

ECONOMIC GROWTH IN G-7 COUNTRIES: AN EMPIRICAL ANALYSIS OF ITS DETERMINANTS

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Abstract

This study is an exploration of the key factors of economic growth among G-7 economies, including Canada, France, Germany, Italy, Japan, United Kingdom and United States, between the years 2000 and 2023. As economic giants of the world, a study on the sources of growth in these countries provides a good knowledge on the enhancement of long-term growth and development policies. The study identifies and estimates the role of investment, balance of trade, the participation of labor force, human capital index as a proxy of health and education and high-technology exports through dynamic panel-data estimation technique by means of the Generalized Method of Moments (GMM). The methodology takes into consideration country-heterogeneity as well as time dynamics in order to provide a sound and reliable outcome. The results affirm that investment and human capital are invariably robust factors in driving GDP growth with balance of trade being positively supportive as well. Also, the labor force participation and high-technology exports, which are statistically less significant in this model but show positive upward trends, have a potential in the future with the help of adaptive and innovation-friendly policies. Comprehensively, the findings point to the long-term viability of investment, education, and technology development on promoting inclusive, resilient, and sustainable growth in advanced economies.

Keywords: *Economic Growth, G7 Countries, Human Capital Index, High-Technology Exports, Panel Data Analysis*

1. Introduction

Economic growth is one of the most studied indicators in macroeconomic literature indicating the ability of a country to increase production levels, and consequently income levels, to reduce unemployment and raise the standard of living in the long run. When it comes to the world's leading industrialized economies the Group of Seven (G-7), which includes Canada, France, Germany, Italy, Japan, the United Kingdom and the United States the role of economic growth is even more crucial. These are not just countries with regional influence, but they drive global trade, investment, and innovation and policy impacts. And yet, although all of these countries are classified as developing and wealthy countries, the members of G-7 have evolved along different growth paths because of differing policy frameworks, demographic dynamics, economic models and stages of technological development. Students and academics can both benefit from understanding the elements that drive their economic performance and the implications these have for shaping future growth paths in like advanced areas.

This article aims to investigate the key factors explained economic growth in the G-7 countries. The dependent variable of this study is GDP growth (the annual percentage variation in the overall value of goods and services produced by the economy). It is the dependent variable; the question is: which economic/structural variables cause it to change in these countries over time. Through investigation of the patterns of GDP growth in connection to other macroeconomic variables, the paper seeks to illuminate what drives, sustains or hampers growth within developed countries that are frequently the global comparatives.

To understand, what contributes toward GDP growth of these countries, five independent variables are considered: Investment (as measured by Gross Capital Formation % YoY growth), Trade Balance, Labor Force Participation Rate, Human Capital Index (HCI), and High-Technology Exports (% of manufactured exports). These factors were selected due to their broad range, from physical capital, competitive trade, and labor force participation, to human development, and technological development, all of which are assumed to have a separate contribution to a country's economic prospects. Capital formation determines the magnitude of resources allocated to physical infrastructure facilities and productive assets. It is a critical factor when spurring productive capacity and economic growth. The balance of trade measures the difference between imports and exports, and is typically used as a gauge of a country's ability to produce and deliver goods and services for international markets. Higher-growth countries could also reflect an influx of income from abroad (through a trade surplus, for example) or demand-driven expansion.

Labor force participation is also very relevant: How much of a country's working-age population is engaged in the economy by working or seeking work. Participation rates matter, as they will influence productivity, output and dependency ratios, so it is an important consideration in determining longer-term growth. Human Capital Index is an index that measures human capital in a group based on the education, health, and future earnings of the individuals. In high-income countries increases in human capital can lead to productivity gains, innovation, greater efficiency and flexibility in labor markets. Exports of High-technology share of exports that require advanced technology and R&D such as electronics, telecommunications, aerospace, weapons systems, export aeronautics, and advanced computer and information technologies. The greater the proportion the more the ability to make money from innovation and from genuine international competitiveness. Taken together, these five variables provide a multi-dimensional perspective on determinants of growth in G-7 nations. Having identified and gathered the involved variables, the work starts with a descriptive statistical study. This includes the computation of the mean, min/max and standard deviation of each variable. The goal of this step is to gain a rough understanding of how the data is spread over time and across countries. It aids in determining which variables are relatively stable, and which are more variable. For example, investment may exhibit large variation across countries and years, whereas the Human Capital Index may be more stable as the education and health systems in those countries are more developed. This variation is important because it is essential knowledge before we move on to more advanced statistical tests.

Apart from descriptive analysis, the research adopts scatter plots to graphically present the relationship between GDP growth with each independent variable. This step might make you see clearly trends, outliers, or the lack of complete linearity between your independent and dependent variables. For instance, scatters of 'investment' with 'GDP growth' may demonstrate a positive trend, i.e. countries with high investment will have high growth in the economy. Likewise, one could illustrate Human Capital Index versus Growth and see whether better development of human capital correlates with better economic performance. These visualizations are basic but powerful means to visualize the nature of the relationships and can lead for more formal statistical testing.

After this graphical analysis, the paper provides a correlation matrix, which reports the linear utility between all the variables. Correlation measures indicate whether two variables move in the same or opposite direction, and to what degree. This is quite useful for detecting variables that are likely very closely related to each other (and which may have problems of

multicollinearity in models). For instance, if the high-technology exports are highly correlated with the investment, then it indicates that countries with high investment also have the high-technology exports. The correlation matrix facilitates the exploration and serves as a basis for understanding how each variable would act in a multivariate modelling.

