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The Nexus Between Tax Revenue, Economic Policy Uncertainty, and Economic Growth: Evidence from G7 Economies

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Abstract

Economic policy uncertainty is an important macroeconomic risk factor that can have direct effects on investment decisions, growth dynamics, and public finance. In particular, its potential impact on tax revenue is critical in terms of fiscal sustainability. This study investigates the Granger-causal relationship between economic policy uncertainty, total tax revenue, and economic growth in G7 economies over the 1997–2021 period, applying symmetric and asymmetric panel causality tests. The empirical findings revealed evidence of causality between economic policy uncertainty and tax revenue and between economic growth and economic policy uncertainty. In asymmetric analyses where the effects of positive and negative shocks were separated, the direction of causal relationships differed between countries. These results imply that asymmetric effects vary by country. Overall, the empirical findings suggest that enhancing transparency and predictability in tax systems could play a vital role in reducing economic policy uncertainty and thus positively affect tax revenue performance and fiscal resilience.

Keywords: economic policy uncertainty; tax revenue; economic growth; asymmetric bootstrap Granger causality; panel data analysis; fiscal sustainability; G7 countries

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1. Introduction

Tax revenue is the main source of financing for public goods and services such as infrastructure, health, defense, and education, and it is a key component in fiscal policy to ensure the sustainable development of national economies [1–5]. In terms of fiscal sustainability, tax revenue plays an important role in ensuring that governments can finance their expenditures without excessive borrowing [6,7]. A stable and sufficient tax revenue inflow is essential for shaping macroeconomic policy, sustaining government operations, stimulating economic growth, and ensuring fiscal stability [8–11]. Regular and stabilized tax revenue streams enable governments to implement effective fiscal policies that stimulate economic activity and appropriately manage business cycles [12–14]. Therefore, it is crucial to identify the determinants of tax revenue and to reveal their impacts on the country.

There are numerous studies on the sources of tax revenue. Empirical evidence from these studies indicates that a wide range of factors, including economic, structural, social, political, institutional, sectoral, technological, and global variables, are the main determinants of tax revenue in many countries [15–21]. In addition, the phenomenon of uncertainty affecting economic and financial behavior is also an important factor in taxation and affects total tax revenue generated from many types of direct and indirect taxes [22–25].

Since the publication of John Kenneth Galbraith's The Age of Uncertainty in 1977 [26], numerous significant events highlighted in both the media and academia have brought uncertainty to the forefront as a critical issue in the financial world. There is no doubt about the importance of uncertainty; however, the literature lacks a universally accepted definition of the concept [27]. In economics, the concept of uncertainty essentially denotes unpredictability or ambiguity about future economic conditions or policies [28]. The size and stability of tax revenue can be affected by economic and political uncertainties in various ways. Uncertainty related to economic policy attracts considerable attention both in academic research and policy debates [29]; this type of uncertainty is mainly linked to government actions based on fiscal, monetary, trade, and regulatory policies that influence the state of the economy [27]. Changes in economic uncertainty can stem from a variety of sources, including economic recessions, wars, natural disasters, political campaigns, elections, and legislative changes. While some of these are inevitable, others can be controlled and, to some extent, addressed by policymakers. A lack of information regarding current events and policy implementation can lead to uncertainty about future outcomes for both businesses and households [30]. Today, the level of uncertainty is higher and more significant than ever, driven by the transformative effects of globalization and technology on our way of life. Political fragmentation, polarization, and the growing role of government spending in the overall economy have also contributed to the recent rise in uncertainty. Furthermore, uncertainty tends to increase sharply during periods of recession and decline during times of economic expansion [31].

Empirical studies have demonstrated that higher economic policy uncertainty is associated with weaker investment and slower economic growth [32–35]. Policy-related uncertainty also negatively influences the determinants of tax revenue and has adverse impacts on the amount and stability of various types of taxes. In this respect, direct and indirect tax revenue obtained from different tax types, such as revenue from corporate and sales taxes, may be adversely affected [23,36–38] by reduced investments and consumption by firms and consumers [34,39–41]. Furthermore, volatilities in asset prices arising from uncertainty [42,43] may have adverse effects on capital gains taxes by affecting the volume of taxable transactions and asset values. Finally, economic policy uncertainty changes tax compliance and tax avoidance behaviors as well [24,44].

Considering the possible detrimental effects on tax revenue, it is essential to quantitatively recognize and measure economic policy uncertainty (EPU) in terms of the scope of the study.

