overline{\Delta RE_t} + \gamma_{7,i} \overline{\Delta MO_t}$$

then, average the coefficients across all cross-sections:

$$\beta_j = \frac{1}{N} \sum_{i=1}^{N} \beta_{j,i} \quad \text{for } j = 1, 2, \ldots, 6$$

The CCEP and CCEMG estimators perform best (lower standard errors and variance) when using large panel data (i.e. large N and large T), however they have been shown to be consistent and reliable for smaller panels as well, as is the case for this study [65]. Additionally, since the significance of slope heterogeneity is already known, the CCEMG estimator is the more appropriate one [65]. The results of the CCEMG, as well as the diagnostic plots are shown below:

Table XIX: Differenced Common Correlated Effects Mean Groups Model

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**
(Intercept)	-	-	-	-
ΔLnlabor_stock	0.16797182	0.03567114	4.7089	2.491e-06 ***
ΔLncapital_stock	0.34195022	0.14286339	2.3935	0.0166863 *
ΔRL	-0.00217232	0.00022638	-9.5958	< 2.2e-16 ***
ΔGS	0.00062688	0.00017441	3.5942	0.0003253 ***
ΔRE	-0.00230020	0.00030615	-7.5134	5.760e-14 ***
ΔMO	0.00136401	0.00030951	4.4070	1.048e-05 ***

Signif. codes: '***' 0.001 , '**' 0.01 , '*' 0.05 , '.' 0.1

Balanced Panel: n = 30, T = 19, N = 570
Residuals:
Min: -0.0668383 1st Qu.: -0.0075896 Median: 0.0003037 3rd Qu.: 0.0074157 Max: 0.0728149

Total Sum of Squares: 1.374
Residual Sum of Squares: 0.13567
HPY R-squared: 0.61902