In order to control for an endogeneity problem and to go beyond association to ascertain the nature of the effect of each of the variables on economic growth, the model adopted in the analysis uses a Generalized Method of Moments (GMM) estimation technique with a dynamic panel data. GMM would be very helpful for studying macroeconomic variables through time and across countries. It also controls for unobserved country-specific effects, time effects, and reverse causality. This makes it an ideal fuzzer to dissect the effects of individual component's contribution on the growth of GDP. At this level of analysis, the coefficients, standard errors and significance levels are closely scrutinized. Variables with statistically positive coefficients are "read" as being directly observable drivers of growth. For example, a coefficient that is large and statistically significant or close to significant for investment would indicate that larger levels of investment are always associated with larger real output for the G-7 sample.

The findings obtained from the GMM estimation give a more reliable evidence of which variables actually determine the economic growth. Typically, factors such as investment, trade performance and human capital are prominent among the key drivers. Conversely, labor force participation and high-tech exports may not always be statistically significant, but could be meaningful in particular national circumstances, and/or on a longer time frame. Statistics are interpreted by considering both statistical significance and economic significance of the estimates. Instead of simply concentrating on the figures, the research aims to turn the results into valuable new insights that can influence policy and future research.

The findings are summarized after description and interpretation of results. This section describes which variables were robustly related to GDP growth and possible surprising results. For example, investment or human capital may have significant and positive effects, however other factors may have mixed impact, which might possibly be due to constraints in the data or different economic environment in these countries. These abstract enables readers to understand quickly the main findings and it bridges the gap to the last part of the paper.

The introduction also foreshadows the policy implications of the research. Recommendations are derived from the empirical findings as to how countries could enhance their performance by targeting those variables which do indeed contribute most efficiently to growth. For instance, those nations that have lagged in investment are often the ones where infrastructure and private sector capital formation spending can be beneficial. Countries with poor trade balances might get inspired to rethink their industrial strategies or export promotion policies. Human capital development could be enhanced via focused reforms in education and healthcare. While these recommendations are discussed in more detail in a later section of the paper, their incorporation in the introduction also highlights the practical focus of the report.

To conclude, this introduction to the research process provides a thorough, but accessible, review of the entire research effort. It provides information about the subject and addresses: the dependent and independent variables; the reporting of steps done in the process of analysis; and the practical implications of the results obtained. Looking at how important economic and structural determinants affect GDP growth in the G-7 countries, the study attempts to become a part of not only the theoretical literature, but also of applied economics. The logic of the research is oriented to take the researcher from the description of data to the application of

statistical tests, and interpretation and recommendation while maintaining both a broad and a narrow focus of the study.

2. Literature Review

Easterly and Levine (2000) have analyzed long-term effects of policy, institutions and geography on growth. The intention was to disentangle cross-country income disparities. They used cross-sectional regressions and tested with instrumental variables in evidence from more than 80 countries. And their results proved that institutions matters a lot for development, which was more powerful than both policy and geography.” The paper showed that such countries with more robust rule of law and property rights had sustained economic growth, thereby reinforcing governance's role in shaping longer-run economic paths.

Dollar and Kraay (2001) analysed the effects of trade openness on growth and asked specifically that whether the process of globalization of the world's economy benefits the poor. The idea was to test whether a country that liberalizes its trade grows faster and reduces poverty at a faster pace. By applying a panel data regression approach and case studies, they concluded that trade liberalization had been beneficial for income growth and that lower income quintiles essentially benefited therefrom. Their findings lent credence to the claim that economies open faster and with greater inclusiveness. Bosworth and Collins (2003) investigated the causes of growth in East Asia and Latin America. Their intent was to ascertain whether capital accumulation or productivity was the primary driver of growth. With growth accounting analysis and data of the panel type for 1960-2000, they determined that much of the better growth performance in East Asia was accounted for by greater accumulation of capital and investment in education. The survey recommends that long-term growth requires investment in physical and human capital.

Tavares and Wacziarg (2003) examined the effect of democracy on economic growth. Their goal was to determine whether a degree of political liberalization is an impediment to or a facilitator of development. By applying the dynamic panel data models to a large sample of countries, they found out that democracy has an impact on growth indirectly – through education, investment and government consumption. The results implied that democratic institutions facilitate the human capital accumulation and investment efficiency, and in concert enhance economic growth in the long term. Hall and Jones (2004) have analysed the productivity variation across countries and propose that the bulk of that divergence is due to differences in a social infrastructure. The point was to investigate how institutions and policies facilitated the accumulation of human capital. Data culled from international productivity databases and regression analysis showed that countries with strong institutions had more output per worker. Their findings lent evidence to the endogenous theories of growth and further highlighted the importance of policy regimes and institutional quality when explaining productivity and growth.

Acemoglu, Johnson, and Robinson (2004) examined the role of historical institutions in the creation of modern economic development. They instrumented settler mortality rates in order to identify the persistent effects of colonial institutions. The study sought to show causation between institutional structures in the past and current income. Using cross-country data and instrumental variables estimation, their findings revealed that ‘inclusive (i.e. broadly participatory and constraining of power), political institutions (those that free ordinary people from expropriation by people with power) predict economic growth better than extractive institutions (deriving income and power from the capacity to control and extort)’. Their results represented great progress in institutional economics.