From news-based indices to surveys and econometric models, measuring economic policy uncertainty involves a variety of methodologies [45–49]. One of the core variables in this study, economic policy uncertainty (EPU), is measured using the widely cited index developed by Baker, Bloom, and Davis [46]. This index provides a quantitative measure of economic-policy-related uncertainty for selected countries over time, thereby helping economists, policymakers, and other economic actors to identify the potential influence of uncertainty on economic and financial performance and make better strategic decisions. The index quantifies policy-related uncertainty based on the frequency of selected keywords—such as "economy," "policy," and "uncertainty"—in leading newspapers. These keywords typically reflect uncertainty triggered by political gridlock, fiscal debates, regulatory changes, or election outcomes. For each newspaper, this monthly ratio is standardized over time using a unit standard deviation. Finally, the standardized and normalized values for all selected newspapers are averaged to compute the monthly EPU index. Thus, the monthly EPU index can be interpreted as proportional to the average share of newspaper articles in a given month that discuss economic policy uncertainty [50].

Notably, the EPU index often exhibits a right-skewed distribution, with sharp spikes during crises (e.g., the 2008 financial crisis or the COVID-19 pandemic). Moreover, preliminary observation suggests that G7 countries differ in their levels and volatility of policy uncertainty, with some regimes (e.g., Italy and France) showing more persistent fluctuations than others. These characteristics make the EPU a complex yet highly informative variable for assessing its fiscal and macroeconomic effects.

EPU may also adversely affect economic growth and lead to a decline in total tax revenue. By creating a less predictable economic environment, EPU can negatively influence the amount of tax revenue through its effects on economic growth [23,51–53] and the decision-making processes of economic agents [39,41,54]. The connection between economic growth and tax revenue is interrelated; that is, each can affect the other in dynamic and interdependent ways [55]. While stable economic growth generally increases tax revenue [18,19,56], this relationship can be disrupted by high EPU [23,25].

There is extensive academic literature on how economic growth affects tax revenue. Increased incomes of businesses and individuals due to economic growth mean higher corporate and personal income tax revenue [19,57]. Economic growth typically leads to higher consumer expenditures and increases the revenue obtained from consumption taxes, including value-added tax and sales tax [58,59]. Additionally, economic growth typically implies higher employment levels, so payroll tax revenue increases [60] and spending on unemployment benefits is reduced, and it promotes investments in capital goods and infrastructure, which can lead to higher property tax revenue [61,62]. Economic growth can also stimulate wealth creation [63,64], leading to higher revenue from taxes on capital gains, dividends, and inheritance.

It is possible for economic growth and tax revenue to interact dynamically in a virtuous or vicious cycle as a result of a feedback loop [57,65,66]. During a virtuous cycle, economic growth generates greater tax revenue and enables the government to reinvest in activities that further enhance economic growth [67,68]. In contrast, in a vicious cycle, a slowdown or stagnation in the economy can result in reduced tax revenue and limited investment in the public sector. Economic downturns can be worsened by this negative feedback loop [69–71].

An effective tax collection mechanism with a broad tax base enhances the benefits of tax revenue on economic growth, and vice versa [72–75]. In essence, a coordinated economic policy design requires specifying the details of the tax revenue–economic growth interaction for national economies. In developed economies, the tax revenue–economic growth link tends to be more stable owing to well-endowed tax systems and high levels of compliance [76]. In contrast, in developing economies with narrower tax bases and weaker tax administration, this connection is often more volatile and contributes to greater instability [19].

In long-term fiscal planning, uncovering the interaction among tax revenue, policy uncertainty, and economic growth is of paramount importance for policymakers. Designing effective fiscal policies depends on identifying the interactions between these variables accurately [77,78]. Moreover, an accurate determination of this relationship is vital for ensuring fiscal sustainability [79–81]. Identification of dynamic relationships between related variables over time allows policymakers to respond more effectively to economic shocks.

Although there are limited studies indirectly investigating the relationship between EPU and economic growth with various types of taxes rather than total tax revenue [23,82,83], there are no studies examining the interaction of total tax revenue and related variables in the literature. Understanding the effects of EPU on total tax revenue can contribute to more effective tailoring of policy responses. As structurally advanced and institutionally mature economies, the G7 countries provide a compelling

setting for investigating the causal relationships between economic policy uncertainty (EPU), aggregate tax revenue, and economic growth. Their well-established tax systems, high compliance levels, and strong institutional capacity, coupled with their substantial share of global economic output and influence over international policy frameworks, make them especially relevant for such an analysis. Understanding these dynamics within the G7 context can also offer valuable insights for fiscal coordination and policy design in other advanced economies.