Figure 15: Differenced Common Correlated Effects Mean Groups Model Residual Plot

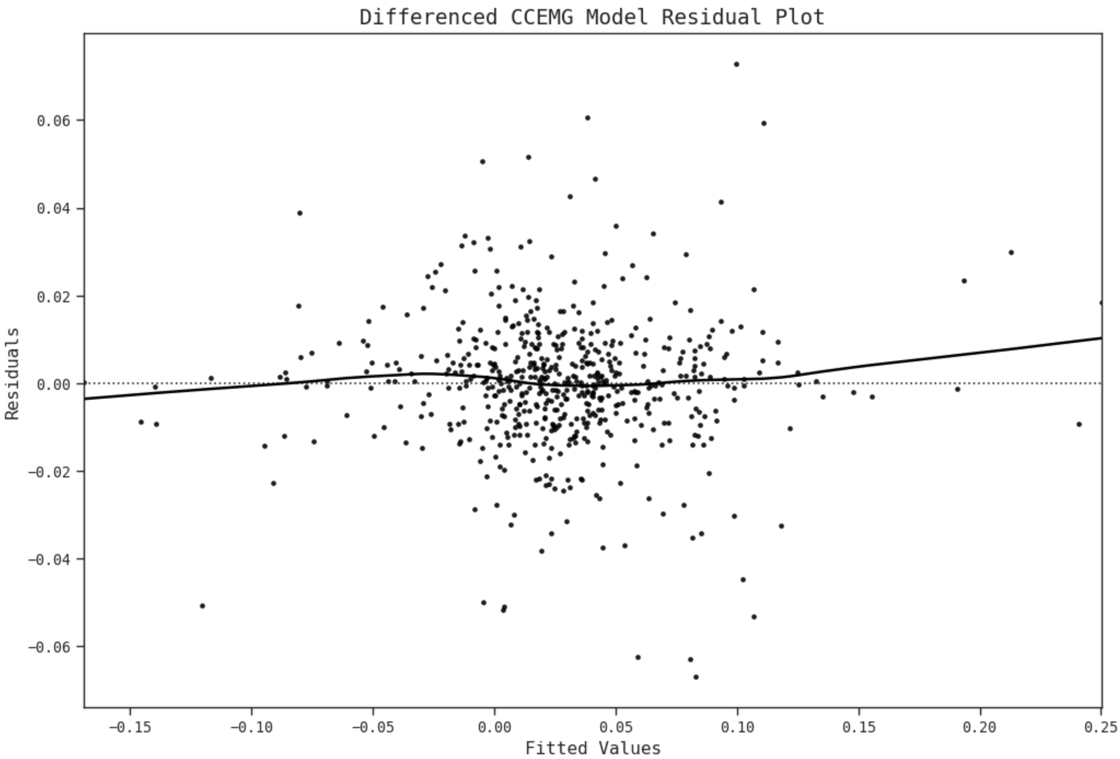


Figure 16: Differenced Common Correlated Effects Mean Groups Model QQ Plot

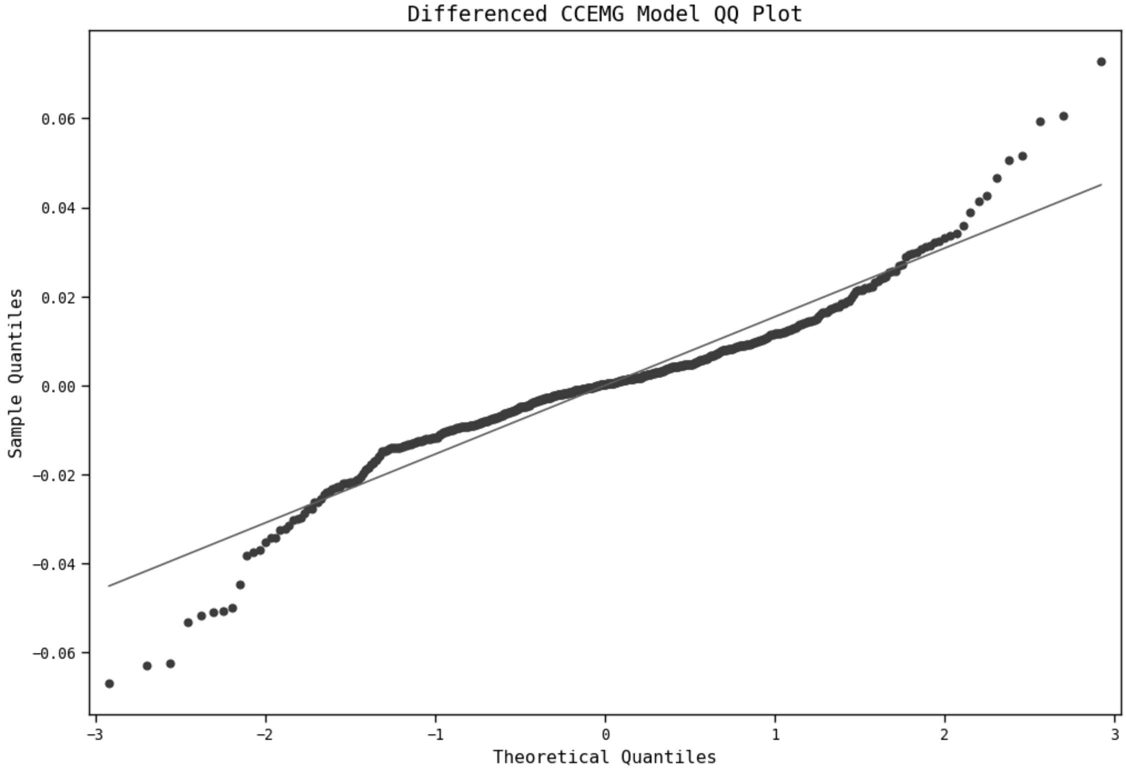
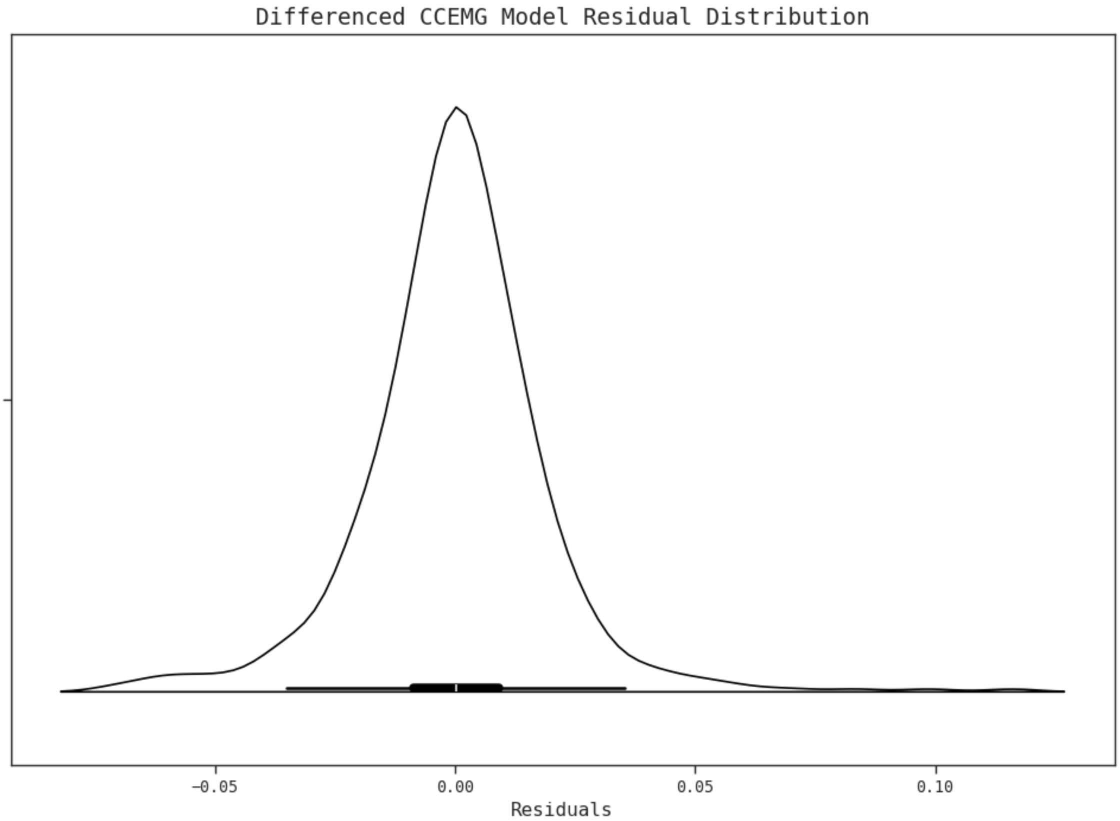


Figure 17: Differenced Common Correlated Effects Mean Groups Model Violin Plot



Using the CCEMG model, significant improvements are observed over the previous FE model in almost all areas, suggesting a more accurate model specification overall. Using the Driscoll-Kraay standard errors, both ΔLnlabor_stock and ΔLncapital_stock are significant, as expected from the theoretical framework, and so are all four components of the IEF. The R^2 has been improved drastically, suggesting a good model fit and decent explanatory power. Finally, sensitivity analysis is performed by estimating two additional models and excluding ΔLnlabor_stock and ΔLncapital_stock to assess the robustness of the coefficients obtained for the four IEF components.