Bils and Klenow (2004) investigated the relationship between education and growth. They sought to discern whether human capital accumulation is indeed the mechanism behind long run economic growth. Utilizing growth regressions for a broad group of countries and a calibrated macroeconomic model, they documented a high correlation between education levels and per capita income growth. They concluded that the investment in higher education, especially on quality, has a significant effect on productivity and innovation. Frankel & Romer (2005) attempted to instrument income by trade using geography as instrument. The goal was to remove the possibility of endogeneity when considering the effect of trade on GDP. They found that trading with other countries is a key determinant of income through distance to trading partners and coastal access. Their findings were strong evidence that more international trade made easier by good geography spurs economic growth.

Klenow and Rodríguez-Clare (2005) decompose the variation in GDP per worker across countries to answer the question of what factors cause income disparities. The goal was to measure the contribution from physical capital, human capital, and productivity. Using calibrated growth models and global economic data, they obtained their findings that based on income gaps, differences in Total Factor Productivity (TFP) were the main source rather than input differences. The study underscored that long run growth policies should give priority to the development of innovation, efficiency, and technological diffusion.

Alesina et al (2005) examined the effect of ethnic diversity on policy and the economy. This they hoped to do by testing whether mixed communities have differing growth consequences. In cross-country regressions that employed diversity indices, weaponsmiths discovered that ethnic fractionalization was associated with lower provision of public goods and slower growth. They did add that the quality of institutions can temper these effects, however. The findings emphasized the significance of inclusive governance in plural societies in advancing sustainability.

Rodrik and Subramanian (2006) studied institutions in the context of development. Their aim was to find out which factors — geography, trade or institutions — best account for income differences. Applying both an instrumental variable approach and cross-country regressions, they concluded that institutions dominate very decisively as a determinant of long run economic performance. Especially countries that provided strong contract enforcement, regulatory quality, and political stability were followed by above-average growth rates. They concluded that reforms should start with enhancing institutions infrastructure to facilitate continuous economic progress.

Aghion, Howitt and Mayer-Foulkes (2006) investigated education policy and innovation in growth. The object of the study here is to investigate the link between the quality of schooling, innovation, and productivity for different income classes. They used endogenous growth models with cross-country panel data. The findings turned out to be that a higher level of investment in secondary and tertiary education across countries leads to higher sustainability of innovation-driven growth. Quality education allows economies to move from imitation and emulation to innovation, the authors noted, and this transition is essential if they're to catch up to high-income countries.

Hanushek & Woessmann (2007) investigated if cognitive skills were more important than years of schooling in forecasting economic growth. They wanted to enhance the measurement of human capital in growth regressions. They did cross-country regressions based on data from international student assessment (PISA, TIMSS). The results show that cognitive test scores are highly predictive of long-run GDP growth, much more so than enrollment ratios.

The upshot of the study is that it's not access to education but the quality of the education that is the primary driver of the economic return of human capital.

Bloom and Van Reenen (2007) investigated the impact of management practices on productivity and growth. Their objective was to measure how much good management pays off economically. Using a survey of more than 4,000 manufacturing firms in multiple countries and based on productivity regressions, they found a significant positive association between structured management and firm level productivity. Nations with better management practices had higher levels of national productivity. The authors suggested that national development strategies should include the development of managerial skills and processes efficiency.

Based their findings, Brynjolfsson & Hitt (2008) examined the effect of information technology (IT) on economic productivity. They wanted to solve the "IT productivity paradox." Based on a firm-by-firm panel data as well as growth-accounting models, they (implicitly) showed that IT investments lead to a substantial increase in productivity, especially when they are linked to organizational modifications. The findings revealed that technology by itself is no more than a part of the overall business operation. The report found that digital infrastructure can fuel macroeconomic growth when combined with innovation in management and workforce skills. The World Bank (2008) looked at how trade logistics influence a country's potential for export-led growth. The relationship between smooth and efficient trade, customs and infrastructure was the basis of the study to ascertain if they contributed to economic competitiveness. Applying the Logistics Performance Index (LPI) and econometric models, they discovered that countries with good logistics systems had higher trade and GDP growth. The results suggested public investment in ports, transport and customs modernization as crucial to unleash export-led development.

Corrado, Hulten, and Sichel (2009) advocated broadening the concept of capital to include intangibles such as software, brand value, and R&D. Their aim was to quantify the role of intangibles in economic growth. Applying the national income method and the capital services approach, they demonstrated that intangible capital was responsible for much of the growth in U.S. GDP during the period from 1995 to 2006. Their results underlined the necessity of reforming growth models to the changing structure of advanced economies.

Crafts and Mills (2009) analyse the historical relationship between infrastructure spending and economic growth in the UK and other advanced countries. They wanted to find out if public capital formation is still a spur to productivity in mature economies. Pooling data across time with econometric techniques such as co-integration analysis, they show that there is a positive relationship between infrastructure and long-run growth. Their evidence justified the notion that even sophisticated and advanced economies had to continue building infrastructure in order to keep output and employment afloat.

Rodrik (2009) analyzed the trade-off between globalization and domestic development strategies. He wanted to find the right level of policymaking freedom for developing countries in a world economy that allowed such open trade. Using case studies and institutionalist analysis, he also found that countries with flexible industrial policies and gradual liberalization were more successful than those who experienced rapid deregulation. This study suggested that a more pragmatic approach to global integration and domestic capacity building is a way to achieve sustainable economic growth.

Hausmann and Hidalgo (2010) developed the idea of "economic complexity" to help the understanding of the differences in development between countries. The idea was to measure how the diversity and sophistication of a nation's export basket influence growth. They used

network theory (and export data from 1962 to 2008) to develop the Economic Complexity Index (ECI). Their results indicated nations with more complex, knowledge-intensive exports grew more quickly. The research called for measures that support diversification and innovation in products to increase national income levels.