This study aims to make three key contributions to the empirical literature. First, it is one of the first studies to analyze short- and long-term interaction between total tax revenue as a share of gross domestic product (GDP), EPU, and economic growth at the macro level. Second, given the characteristics of the data set, analyzing the relationship between the variables using panel data analysis covering a long period provides a more comprehensive assessment of long-term trends. In the existing literature, traditional Granger causality tests are generally based on symmetric assumptions. However, this study adopts a distinct methodological approach by employing techniques that account for both structural breaks and cross-country heterogeneity. Specifically, the direction and structure of causal relationships are analyzed using the asymmetric bootstrap Granger causality test developed by Yilanci and Aydin [84], which considers the presence of asymmetric effects. In addition, the augmented Toda–Yamamoto Granger causality test developed by Emirmahmutoglu and Kose [85] is applied to capture heterogeneous panel structure across countries. This methodological framework aims to contribute to the existing literature by addressing potential asymmetries in causality and incorporating country-specific dynamics within the panel data context. Third, the research topic is investigated in the context of G7 economies, which are considered the major drivers of the global economy and have institutionalized and well-established tax systems. The sample thus facilitates drawing specific conclusions about the dynamics between EPU, total tax revenue, and growth within developed countries.

The hypotheses and research questions related to the study are detailed below:

Hypotheses

H1. *Economic policy uncertainty (EPU) Granger-causes total tax revenue (TR) in G7 countries.*

H2. *Economic policy uncertainty (EPU) Granger-causes economic growth (GR) in G7 countries.*

H3. *The causal effect of EPU on TR varies depending on the direction of shocks (positive vs. negative).*

H4. *The causal effect of EPU on GR varies depending on the direction of shocks (positive vs. negative).*

Research Questions

1. Does EPU Granger-cause total tax revenue in G7 countries?
2. Does EPU Granger-cause economic growth in G7 countries?
3. Do positive and negative shocks in EPU have asymmetric causal effects on TR and GR?
4. What policy insights can be drawn regarding fiscal stability and economic performance in the context of policy uncertainty?

These hypotheses and research questions guide the study in exploring the complex interactions between EPU, economic growth, and tax revenue in order to provide actionable implications for policymakers in G7 countries and advanced economies in general.

To better conceptualize the causal relationships explored in this study, Figure 1 presents a simplified transmission mechanism linking economic policy uncertainty, economic growth, and tax revenue.

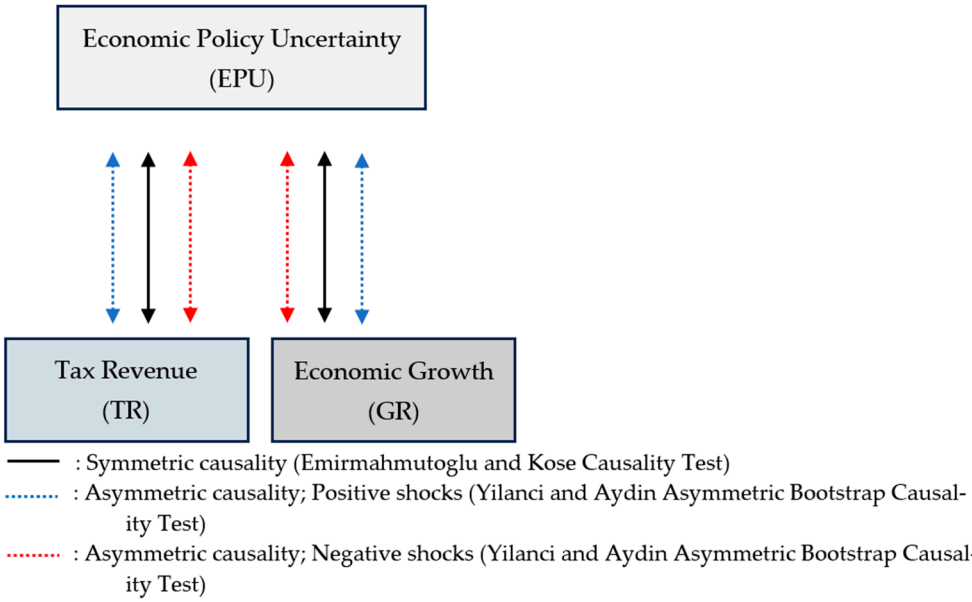


Figure 1. Conceptual framework: hypothesized causal linkages between economic policy uncertainty, economic growth, and tax revenue [84,85].