Table XX: Differenced Common Correlated Effects Mean Groups Model Excluding Lncapital_stock

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**
(Intercept)	-	-	-	-
ΔLnlabor_stock	0.40164806	0.04320314	9.2967	< 2.2e-16 ***
ΔRL	-0.00207695	0.00016544	-12.5538	< 2.2e-16 ***
ΔGS	0.00078698	0.00022573	3.4863	0.0004897 ***
ΔRE	-0.00186128	0.00034474	-5.3990	6.701e-08 ***
ΔMO	0.00168186	0.00035987	4.6735	2.960e-06 ***

Signif. codes: '***' 0.001 , '**' 0.01 , '*' 0.05 , '.' 0.1

Balanced Panel: n = 30, T = 19, N = 570
Residuals:
Min: -0.0712998 1st Qu.: -0.0087479 Median: 0.0001754 3rd Qu.: 0.0091862 Max: 0.1161197

Total Sum of Squares: 1.374
Residual Sum of Squares: 0.21
HPY R-squared: 0.57879

Table XXI: Differenced Common Correlated Effects Mean Groups Model Excluding Lnlabor_stock

	Estimate	**Std. Error**	**z-value**	**Pr(>|z|)**
(Intercept)	-	-	-	-
ΔLncapital_stock	-0.36624109	0.15678682	-2.3359	0.0195 *
ΔRL	-0.00222444	0.00029896	-7.4406	1.002e-13 ***
ΔGS	0.00082037	0.00017394	4.7165	2.399e-06 ***
ΔRE	-0.00212929	0.00036601	-5.8176	5.971e-09 ***
ΔMO	0.00082963	0.00028980	2.8627	0.0042 **

Signif. codes: '***' 0.001 , '**' 0.01 , '*' 0.05 , '.' 0.1

Balanced Panel: n = 30, T = 19, N = 570
Residuals:
Min: -0.1297960 1st Qu.: -0.0096361 Median: 0.0008839 3rd Qu.: 0.0102689 Max: 0.1085741

Total Sum of Squares: 1.374
Residual Sum of Squares: 0.24378
HPY R-squared: 0.51103

Due to high multicollinearity, the estimated coefficients of ΔLnlabor_stock and ΔLncapital_stock show sensitivity to model specification. Nevertheless, both coefficients remain significant. More importantly, all components of the IEF not only continue to be statistically significant, but their signs and estimated coefficients remain consistent. This indicates that the estimated coefficients of all four IEF components are statistically robust. Additionally, all three models, regardless of the excluded variables, display much higher R^2 values compared to the previous FE model.

5 Results and Interpretation

Looking at the regression results in Table XIX, all independent variables have a statistically significant effect on ΔLnrgdpo. The variables with a positive effect on the growth rate are: change in capital stock (ΔLncapital_stock) , change in labor stock (ΔLnlabor_stock), change in government size (ΔGS) , and change in market openness (ΔMO). The variables with a negative effect are: change in the rule of law (ΔRL), and change in regulatory efficiency (ΔRE).

- ΔLncapital_stock and ΔLnlabor_stock:

As anticipated from the theoretical model used, changes in the levels of capital and labor stock have a much more significant impact on the growth rate of GDP compared to RL, GS, RE, and MO. In simple terms, the growth rate of GDP is positively affected by increases in capital stock and labor stock. A 10% year-on-year growth in the capital stock is expected to result in approximately a 3.42% increase in GDP, assuming all other factors remain constant. Similarly, a 10% year-on-year growth in the labor stock is expected to lead to roughly a 1.68% increase in GDP, ceteris paribus. It is noteworthy that the effect of capital stock on GDP is more than double that of labor stock. This is likely because most value creation is capital-driven rather than labor-driven, as seen in sophisticated manufacturing.

- ΔRL:

Regarding changes in the rule of law measure, a 1% increase in the rule of law component year-on-year is expected to cause a 0.217% decrease in GDP. Although this result might initially seem counterintuitive, other empirical studies have found similar outcomes [13], indicating that the negative effect is not merely a statistical error. Typically, improvements in the rule of law are anticipated to promote economic growth by providing a stable and predictable legal environment [1]. However, the negative effect observed could imply that there are short-term costs associated with implementing and enforcing rule of law reforms.

In countries with high rule of law, more "free-wheeling" parts of the business sector may be regulated more strictly, making it harder for monopolies to form. While monopolies can be highly profitable and contribute to GDP growth, they may not benefit individual welfare. Another explanation could be the specific context or time period of the study, where changes in the rule of law may have had unintended economic consequences, such as during periods of economic shock (e.g. dot-com bubble, 2008 financial crisis, European sovereign debt crisis, migration crisis, and Brexit).

Additionally, the subcomponents of rule of law (property rights, government integrity, judicial effectiveness) and regulatory efficiency (business freedom, labor freedom, monetary freedom) as defined by the IEF are often intertwined and difficult to distinguish in reality. In fact, both sets of subcomponents tend to have the same overall effect.

- ΔGS:

Government size, which includes government spending, tax burden, and fiscal health, has a positive impact on economic growth. A 1% annual improvement in government size—achieved by reducing the tax burden and government spending while enhancing fiscal health—can lead to a 0.063% increase in GDP. Generally, a lower tax burden leaves more disposable income for consumers and more capital for businesses to invest. Reduced government spending can result in more efficient resource use, lower fiscal deficits, and a more stable economic environment. Improved fiscal health can boost investor confidence, reduce borrowing costs, and create a more favorable business environment. However, it also needs to be taken into account that throughout most of the EEA, many sectors contributing to the GDP have large public influence, which are primarily government driven.

- ΔRE:

Similar to the rule of law, regulatory efficiency unexpectedly has a negative effect on economic growth. A 1% increase in regulatory efficiency year over year is associated with a 0.230% decrease in GDP. Typically, an increase in regulatory efficiency is expected to promote economic growth [1]. One possible reason for this negative effect could be that reforms in regulatory efficiency initially disrupt existing business practices, requiring significant adjustments and incurring compliance costs, which can temporarily slow down the economy. Another possible reason is that extensive regulations can create business opportunities. For instance, tax advisory services in Germany constitute a large industry, larger than in many other countries, directly resulting from complex tax regulations. Similar effects can be seen with housing regulations and other regulatory areas.