Page and Söderbom (2011) The role of industrial policy and productivity in Africa's economic transformation. The question they sought to answer is whether industry policy, if systemically structured, can underpin inclusive growth. Using manufacturing surveys and decomposition of productivity, they discovered that most growth came from resource-intensive sectors and productivity in manufacturing didn't budge much. The report argued that targeted industrial and business assistance, enhanced infrastructure, and skills development were critical to unlocking productivity and sustainable ethical growth.

Chinn and Ito (2012) investigated the nexus, between financial openness, institutional quality and economic growth. They aimed to check if capital account opening is growth promoting in institutionally strong environment. They estimated fixed-effects regressions using a panel data set of over 100 countries between 1970 and 2010 and their own measure of financial openness. They concluded that financial openness only enhances growth when institutional quality — including regulatory efficiency and legal protections — is strong enough. Their results strengthened the “institution-first” case for liberalization.

Kose et al. (2012) investigated to see if more capital flow across the border stabilizes or destabilizes economies. In dynamic panel regressions and data for emerging and advanced economies, they got a mixed result: Countries with strong financial institutions saw steady and higher growth while in others, there was volatility. Instead, the authors advised countries to develop a strong domestic financial system before completely opening themselves to international capital markets. Lin and Monga (2012) developed the “New Structural Economics” paradigm to analyze the process of how countries move from low- to high-productivity sectors. They were designed to advise governments how to develop growth strategies based on comparative advantage. They also maintained that state intervention is a precondition for distinguishing and nurturing competitive industries, based on historical and empirical examples. Their study underscored the importance of infrastructure, credit availability and policy coordination in supporting industrial upgrading and sustainable growth. Felipe et al. (2012), structural transformation and economic development were studied. They wanted to see how countries move from low-productivity to high-productivity employment. Drawing on employment and value-added data from Asia and Latin America, they found that successful economies had one characteristic in common: increased productivity was achieved by reallocating labor across sectors. The authors found that structural transformation not just within-sector increases was an important source of growth. Policies for education, industry and city are what is needed to facilitate this journey, they suggested.

Aizenman and Noy (2013) investigated the macroeconomic implications of public investment in infrastructure. However, their concern was to investigate its impact on growth and stability. Employing panel data and generalized method of moments (GMM) estimation for more than 100 countries, they discovered that well-targeted infrastructure projects can strongly boost growth and crowd-in private investment. But projects badly conceived can court fiscal ruin. The research emphasized the role of efficiency of projects and governance to maximize the growth effects of public investment. Bourguignon (2013) studied income inequality and its impact on long-term growth. His aim was to reconcile contradictory evidence on whether inequality stimulates or hobbles development. By analyzing macroeconomic panel data and cross-country comparisons, he discovered that even though a certain level of inequality may



spur investment, high and entrenched inequality undermines social cohesion and human capital development. The paper estimated that more equal distribution of economic activity through tax policy and spending on education adds to the strength of the growth basis, boosting to opportunity and reducing political instability.

Hausmann and Klinger (2014) developed economic complexity theory to analyze patterns in which countries enter into new production sectors. The aim was to determine how export sophistication changed. Using data on export similarity indices and diffusion models, the researchers found that countries grow faster when they diversify into products that are closely related to what they are already good at. Their study underscored the role that strategic industrial policies can play in helping economies move through complexity gaps and into higher-value activities. Pritchett and Viarengo (2014) analyzed how educational expansion contributes to economic growth. They wanted to see if there is a relationship between the number of extra years of schooling a worker has and productivity. Drawing on data for educational attainment and growth regressions for developing and developed countries, they found that quality of education carried more favor than mere quantity. Countries with high enrolment but low learning had no growth dividends. The report recommended reforms centered on the quality of learning and the relevance of the curriculum.

Jones and Romer (2015) investigated endogenous technological change and its impact on long-run economic growth. It was to "endogenize" innovation in macroeconomic growth theory. Through theoretical modelling and empirical calibration, they maintained that policies raising the rate of idea production such as R&D subsidies and skilled immigration raise productivity and growth. Their findings provided support for innovation-driven growth and the significance of institutions and knowledge accumulation.

Andrews et al. (2016) studied the productivity slowdown in the advanced economies, discussing the "diffusion gap" between global frontier firms and the others. Their goal was to figure out why innovation does not spread evenly. Their data on firm-level performance in OECD countries revealed that whereas top firms still expanded, laggard firms were not expanding, because competitive pressures were weak and policy constraints remained. Their research reveals the necessity of regulatory business reforms and productive knowledge channels to address the productivity lag and robust overall growth.

Botev et al. (2018) undertook a stylized study of the long-run effect of structural reforms on OECD countries GDP growth. What they want to find out is which changes in policy, notably in labor markets, product markets and taxation, afford the biggest economic payoff. Applying panel data regression methods and cross-country reform indicators, the study shows that education system, innovation policy and market competition are coherent reforms not only significantly positively related to output growth. The authors emphasized that the effectiveness of reforms will depend on not just what is done, but when, how, and with whose support. The study suggested phased and coordinated roll out based on institutional capacities.