As illustrated in Figure 1, the framework focuses on the potential causal effects of economic policy uncertainty (EPU) on total tax revenue (TR) and economic growth (GR). Hypotheses H1 and H2 propose that EPU Granger-causes both TR and GR, respectively, reflecting the idea that heightened uncertainty may suppress economic activity and fiscal performance. Hypotheses H3 and H4 extend this perspective by accounting for asymmetric effects, suggesting that the impact of EPU on TR and GR may differ depending on whether the shocks are positive or negative. To test these propositions, the study employs both symmetric (Emirmahmutoglu and Kose [85]) and asymmetric (Yilanci and Aydin [84]) panel Granger causality tests.

The structure of the paper is outlined as follows: Section 2 addresses previous studies and provides a comprehensive literature review on tax revenue, EPU, and sustainable economic growth. Section 3 presents the data, econometric models, and tests. In Section 4, the research findings are presented, and the paper is then finalized with a discussion and conclusion.

2. Literature Review

This literature review investigates the theoretical foundations and empirical findings related to the macroeconomic and fiscal implications of uncertainty, with particular attention to its effects on tax revenue and economic growth. The review is structured into two subsections. Section 2.1 presents the theoretical framework and the logical basis for the hypotheses by drawing from the existing literature. Section 2.2 synthesizes empirical evidence from prior studies that examine the relationships among economic policy uncertainty, economic growth, and tax revenue, offering insights into the nature and direction of these interactions.

2.1. Theoretical Framework and Hypothesis Formulation

The macroeconomic and fiscal effects of uncertainty have attracted significant attention in numerous studies [32,86–92]. In this regard, Baker, Bloom, and Davis [46] developed a monthly index to quantify economic policy uncertainty, namely the EPU index, which is based on newspaper coverage frequency. In order to compute EPU, the index first compiles the number of monthly newspaper articles containing the terms economy (E), policy (P),

and uncertainty (U). In the next stage, the index scales the raw numbers, standardizes the newspaper variations, calculates the averages based on newspaper articles by month, and normalizes them. The availability of indices for different countries has encouraged many researchers in diverse fields to answer a wide range of questions related to EPU [27].

Both theoretical and empirical studies have indicated that increasing EPU harms economic activity [77,93,94]. In addition to shaping macroeconomic outcomes [95–98], EPU affects consumption [39,40,54,99–101], investment [34,41,55], and general economic performance by influencing the decision-making processes of households, firms, and policymakers. The results of previous studies mainly indicate that EPU shocks induce sharp economic recessions [102–105].

Numerous studies have confirmed that when EPU increases, firms decrease their investments [34,36,87,106–108]. In the theoretical literature, an increase in EPU is accompanied by the "wait and see" investment strategies by firms and "precautionary savings" behaviors by households [78,89,109–113]. Although EPU can have conflicting effects, studies have consistently associated increases in uncertainty with declines in economic activity. Jeong [114] theoretically demonstrated that policy uncertainty increases the cost of capital and reduces investment and output in the long term by creating a short-term bias in investment. The uncertainties of economic policy related to investment plans have a significant impact on the economic growth of developing countries and also influence future investment decisions [53,87,115]. Several studies have demonstrated that in developed economies such as G7 countries, EPU has a countercyclical character; real output does not respond symmetrically to positive and negative shocks, and shock effects amplify with the size of the shock [105,116].

During times of policy uncertainty, households can change their current consumption or saving patterns to protect themselves against possible contractions in their income and to maintain lifelong consumption levels [117–119]. Thus, households tend to reduce their total demand by saving as a precaution when they encounter rising uncertainty [77,104,120]. These behavioral responses reduce the overall level of economic activity, shrink the tax base, and may also alter tax compliance behavior, particularly in financially constrained firms [23,44]. Accordingly, this study proposes the following hypothesis:

Hypothesis 1. *Economic policy uncertainty (EPU) Granger-causes total tax revenue (TR) in G7 countries.*