- ΔMO:

Lastly, market openness has a positive effect on GDP, with a 1% increase in market openness leading to a 0.136% rise in GDP year over year. This positive impact is widely supported by empirical evidence [13], [41], [42]. By reducing barriers to international trade, such as tariffs and quotas, economic efficiency improves, and access to larger markets is granted. This typically results in fewer restrictions on both foreign and domestic investments, encouraging capital inflows and business growth. Reducing trade barriers also enhances economic efficiency by allowing countries to specialize in the production of goods and services where they have a comparative advantage. Fewer investment restrictions encourage capital inflows, essential for infrastructure development, business expansion, and technological innovation. Additionally, liberalized financial markets ensure stability and accessibility of financial services, facilitating efficient banking, stock markets, and other financial institutions.

While the direct effects of each component on the GDP growth rate were described above, it is important to note that the exact functional relationship between EF and GDP is not well-defined and has not been robustly demonstrated, as discussed before. Consequently, although the signs of these effects are reliable, the magnitudes should not be considered precise estimates.

Furthermore, EF influences growth through multiple channels, including stimulating effects on capital stock [4] and labor stock, which have not been modeled in this study. This multifaceted interaction makes the relationship between the independent variables complex and difficult to interpret. However, it can be confidently stated that the IEF components *GS* and *MO* have statistically significant and positive effects on GDP growth. Conversely, *RL* and *RE* have statistically significant and negative effects on GDP growth. The findings of this research line up well with the previous findings of Sturm and de Haan [36], and Wu [66], suggesting that changes in the levels of EF are more significantly related to economic growth than its static levels.

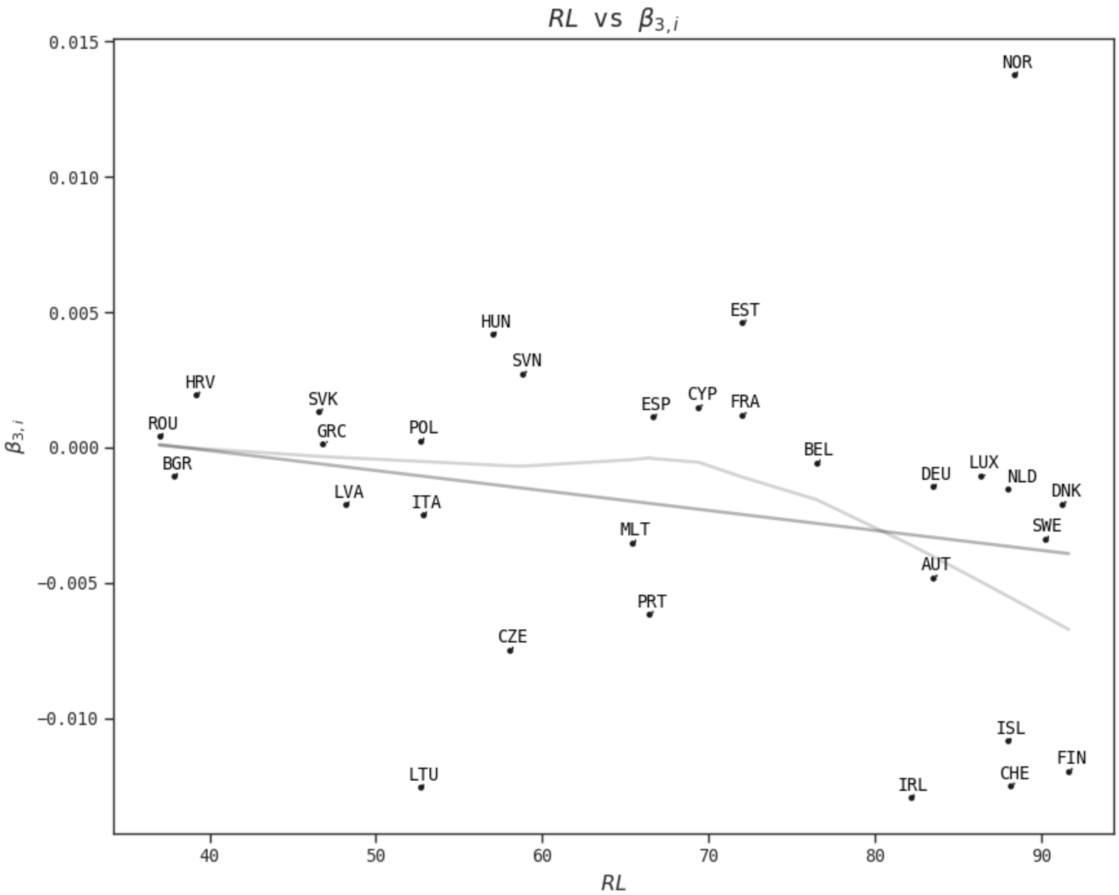
Revisiting the original research hypothesis, there is robust evidence to reject H_0. However, H_1 cannot be fully accepted, as not all components exhibit positive effects. Thus, H_0 is rejected, but H_1 is not accepted. These findings suggest that the relationship between EF and economic growth is more intricate than initially thought.

To delve deeper into this complexity, recall that the CCEMG model estimates entity-specific coefficients for each time series and averages these coefficients across all time series (7). These individual estimates may provide further insights into how the IEF components relate to growth. Appendix B lists all the country-specific (i for each country) estimates for $\beta_{j,i}$ where $j = 1, 2, \ldots, 6$. Figures 18, 19, 20, and 21 plot the estimated respective $\beta_{j,i}$ for each country against the averaged values of *RL*, *GS*, *RE*, and *MO* over the time period of the study. Examining these plots, certain patterns become clearer.