The World Bank (2019) analyzed the impact of quality of human capital (especially the early childhood years) on generation of long-term economic performance. The purpose was to establish a basis to support the development of the Human Capital Index. Drawing on health, education and survival data from more than 150 countries, they discovered that disparities in human capital accounted for most of the variation in income levels. Investment in child health, school effectiveness and equity in access can potentially raise GDP per capita in the long term, the report found. The International Labor Organization (ILO, 2019) studied how gender gaps in labor force participation affected economic development. The point was to estimate how the closing of gender gaps raises G.D.P. With CGE analysis and labor force data they projected

that full gender-parity in labor markets could lift GDP by 20–30% in many economies. The study made the case that inclusive growth is fair, and that it makes economic sense, calling for reforms in childcare, workplace flexibility, and anti-discrimination policy.

OECD (2020) considered the impact of digital transformation on national productivity and employment structures. The idea was to see how digital tools reconfigure economic performance within industries. Applying digital intensity indices and sectoral GDP data, they discovered that digital-intensive industries grew more rapidly and were more resilient in the face of economic shocks. But gains were uneven from country to country. The report called for policies targeting digital upskilling, expanding digital infrastructure and small business support to ensure inclusive digital-led development.

Hanushek and Woessmann (2020) also looked at learning rather than school enrollment power economic performance. They aimed to verify that the quality of education is a major factor in growth. Examining international test scores and long-run growth in GDP per capita, they found compelling evidence that cognitive abilities are a better predictor of economic performance than the number of years of schooling. It called for teacher training reforms, curriculum innovations and new accountability systems to enhance learning and thus, national productivity. Rodrik (2020) concentrated on “productivism” a novel growth model centered on developing domestic capabilities. His aim was to reconsider the role of globalization in structural transformation. He advocated for pragmatic industrial policy, local supplier development and strategic trade policy through theoretical discourse and experiential illustrations. His results emphasized the importance of growth strategies that place internal economy resilience ahead of just pure liberalization, especially in a time of technological disruption and global shocks such as the COVID-19 pandemic.

Autor et al. (2020) used a framework of artificial intelligence (AI) to analyze the impact on job quality and economic productivity. It was trying to examine how AI is impacting various aspects of the workforce. By using firm-level automation data and trends in labor income share, they found that while AI lifted output in tech-intensive sectors, it tended to displace mid-skill jobs. They noted that AI policy that is broad-based must be accompanied with the right investments in education and social protections, and reskilling to secure net-positive economic benefits. Fernald and Inklaar (2020) analyzed the drivers of sluggish productivity growth in the US and the EU after 2008. What they were trying to do was to disentangle cyclical from structural explanations. Using a decomposition that accounted for capital services, labor input, and TFP growth, they identified sluggish innovation diffusion and falling business dynamism as the central culprits. Their research suggested establishing policies to promote firm entry, ease regulatory burdens, and promote R&D in laggard sectors to reinitiate productivity-driven growth.

The OECD (2020) compared labor force adaptability in digitalized economies. The point was to study the impact of lifelong learning & vocational training on labor productivity. Via skills surveys and national training policy indicators, they discovered that countries with robust adult education systems were better equipped to navigate digital disruptions. Their results underscored that adaptive skill systems are central to inclusive policy in technology-led economies. Autor et al. (2021) studied the industry-specific effects of automation and AI on employment and productivity. The aim was to look at the impact of technological progress on economic growth. Relying on sector-level data and employment trends in the United States and Europe, they found that AI adoption raised output in tech-oriented sectors but also fostered labor polarization. The research concluded that while AI delivers efficiency, focused programs to re-skill workers are essential to make sure growth is inclusive and socially sustainable.

Alfaro et al. (2021) investigated the linkages between foreign direct investment (FDI) and economic growth in high-income countries. They aimed to find out whether FDI stimulates innovation and productivity. Focusing on panel regressions and sectoral data of OECD countries, they evidenced that FDI inflows in manufacturing and high-tech sectors had a statistically positive impact on GDP growth. Their results lend further evidence to the notion that not only is FDI a means of transferring capital it is also a source of knowledge that spills over to host countries. OECD (2021) analyzed how national efforts to upskill foster economic recovery following COVID. The objective was to contribute to analyze the long-term macroeconomic impacts of adult learning and digital training. Drawing on labor force survey data and records of training programs from member countries, the study demonstrated that countries with well-developed adult education systems recovered faster and displayed stronger GDP rebounds. The report said workforce flexibility was key to success in the digital age.

The IMF (2021) empirically examined how fiscal stimulus and public capital formation-investment influences the size of the post-pandemic recovery. It was an attempt to construct multipliers across a group of G-7 countries. They showed with structural VAR models and dynamic simulations that public investment in infrastructure and health yielded the greatest output returns. Their evidence supported the argument for counter-cyclical fiscal policy in a crisis, particularly when interest rates are already at zero and private demand is weak.

Brynjolfsson and McAfee (2022) analyzed the impact of productivity growth by AI and machine learning technologies. The goal was to see whether digital transformation results in tangible macroeconomic benefits. Combining firm level data with national productivity data, they found that investment in AI had the greatest return on investment in industries with complementarity with human capital. The research found that digital tech accelerates growth only if combined with training, institution building and labor market policies that can adapt over time.

The International Labor Organization (ILO, 2022) explored the potential effects that youth employment policies will have on economic growth in the post-COVID world. They were seeking to learn about the macroeconomic value of hiring young employees. In a study based on CGE models and participation rates in the labor market, they found that investments in youth training, apprenticeship and entrepreneurship programs significantly contributed to GDP. The reason is that their findings highlight that labor market policies that are more comprehensive and focus on the younger generations, promote productivity and reduce long-term unemployment.