Numerous theoretical and empirical studies have underscored the adverse effects of economic policy uncertainty (EPU) on macroeconomic performance [77,93,94]. EPU alters the expectations and decision-making behavior of households, firms, and policymakers, thereby influencing key economic components such as consumption, investment, and overall output [34,39–41,54,55,99–101]. Heightened uncertainty often leads to delays in consumption and investment decisions as economic agents adopt a wait-and-see approach to mitigate potential risks. These behavioral responses can suppress aggregate demand and reduce capital formation, ultimately hampering economic growth. Moreover, empirical evidence demonstrates that elevated EPU is frequently associated with sharp contractions in economic activity and deep recessions [95–98,102–105]. Based on these foundations, we formulate our second hypothesis as follows:

Hypothesis 2. *Economic policy uncertainty (EPU) Granger-causes economic growth (GR) in G7 countries.*

While the causal relationships above are based on aggregate effects, economic agents may respond differently to positive and negative EPU shocks. Hatemi-J [121] highlights

that the effects of shocks in macroeconomic variables may be nonlinear, and their direction (positive vs. negative) may produce asymmetrical responses. For example, a sudden increase in uncertainty (a negative shock) may trigger stronger contractions in investment or consumption than the corresponding increase in confidence during positive shocks. Accordingly, failing to differentiate between the effects of upward and downward EPU movements may mask important causal dynamics. Hence, the following hypotheses are formulated to capture the potential asymmetric effects:

Hypothesis 3. *The causal effect of EPU on TR varies depending on the direction of shocks (positive vs. negative).*

Hypothesis 4. *The causal effect of EPU on GR varies depending on the direction of shocks (positive vs. negative).*

In this study, these hypotheses are tested using both symmetric and asymmetric panel Granger causality tests. While the Emirmahmutoglu and Kose [85] method is employed to test the general causal linkages, the asymmetric bootstrap causality test developed by Yilanci and Aydin [84] enables the decomposition of EPU into positive and negative shocks, thereby capturing nonlinear transmission mechanisms. Together, these approaches allow for a more nuanced understanding of how uncertainty affects macroeconomic and fiscal outcomes across G7 economies.

2.2. Empirical Evidence in the Literature

A significant body of empirical literature has explored the multifaceted relationship among EPU, GR, and TR. These studies offer robust evidence on how uncertainty and macroeconomic fluctuations affect fiscal outcomes through various behavioral and institutional channels.

EPU can significantly affect government decisions about taxation, public expenditure, and debt management. Bloom [77] claimed that policymakers are more likely to be conservative in approaching large-scale commitments when EPU increases. The timing of fiscal policy measures is also critical in times of higher uncertainty. In this regard, Fernandez-Villaverde et al. [78] determined that policy uncertainty can delay fiscal actions as policymakers prefer to wait for additional information before making significant policy changes. Higher levels of EPU may cause decreases in the efficiency of fiscal multipliers as firms and households become more cautious in their economic decisions [122,123]. In the context of EPU–tax burden nexus, Kang and Wang [37] investigated the impact of EPU on corporate cash effective tax rate in the United States using monthly aggregated and firm-level data with structural vector autoregression (SVAR) and clustered linear regression analyses. The aggregated data analysis results demonstrate that the corporate cash tax burden within a year rises when EPU heightens. In addition, the firm-level analysis indicates that EPU has an asymmetric effect on firms' cash effective tax rate. Similarly, Dang et al. [23] investigated the impact of EPU on corporate tax burdens using the panel data of Chinese firms for the 2003–2016 term. Their findings suggest that EPU positively affects corporate tax burden and that the impact of EPU is stronger when tax quotas are higher. Furthermore, tax collection is strengthened due to the government's fiscal pressure as a result of EPU. Clance et al. [124] examined the relationship between EPU and corporate tax rates in 126 countries for the 2013–2018 period. Their findings revealed that the World Uncertainty Index (WUI) is positively related to corporate tax rate; specifically, a one-unit increase in the lagged WUI is accompanied by a 1.25% increase in corporate tax rates.