Table XXII: List of Countries and Their Abbreviations

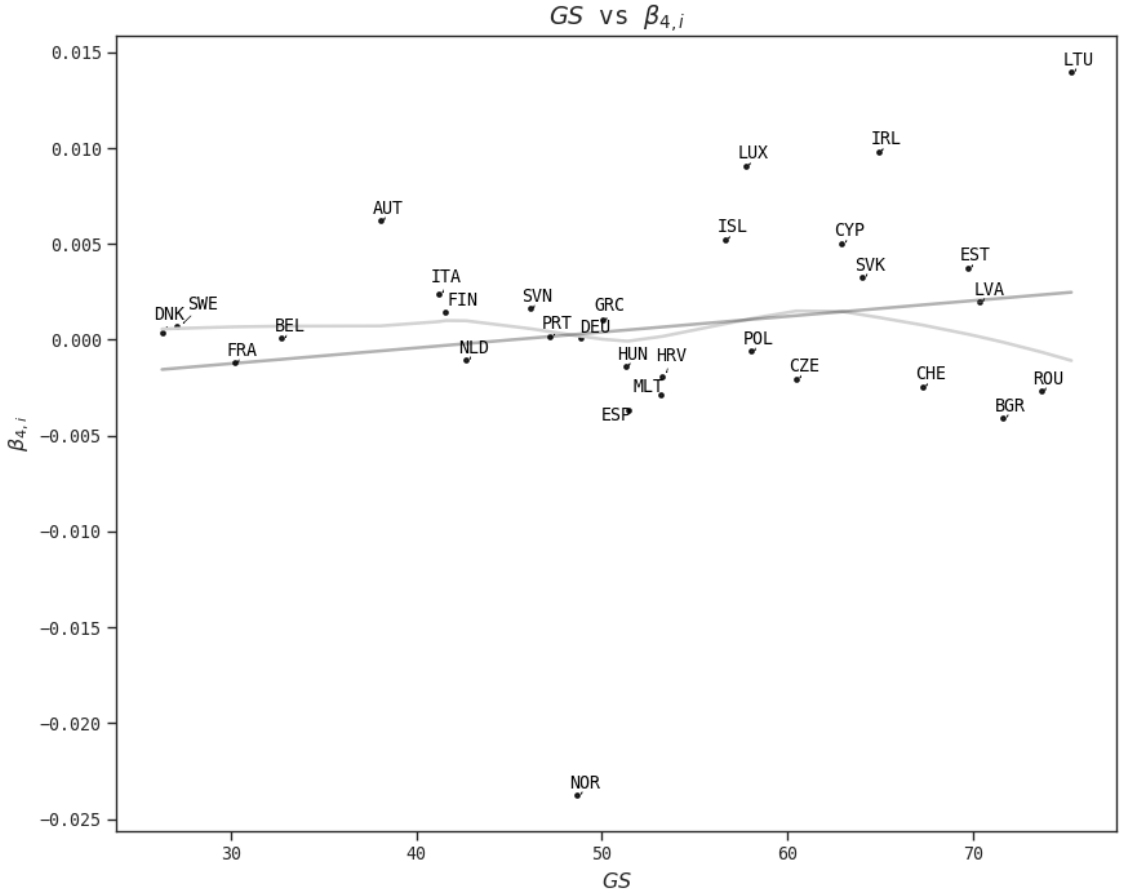
Austria	AUT	Germany	DEU	Netherlands	NLD
Belgium	BEL	Greece	GRC	Norway	NOR
Bulgaria	BGR	Hungary	HUN	Poland	POL
Croatia	HRV	Iceland	ISL	Portugal	PRT
Cyprus	CYP	Ireland	IRL	Romania	ROU
Czech Republic	CZE	Italy	ITA	Slovakia	SVK
Denmark	DNK	Latvia	LVA	Slovenia	SVN
Estonia	EST	Lithuania	LTU	Spain	ESP
Finland	FIN	Luxembourg	LUX	Sweden	SWE
France	FRA	Malta	MLT	Switzerland	CHE

Figure 18: Country-Specific Estimated $\beta_{3,i}$ vs. *RL*



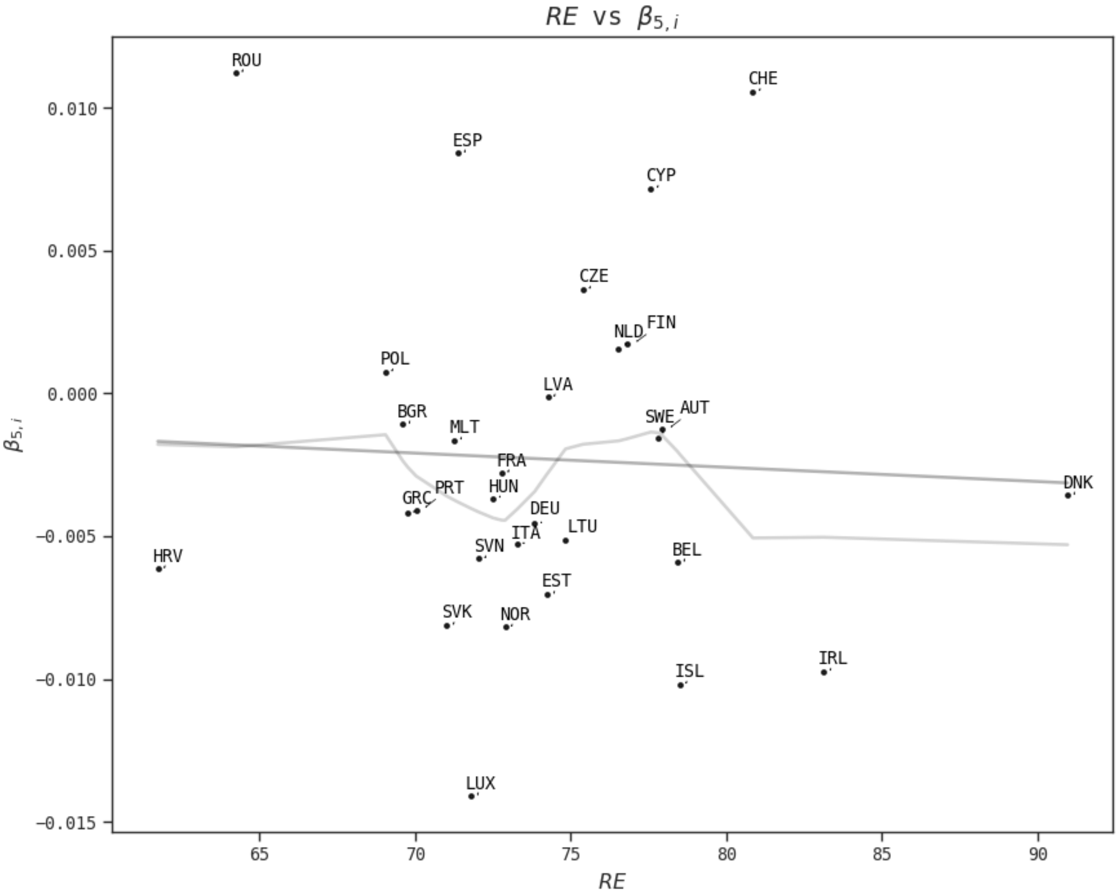
As estimated by the CCEMG model as well, *RL* shows a negative trend as it increases, confirming the negative effect on the growth rate as discussed before. The Locally Weighted Scatterplot Smoothing (LOWESS) line also follows the linear line closely, suggesting no major deviations.