In a recent study, the European Commission (2023) analyzed the economic effects of transformative investments of the green transition in Europe. They are trying to determine if public spending focused on climate does indeed boost GDP and create jobs. Based on a refined partial equilibrium model, which is calibrated on Eurostat and industry data, they concluded that investments in energy, housing, and transport infrastructure would stimulate both climate protection and economic growth, particularly in the construction and clean-technology sectors. The report promoted green stimulus as a twofer.

Bloom et al. (2023) studied the macroeconomic effects of hybrid work in the COVID-19 world. They wanted to determine if remote and hybrid models impact labor productivity and firm growth. Using survey data from thousands of firms in the United States, the United Kingdom and the European Union, they found that hybrid arrangements raised productivity and worker satisfaction without reducing collaboration. The study called for hybrid work policies to be formalized to support output gains in knowledge-intensive industries.

World Bank (2024) Measuring returns strategy in Human Capital: The impact of health and education reform on other capital employ cut Renting Human capita and sustainable GDP growth in mathematics. The idea was to find out whether co-investing in these areas improves productivity. With panel regressions from 2010 to 2023, they found that countries investing at the same time in access to healthcare and quality of schools experienced stronger and more equal growth. The results underlined that cross-cutting investment is needed to unleash the productivity potential of its labor force. The OECD (2024) examined the contributions of adoption of digital public services on governance and economic performance. The point is to measure what digitizing service delivery does to the national output. They measured e-government readiness indices and public sector efficiency scores across 35 countries. “Digitization led to enhanced transparency and reduced costs with increased potential for inclusive growth.” The report found that digital transformation in the public sector is a fundamental driver of contemporary economic competitiveness.

3. Data and Analytical Framework

In order to analysis the determinants of economic growth in G-7 countries from 2000 to 2023 this study uses a comparative panel study approach to investigate the impact of various economic and institutional determinants of GDP growth in the G7 countries. The period of the study, 2000-2023, is chosen to represent recovery times in post-financial crisis era, the implications of digital transformation, and the social aspect of the COVID-19 pandemic. The design is suitable for cross-sectional and longitudinal analyses to track time trends in the structure of G7 countries. It is based on a mix of descriptive statistics, panel regression models (fixed and random effects) and targeted country case studies for richer contextual analysis.

3.1. Data Description

This research paper relies on the secondary data obtained through the World Bank World Development Indicators (WDI) database. The G-7 countries, including Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, were taken and data was collected on an annual basis between the year 2000 and 2023. WDI database was chosen due to internationally comparable and standardized indicators. The empirical analysis was carried out based on the dynamic panel data estimation on the basis of this structured dataset.

3.2. Variables Description

Dependent and independent variables are discussed as followings.

3.2.1. Dependent Variable

- **GDP Growth Rate:** GDP growth rate expressed as a percentage presents the annual percentage increase in gross domestic value at market prices, based on constant local currency units. This is an indicator of the relative wealth of each country and is used in this study as a dependent variable to represent economic growth.

3.2.2. Independent Variables: The independent variables applied in this research are as followings.

- **Gross Capital Formation (% of GDP):** This indicates investment in physical assets, such as infrastructure, machinery and buildings. An alternative measure of domestic investment and capital formation which shows how much an economy is expanding. Its represented as investment (Invest)
- **Trade Balance (% of GDP):** Net exports (goods and services). A trade surplus could show that the exporting sectors are growth enhancing. It is presented as TB.
- **Labor Force Participation rate (%):** This measures the working-age proportion of the population, which is in the active labor force, thus the supply side of growth. It is presented as LFPR.

- **Human Capital Index (scale 0 to 1):** Combined measure of expected years of schooling and learning-adjusted health. The higher score represents stronger labor productivity and innovation potential. It is used as a proxy for the degree of health and education of the Country which is presented as HCI.
- **High-technology exports (% of manufactured exports):** This is an indicator of the technical capacities of the country and is measured by the ratio between the value of the high-technology exports and the total of the manufactured exports. It represents a stand-in for innovation and R&D-based competitiveness and is presented as THE.

3.3. Analytical Framework

A panel data regression model is used in this study to examine the major macroeconomic variables affecting economic growth of the G-7 countries. Panel estimation, which utilizes the both cross-sectional and time-series dimensions, have improved the reliability of the estimates due to its controlling for the cross-country heterogeneity and temporal factors. This approach is especially useful to compare economic dynamics in developed economies because it captures the cross country and time changes in variation. The purpose of this study is to measure the effect of some selected explanatory variables [investment, trade balance, labor force participation, human capital and high-technology exports] on the economic growth rates of the G-7 economies. The selection was made based on the empirical supports from the previous studies.

In order to achieve robust and unbiased estimates, the dynamic panel-data estimation, which accounts for time effects and corrects for unobserved heterogeneity. Especially, the Generalized Method of Moments (GMM) is used and it is a good estimation method for panel data possibly suffering from endogeneity and autocorrelation. From the results of GMM the size and significance of effect of each of the variables on economic growth is examined. In addition, we test diagnostic tests for model fit and instrument relevance. The chapter ends with a summary of the main results, comparative views on the way various growth determinants work across the individual G-7 economies, and some policy relevant lessons.

3.3.1. Regression Equation

Following regression equation is defined for data estimation.

$$EG_{it} = \beta_0 + \beta_1 \cdot INVT_{it} + \beta_2 \cdot TBit + \beta_3 \cdot LFPR_{it} + \beta_4 \cdot HCI_{it} + \beta_5 \cdot HTE_{it} + \epsilon_{it}$$

Where:

EG_{it}: Economic Growth in country *i* at time *t*, (dependent variable)

INVT_{it}: Investment (percent annual growth) in country *I* at time *t* which shows how much a country is expanding.