The level of EPU has a considerable effect on the tax avoidance behavior of firms and individuals. Firms facing uncertain economic policies may avoid taxes to ease potential

negative economic effects. A considerable portion of tax revenue may therefore be lost due to tax avoidance, which may have various consequences for public finance and economic policy. However, Shen et al. [125] provided evidence based on Chinese firms that EPU has a negative impact on corporate tax aggressiveness and concluded that high financial constraint and managerial shareholding amplify the negative impact of EPU on corporate tax avoidance. Athira and Ramesh [82] examined how EPU affects firms' corporate tax avoidance behavior in a cross-country framework using a dataset of firms in 22 countries from 1999 to 2019. Their findings suggest that firms in developed countries with strong governance structures and strict auditing standards are less likely to avoid taxes. Furthermore, tax avoidance is positively related to EPU for firms in developing economies with low GDP per capita and weak governmental structures. Benkraiem et al. [126] explored the relationship between corporate tax avoidance, EPU, and the value of excess cash on a global sample of 41,535 firms in 39 countries from 2005 to 2018. They concluded that tax avoidance reduces the value of excess cash and that EPU prevents a discount in the value of excess cash. They also demonstrated that corporate tax avoidance has a negative impact on the value of excess cash only for firms operating in countries with strong investor protection laws. Nguyen and Nguyen [44], using a sample of 72,780 U.S. firms from 1987 to 2015, revealed that when EPU increases, firms lower their cash effective tax rate (CETR), which is considered to be a measure of tax avoidance.

From the macroeconomic perspective, EPU affects total tax revenue from multiple channels. Some of these channels are related to firms' and households' investment and consumption decisions. EPU mainly reduces investments [34,36] and consumption [40,46,104]. When EPU rises, firms also postpone or reduce their fixed capital expenditures [127]. In this case, firms' profits may decrease, potentially causing a decline in corporate tax revenue [37]. In periods of EPU, consumer attitudes, such as being more cautious, decreasing consumption expenditures, and increasing savings [128], lead to lower sales tax revenue. Additionally, high EPU levels change tax compliance behavior [24,129] and cause fluctuations in financial markets [130–132]. An increase in policy uncertainty can reduce consumer confidence and increase precautionary savings [133]. In this case, since consumption expenditures decrease, sales tax and value-added tax (VAT) revenue also decrease. Gu et al. [120] explored the impact of EPU on consumption expenditures using a sample of 17,341 households for the period between 1997 and 2011. Their findings indicate that EPU can significantly reduce consumption expenditures through the precautionary saving and investment–employment channels. Studies investigating the impact of EPU on financial markets have generally focused on the implications of financial market volatility for capital gains [42,46,134]. The negative impacts of EPU on financial market volatility could also reduce capital gains tax revenue and other revenue related to financial markets. During periods of high EPU, firms and individuals may engage in tax avoidance and tax evasion [44] due to changes in the tax compliance behavior of firms and individuals [135]. Hence, decreasing tax compliance and increasing tax avoidance behaviors may lead to a decline in total tax revenue.

Many studies have analyzed the relationship between economic growth and tax revenue. As one of the fundamental macroeconomic determinants of tax revenue, economic growth raises total tax revenue by affecting different tax types through different mechanisms [19,73,136]. Most empirical studies indicate that by broadening the tax base, economic growth increases tax revenue through higher income, consumption, and business activity levels [137,138]. Countries' institutional quality, economic structure, tax policy, and governmental organization have an impact on the effectiveness of this nexus [57,72,139]. Based on the findings of these studies, sustainable economic growth can increase tax rev-

enue, and it is emphasized that supportive policies and reforms are needed to maximize these benefits.

Although a limited number of studies have indirectly examined the relationship between economic policy uncertainty (EPU) and economic growth with specific types of taxes—such as corporate or income taxes—rather than with aggregate tax revenue, the existing literature lacks a comprehensive analysis of the causal interactions among EPU, economic growth, and total tax revenue. Understanding the direction and nature of these causal linkages is critical for formulating timely and effective fiscal responses, particularly in times of heightened uncertainty. Moreover, many of the empirical studies rely on traditional symmetric Granger causality tests or standard time series methods, which may not adequately capture the asymmetric dynamics, nonlinearities, or country-specific heterogeneities in the data. This study contributes to filling these gaps in three significant ways. First, it simultaneously examines the causal relationships between EPU, economic growth, and total tax revenue—a nexus that has received limited attention in the existing empirical literature. Second, it employs a novel econometric framework by integrating the asymmetric bootstrap Granger causality test [84] and the augmented Toda–Yamamoto panel causality test [85], thereby accounting for asymmetries, cross-sectional dependence, and heterogeneous country dynamics. Third, by focusing exclusively on G7 economies, which represent structurally advanced fiscal and institutional systems, this study provides context-specific evidence on the causal pathways through which economic policy uncertainty and growth dynamics influence tax revenue performance. Analyzing these causal relationships within developed economies enhances our understanding of how macroeconomic shocks are transmitted through well-established tax systems.