Figure 19: Country-Specific Estimated $\beta_{4,i}$ vs. GS



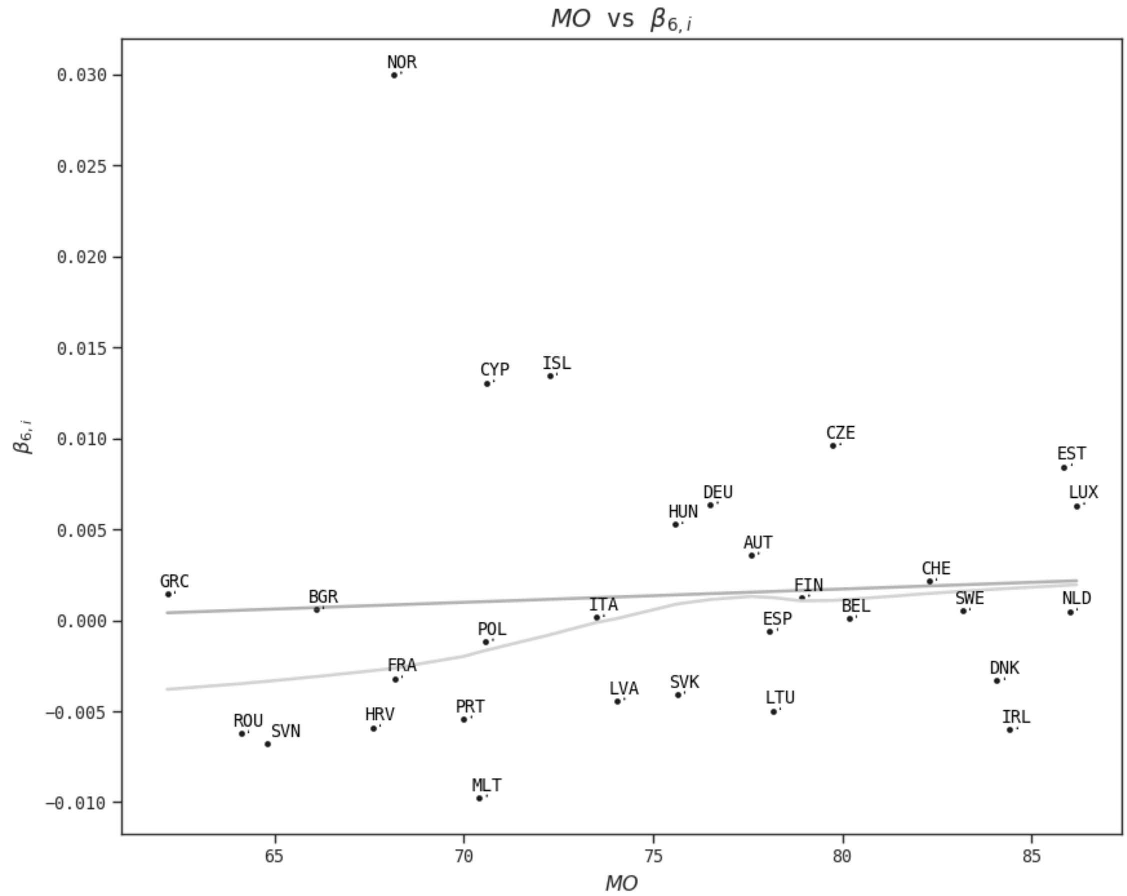
For GS a slight upward trend is observed and the linear line and the LOWESS line follow more or less the same trend. The LOWESS line does seem to show potential threshold behavior, similar to what Altman [17] discussed.

Figure 20: Country-Specific Estimated $\beta_{5,i}$ vs. *RE*



The plot for *RE* is much more scattered compared to the rest of the components. Overall, there are more observations that show a negative relationship than a positive one. The LOWESS line has a very distinct peak. This warrants further investigation and could point to a certain "sweet spot" range of *RE* values.

Figure 21: Country-Specific Estimated $\beta_{6,i}$ vs. MO



Similar to *GS*, a very slight upward trend for MO is present, however the LOWESS line shows that the linear line overestimates the effects for most values of MO.

Looking at all four figures, Norway's (NOR) β estimates are clearly outliers compared to the rest of the countries in the dataset, especially the estimates for *RL*, *GS*, and MO. Its unique position as an outlier in the EEA can be attributed to several distinctive characteristics that set it apart from other member nations.

Norway's economic structure is significantly influenced by its substantial oil and gas reserves [67], which have contributed to a high GDP per capita and the establishment of one of the largest sovereign wealth funds in the world, the Government Pension Fund Global (GPFG). This wealth provides Norway with financial stability and enables substantial public investment in welfare, healthcare, education, and long-term projects. Unlike many other countries, Norway's wealth from natural resources allows for greater flexibility in government spending, supporting a robust social safety net and high quality of life.