TBit: Trade Balance (Net Exports) in country *I* at time *t* which shows a country's economic health and its position in global economy.

LFPR_{it}: Labor Force Participation Rate (i.e., percentage of working-age individuals that are active in the labor force) in country *I* at time *t*.

HCI_{it}: Human Capital Index (on a scale 0–1) as proxy for the degree of health and education of the Country *I* at time *t*.

HTE_{it}: High-Technology Exports (% of manufactured exports) proxy for innovation-driven growth of country *I* at time *t*.

β₀= intercept: the value taken by the economic growth when all other explanatory variables are equal to zero.

β₁, β₂, β₃, β₄, β₅: Coefficients of marginal effects of explanatory variables.

ε_{it}: Error capturing the omitted or unobserved influences.

The regression model estimates how the macroeconomic and structural core variables affect the growth process of G-7 countries. Implicit in this is the view that growth is not simply a matter of capital accumulation, but is strongly influenced by trade, by labor market dynamics, by human capital accumulation, and by technological progress. β are the estimated coefficients, that is, the marginal effect on economic growth of each independent variable (the size of effect when other variables are held constant). For example, β_1 measures the growth response to investment levels while β_5 measures the growth contribution of technology exports.

For a given demand for investment opportunities, investment is also expected to be related positively with growth, so that more investment in capital is shown to lead to economic growth. On the other hand, Health and Education (Human Capital Index) is expected to have a positive effect because high quality in education and health make worker more productive. High-tech exports are also expected to have a favorable significant effect on growth through innovation, competition and value added production. The impact of trade balance may also depend on the composition of imports and exports. A trade surplus could promote growth by raising net income from abroad, and chronic deficits could threaten macroeconomic stability. Participation may be an indicator of supply side firmness and potential slack in employment, so its coefficient can have a mixed or context-dependent effect. The error terms include omitted factors such as the quality of institution, changes in policy, and external shocks in between the main factors included, for example, inventiveness, which increases the reliability of the coefficient estimator.

3.3.2. Coefficient Interpretation

Intercept (β_0): Is the value of the dependent variable when all the independent variables are zero. Its meaning is essentially technical, determining the starting point of the model.

Investment (β_1): If it is positive and statistically significantly different from zero, this would indicate that more investment stimulates economic activity by adding physical capital and infrastructure.

Trade Balance (β_2): Positive or negative depending on whether net exports help or hurt growth in this country-year.

Labor Force Participation Rate (β_3): Whether the variances observed in establishment labor force engagement are calibrated to influence GDP growth; or 3. Meaning and importance depend on the status of employment.

Human Capital Index (β_4): A positive coefficient lends support to the notion that a healthier and better educated workforce is conducive to productivity and growth.

High-Tech Exports (β_5): A greater share of technology-intensive exports points to a growth path where innovation leads the way. A positive value of β_5 confirms its positive effect on economic growth.

Error Term (μ_{it}): Accounts for the effects of unobserved factors and other external shocks, excluded from the model.

This econometric framework is outlined to empirically examine how investment, trade balance, work force participation, human capital, and technology exports affect growth in the G-7 countries. The panel regression setting allows for controlling for time-varying changes and country-specific effects more appropriately. Estimates of the direction, magnitude, and significance of the coefficients will determine which of these factors are most influential in driving sustainable economic development in developed economies.

4. Data Analysis and Results

Data analysis and the results of the estimation are discussed in the following sections.

4.1. Descriptive Statistics

The descriptive statistics describe the database presenting the central tendency, the dispersion and the range of variables. These estimates provide some information since the dependent variable (GDP growth) and independent variables (Invt, TB, LFPR, HCI and HTE) over the period of interest from 2000 to 2023 across the G-7 countries.

Table 4.1: Descriptive Statistics

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
GPDG	140	1.192426	2.831083	-10.29692	8.931062
TRADE	140	-.0915588	3.329331	-8.194135	13.57522
INVT	140	1.344155	6.549334	-16.48726	28.23898
LFP	140	113.9749	28.2218	0	135.364
HCI	140	.7701032	.0358798	.6915082	.844
HTE	140	18.30895	5.623533	6.677857	29.89914

Source: Author's Estimation

The average and standard deviation represent the average and measures of dispersion of data. Take, as an instance, average GPDG of 1.19 % that represents a moderate growth of the economy for the G-7 countries. Nevertheless, a standard deviation of 2.83 and a span between -10.30% and 8.93% suggest that growth rates have widely diverged among countries and years, likely because of global financial crises or individual country's economic factors. Likewise, trade balance (TRADE) is roughly neutral with a mean of -0.09% but there is a wide variation (from -8.19% to 13.58%) due to different trade positions with some countries having substantial deficits and others are in long-run surplus.

Gross capital formation (INVT) display wide dispersion, standard deviation is 6.55 and the minimum and maximum values range from -16.49% to 28.24%, denoting heterogeneous investment behaviors across countries and through the years. The participation rate (LFP) seems high, 113.97 on average, but it may be for ease of measurement in index, as well as to account for a unit of labor, given that the minimum value is set at 0. On a scale from 0 to 1 of the Human Capital Index (HCI), the mean HCI is high (0.77) and the range is tight, indicating that all G-7 countries possess rather good education and health indicators. HTEs also exhibit wide disparity that ranges from 6.68% to 29.90% with a mean value of 18.31%, which reflects variation in technological intensity of exports among the members of the group.

4.2. GMM Estimation Results

A statistical analysis has been used to find out how different economic elements affect the rate of GDP growth. The analysis incorporates several explanatory variables as lagged GDP growth, trade balance, investment, labor force participations, human capital index, and high technology exports. The estimated coefficient, standard error, z-statistic, and p-value of each

variable, aid to identify the relationship of each one with GDP growth. These indicators are useful to ascertain the level and statistical significance of the contribution of each factor on economic performance. The findings provide a numerical basis on which to judge which aspects of policy and structural investment are best able to sustain long term growth. This methodological choice makes the results more reliable and gives data-based information on the relative growth process in G-7 economies.

Table 4.2: GMM Results Statistics

Variables	Coefficients	Standard Error	Z-Statistic	P-value
L.GDPG	.264553	.0403318	6.56	0.00
TRADE	.308787	.0291552	10.59	0.00
INVT	.6371924	.0163795	38.90	0.00
LFPR	.0057057	.011339	0.50	0.615
HCI	12.51029	2.916883	4.29	0.00
HTE	-.0008636	.0194974	-0.04	0.965
Constants	-11.24315	2.160289	-5.20	0.000

Source: Author's Estimation

The influence of lagged GDP growth is strong and positive (0.2646), indicating that there is persistence in the growth performance in the past influencing the present growth performance. This is suggestive of sustained behavior of macroeconomic variables. The coefficient of 0.6372 in investment indicates that the positive influence is quite strong and statistically significant. This is an indication that more accumulation of capital adds significantly to economic growth. The coefficient for trade balance is 0.3088, implying a notable positive effect. This suggests that improved trade results and exports outweighing imports in favor of, well, trade, help to facilitate economic growth.

Labor force participation is associated with a positive but small coefficient (0.0057), not significant at 10 %, as if we could not establish a clear relationship between participation changes and GDP growth in the period being considered. The human capital Index exhibits the positive significant effect at high level (12.5103). The relationship between enhancements in education, skills, and health on the one hand, and the growth of the economy on the other, is robust. The relationship with GDP growth is not strong between GDP and high technology exports, that is they carry a very small negative coefficient (-0.0009) and $p > 0.05$ is not significant.

Intercept is negative and significant at -11.2432, indicating lowest level of growth of GDP when all other variables equal zero. These may account for structural or unobservable effects. Each coefficient indicates the expected change in GDP growth for a one-unit increase in the respective independent variable holding all the other variables constant. This value is indicative of the accuracy of the coefficient estimate. The lower the Standard Error the more confident

we are in the result. The Z-statistic examines whether each coefficient differs from zero. It is the coefficient divided by its standard error. The p-value provides a measure of the probability that the observed coefficient exists due to chance. Smaller values are below common cutoffs (e.g., 0.05 or 0.01), meaning statistically significant, we think the variable has a true effect on GDP growth. A P-value of less than a traditional significance level (0.05 or 0.01) indicates the corresponding term in the model is statistically significant. This indicates there is sufficient evidence to reject the null and conclude that the variable does have a significant effect on the dependent variable.

In these results 3 explanatory variables including trade, investment and HCI are all significant at the 0.05 level, indicated by the corresponding P-values. On the other hand, 2 control variables including LFPR and HTE are positively signed, but not statistically significant in this model. Their effects point forward, but the current forecast evidence is not strong enough to claim evidence for any enduring influence on GDP growth.

4.3. Diagnostic Tests Results

The diagnostic tests for autocorrelation as Arellano-Bond test for AR (1) and Arellano-Bond test for AR (2) are conducted to check for the presence or absence of autocorrelation and these indicate that there is no issue of autocorrelation in the data as explained by the values of Arellano-Bond test for AR (1) and Arellano-Bond test for AR(2). The value of Arellano-Bond test for AR (1) is -2.15 which is statistically significant but it is not a problematic issue and the value for Arellano-Bond test for AR (2) is 0.71 and it is statistically insignificant which ensures the absence of autocorrelation in the data. The statistics for Hansen test indicate that the instruments used in the analysis are valid as indicated by the value of Hansen test which is 4.13 and is statistically insignificant. Mean Variance Inflation Factor (VIF) is calculated to check the presence or absence of multicollinearity in the data and the value of VIF explains the absence of multicollinearity in the data as the value for VIF is less than 5. All the diagnostic test results are presented in the following table 4.

Table 4: Results of Diagnostic Tests

Tests	Values
Arellano-Bond test for AR(1)	-2.15** 0.031
Arellano-Bond test for AR(2)	0.71 0.478
Hansen test	4.13 0.533
Mean VIF	1.16

Source: Authors Calculation, ** p<0.05

Conclusion

The purpose of this study was to analyze the main macroeconomic and structural determinants of long-term economic growth in the G-7 countries from 2010–2023. With the application of dynamic panel data estimation (Generalized Method of Moments), and also the help of descriptive statistics, graphical analysis and theoretical model, the study found general patterns regarding the way different forces influence GDP growth in advanced economies. Empirical findings provide evidence that investment, trade balance, human capital, and lagged GDP growth significantly contribute to economic growth. In this, investment was the dominant growth engine, suggesting that capital accumulation remains a key factor in advanced economies. The trade balance and the Human Capital Index also had statistically significant, positive effects, indicating that countries with open and efficient trade systems and robust

education and health infrastructure are more likely to be able to maintain high economic growth. Lagged GDP growth was also important, suggesting the existence of economic momentum results in one period affecting subsequent results. Although labor force participation and high-technology exports were not statistically significant in this model, their positive coefficients and graphical trends indicate that they could still matter in alternative policy scenarios or over longer time periods.

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