Norway's government size is large relative to its economy, however despite its size, the Norwegian public sector is characterized by high efficiency and low corruption, ensuring effective public services. The extensive welfare state contributes to social stability and economic security, which are less common in countries with similarly large governments but less efficient public sectors (e.g. Germany). Additionally, Norway excels in the rule of law due to its strong legal and institutional framework, characterized by low corruption and robust law enforcement. High levels of social trust and cohesion bolster the effectiveness of its legal system, creating a stable environment that fosters economic growth and institutional trust. This strong rule of law also ensures that both domestic and international investors have confidence in Norway's market environment.

Although not a member of the European Union, Norway participates in the single market through the EEA agreement, which allows it to maintain control over its trade policies while engaging in free trade with EU countries. Norway's adherence to high standards and regulations promotes a competitive and transparent market environment, attracting investment and ensuring economic stability. This balance of market openness and regulatory control helps Norway maintain economic resilience. Norway's political environment is notably stable, with a well-functioning democracy that supports economic stability and growth. The country boasts high standards of living, low levels of inequality, and strong social safety nets, contributing to a productive and stable workforce. These elements of social and political stability are critical in differentiating Norway from other EEA nations.

Investment in education and innovation is a cornerstone of Norway's economic strategy [68]. The country prioritizes education and research, ensuring a highly skilled workforce capable of adapting to changing economic conditions. Norway's emphasis on innovation and technology, supported by significant investments in research and development, contributes to high productivity and economic diversification. Norway's natural geography, including its extensive coastline and hydropower resources, has historically supported a maritime culture and industrialization. The country's policies have balanced industrial growth with environmental sustainability, utilizing hydropower for 92.1% of its electricity needs and promoting electric vehicles to reduce oil dependency. The discovery of oil and gas in the North Sea further boosted Norway's wealth, but prudent policies and the establishment of the GPFG have ensured long-term economic stability and resilience against oil price fluctuations.

Finally, Norway has managed to avoid the typical pitfalls of a petrostate, maintaining democratic institutions and avoiding high levels of corruption. The country's strategic investments and long-term planning, such as the strict investment rules of the sovereign wealth fund, have positioned it as a significant player in global markets while maintaining domestic stability and prosperity.

6 Conclusion

Both The Heritage Foundation and the Fraser Institute unconditionally advocate for libertarian policies through their respective indexes, the Index of Economic Freedom (IEF) and the Economic Freedom of the World (EFW). They assert that adopting such policies is the sole path to stable long-term growth and prosperity. However, this study empirically demonstrates that a positive relationship does not necessarily exist for all factors of economic freedom with respect to economic growth. In fact, certain measures show a negative relationship. While there are limitations to these findings, the main issue with blindly adopting libertarian policies is the impact of external factors that often outweigh how governments implement economic freedom measures. Furthermore, once economic freedom scores surpass certain threshold levels, marginal improvements in economic freedom appear to have diminishing effects on growth [17], [19].

Economic growth is central to policy discussions, especially given the global shift from globalization to fragmentation. Significant changes are necessary for sustained economic growth in this new context. Economies that can successfully transition by adopting new growth models will benefit from the evolving global order. Economic fragmentation typically leads to reduced trade, decreased capital movement, and restricted movement of people. However, the EEA members are designed to avoid these restrictions among themselves, presenting a significant opportunity for higher growth rates through deeper integration. Future expansions of the EEA must carefully consider the effects of new members on current policies.

Moreover, EEA members need to remain nimble and flexible in their regulatory approaches, quickly adapting to changes and adopting necessary policies in response to external forces [34]. The model results indicate that preventing the public sector from becoming overly large and inefficient is crucial (*GS*), as is avoiding broad protectionist trade measures and maintaining fairly open markets (*MO*). This does not imply minimizing the public sector or advocating for completely open and free markets. Instead, a balanced policy-making approach that considers both political and economic challenges should be adopted at both the national and EEA levels.

Further research could aim to establish a more robust functional relationship between EF and GDP to measure effect sizes more accurately. Employing a more sophisticated model specification, such as a dynamic panel model, could better capture the significant lag effects inherent in this macroeconomic context. Additionally, both indexes could be further disaggregated to provide a more granular view. Given the large number of subcomponents, alternative approaches to OLS, such as ridge regression or Least Absolute Shrinkage and Selection Operator (LASSO) regression, may be necessary to avoid overfitting.

For sensitivity analysis and robustness checks, further examinations using different measures of economic growth, such as GDP per capita (GDPPC) or Gross National Product (GNP), could be conducted.

Finally, an alternative way to study the EF-growth relationship could be to empirically identify the statistically significant drivers of sustainable growth on a per-country basis. Such results would be easier to interpret and could more effectively inform policy decisions.

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Appendix A: R/Python Packages and Function Calls

Packages used:

Python

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.ticker as ticker
import seaborn as sns
from scipy import stats
from scipy.stats import pearsonr, spearmanr, kendalltau
from scipy.stats import rankdata, norm
import statsmodels.api as sm
```

R

```
library(plm)
library(lmtest)
library(sandwich)
library(zoo)
```

Pooled model function call:

```
Pooled <- plm(Lnrgdpo ~ Lnlabor_stock + Lncapital_stock + RL + GS + RE
+ MO, data = pdata, model = "pooling")
```

FE and RE model function calls:

```
FE <- plm(Lnrgdpo ~ Lnlabor_stock + Lncapital_stock + RL + GS + RE +
MO, data = pdata, model = "within", effect = "twoways")

RE <- plm(Lnrgdpo ~ Lnlabor_stock + Lncapital_stock + RL + GS + RE +
MO, data = pdata, model = "random")
```

Differenced two-way FE model function call:

```
FE_diff <- plm(delta_Lnrgdpo ~ delta_Lnlabor_stock +
delta_Lncapital_stock + delta_RL + delta_GS + delta_RE + delta_MO,
data = pdata, model = "within", effect = "twoways")

summary(FE_diff, vcov = vcovSCC)
```

Differenced CCEP and CCEMG function calls:

```
CCE_P_diff <- pcce(delta_Lnrgdpo ~ delta_Lnlabor_stock +
delta_Lncapital_stock + delta_RL + delta_GS + delta_RE + delta_MO,
data = pdata, model = "p")

summary(CCE_P_diff, vcov = vcovSCC)

CCE_MG_diff <- pcce(delta_Lnrgdpo ~ delta_Lnlabor_stock +
delta_Lncapital_stock + delta_RL + delta_GS + delta_RE + delta_MO,
data = pdata, model = "mg")

summary(CCE_MG_diff , vcov = vcovSCC)
```

Differenced CCEMG function calls excluding `Lncapital_stock` and `Lnlabor_stock`:

```
CCE_MG_diff2 <- pcce(delta_Lnrgdpo ~ delta_Lnlabor_stock +
delta_RL + delta_GS + delta_RE + delta_MO,
data = pdata, model = "mg")

summary(CCE_MG_diff2 , vcov = vcovSCC)

CCE_MG_diff3 <- pcce(delta_Lnrgdpo ~ delta_Lncapital_stock +
delta_RL + delta_GS + delta_RE + delta_MO,
data = pdata, model = "mg")

summary(CCE_MG_diff3 , vcov = vcovSCC)
```

To access all raw data, R/Python code used for data cleaning, processing, estimation, testing, and visualization, please visit: https://github.com/Cosroe/Bachelor_Thesis

Appendix B: CCEMG Country-Specific β Estimates

Table XXIII: CCEMG Country-Specific β Estimates

Country	ΔLncapital_stock	ΔLnlabor_stock	ΔRL	ΔGS	ΔRE	ΔMO	RL	GS	RE	MO
Austria	0.167694	2.736604	-0.004804	0.006224	-0.001268	0.003585	77.63	53.50	75.03	82.00
Belgium	-2.262202	-2.401243	-0.000554	0.000076	-0.005902	0.000109	71.80	45.23	71.73	80.33
Bulgaria	0.316151	-1.380173	-0.001058	-0.004065	-0.001073	0.000594	46.50	84.30	73.03	72.00
Croatia	0.058626	-2.029624	0.001955	-0.001933	-0.006137	-0.005887	49.17	61.73	61.07	73.67
Cyprus	-0.118367	0.805607	0.001488	0.005043	0.007173	0.013055	54.97	70.13	73.47	73.67
Czech Republic	-0.076882	5.068162	-0.007473	-0.002023	0.003641	0.009587	58.17	77.43	77.33	82.00
Denmark	-0.322353	-1.980076	-0.002088	0.000392	-0.003562	-0.003314	83.27	51.03	87.07	85.33
Estonia	0.181673	0.475391	0.004618	0.003756	-0.007026	0.008448	76.87	76.93	70.70	82.00
Finland	-1.265483	8.513349	-0.011948	0.001449	0.001725	0.001256	87.77	53.47	74.83	83.67
France	1.022482	0.425346	0.001201	-0.001195	-0.002785	-0.003203	72.17	39.07	68.50	75.33
Germany	0.796708	-5.526173	-0.001455	0.000124	-0.004571	0.006365	78.87	64.97	71.33	78.67
Greece	1.150020	-1.065278	0.000153	0.001024	-0.004193	0.001434	46.53	53.80	68.57	62.00
Hungary	0.486519	0.587488	0.004173	-0.001374	-0.003672	0.005258	47.13	65.10	69.20	78.67
Iceland	0.654692	-5.905568	-0.010850	0.005238	-0.010177	0.013437	78.33	71.13	78.07	80.67
Ireland	0.830274	1.059422	-0.012921	0.009825	-0.009725	-0.006027	77.40	80.90	81.80	82.00
Italy	0.261960	0.033834	-0.002477	0.002418	-0.005286	0.000157	55.07	51.13	68.93	73.67
Latvia	0.194095	1.583162	-0.002103	0.001987	-0.000133	-0.004420	50.40	77.00	77.30	77.00
Lithuania	-0.087911	-4.847988	-0.012549	0.013978	-0.005124	-0.004964	60.87	82.93	74.47	78.67
Luxembourg	1.067722	-1.478507	-0.001073	0.009073	-0.014080	0.006318	80.40	70.30	65.77	87.00
Malta	0.292534	2.145920	-0.003516	-0.002841	-0.001638	-0.009748	56.83	71.60	68.87	77.00
Netherlands	-1.105722	-0.355861	-0.001532	-0.001046	0.001564	0.000499	83.93	62.60	75.23	85.33
Norway	-2.598868	11.639902	0.013781	-0.023734	-0.008182	0.029997	86.53	60.00	72.83	72.73
Poland	-0.264561	2.628233	0.000252	-0.000594	0.000750	-0.001171	52.03	70.03	70.47	78.67
Portugal	1.001511	-0.096080	-0.006151	0.000192	-0.004076	-0.005416	65.10	55.10	69.00	72.00
Romania	-0.141584	1.581721	0.000424	-0.002668	0.011223	-0.006240	52.80	82.67	70.10	68.67
Slovakia	0.150220	0.885058	0.001334	0.003276	-0.008112	-0.004070	47.80	70.63	64.43	77.00
Slovenia	0.339475	3.146412	0.002727	0.001637	-0.005787	-0.006771	58.83	59.77	74.70	68.67
Spain	1.313490	-1.351530	0.001137	-0.003698	0.008411	-0.000602	58.73	53.20	70.70	80.33
Sweden	1.686375	-4.583236	-0.003370	0.000709	-0.001549	0.000509	87.17	55.50	74.63	83.67
Switzerland	1.310867	-0.055765	-0.012489	-0.002443	0.010562	0.002146	85.10	77.20	77.70	87.47

Declaration of Authenticity

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