3. Data and Methods

This study examines the interaction among tax revenue (TR), EPU, and economic growth (GR) in the G7 economies—comprising Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States—which are classified as advanced economies and play a decisive role in global economic policymaking. The analysis employs both symmetric and asymmetric causality tests. The variables used in the econometric analysis are presented in Table 1.

Table 1. Variables and definitions.

Variable	Abbreviation	Source
Tax revenue (annual % of GDP)	TR	OECD [139]
Economic policy uncertainty index	EPU	Economic Policy Uncertainty Index [140]
GDP growth (annual %)	GR	World Bank [141]

Taking into account the continuity and completeness of the dataset, the period selected for the analysis is 1997–2021. This timeframe ensures full availability of consistent and comparable annual data for all three core variables—tax revenue (% of GDP), economic growth, and economic policy uncertainty—across all G7 countries. Although more recent data may exist for individual countries or indicators, 2021 marks the most recent year for which a fully balanced panel is available. This allows for methodological consistency and enhances the reliability of the econometric analysis.

This structure increases the statistical efficiency of panel data analyses that consider both cross-sectional and time dimensions and allows for the simultaneous examination of cross-country heterogeneity and time-dependent dynamic effects [142].

The TR variable is measured as the ratio of total tax revenue to gross domestic product, with data sourced from the Organisation for Economic Cooperation and Development (OECD) database.

The EPU variable is based on the monthly values of the EPU index developed by Baker, Bloom, and Davis [46]. To ensure compatibility with the annual frequency required for panel data analysis, the monthly values of the EPU index for each country were aggregated into annual figures by computing the simple arithmetic mean of the twelve monthly observations for each year, following the procedure adopted in previous empirical studies [34,81,82,143]. This transformation ensures the temporal alignment of the series and allows for structural comparisons with macroeconomic indicators. The economic growth variable (GR) is represented by the annual growth rate of real GDP, and the corresponding data were sourced from the World Bank database. In this context, a total of 175 annual observations were utilized for all variables. The corresponding time series plots offer additional insight into the dynamics of these variables and are provided in Appendix A.1 (TR), Appendix A.2 (EPU), and Appendix A.3 (GR). The findings related to the descriptive statistics are summarized in Table 2.

Table 2. Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
TR	175	34.341	6.415	22.911	46.068
EPU	175	147.83	86.316	37.603	542.76
GR	175	1.4888	2.592	10.359	8.674

According to Table 2, the average TR ratio is 34.34%, ranging between 22.91% and 46.07%. This variation indicates the existence of significant fiscal structure differences among G7 countries. EPU has an average value of 147.83 and a standard deviation of 86.32. The minimum and maximum values of 37.60 and 542.76, respectively, suggest that there were substantial fluctuations in uncertainty levels during the analysis period. The GR rate has an average of 1.49%, varying between −10.36% and 8.67%. This distribution reveals the coexistence of both positive and negative growth shocks within the period. The structure of the dataset, characterized by variance across both the time series and cross-sectional dimensions, provides a suitable framework for policy analysis. It also allows for the simultaneous evaluation of heterogeneity and time dynamics within the panel data analysis.

The empirical analysis focuses on assessing the directional causal relationships between economic policy uncertainty (EPU) and two key macroeconomic variables: total tax revenue (TR) and economic growth (GR). Specifically, the analysis investigates the following:

1. Whether EPU Granger-causes total tax revenue (TR), and
2. Whether EPU Granger-causes economic growth (GR).

These relationships are examined using two complementary methods: the Emirmahmutoglu and Kose [85] panel Granger causality test and the asymmetric bootstrap Granger causality test developed by Yilanci and Aydin [84]. Both techniques are designed to detect the existence and direction of causality rather than to estimate coefficients or model multivariate structures. Therefore, the models are implemented without control variables, aligning with the study's objective to focus on causality rather than to build a fully specified structural model.

To ensure the robustness of the panel data analysis conducted in this study, preliminary tests were performed to detect the presence of cross-sectional dependence and parameter heterogeneity among the variables. The existence of cross-sectional dependence was measured with the Lagrange Multiplier (LM) test developed by Breusch and Pagan [144]

and the adjusted LM test (LM adj.) proposed by Pesaran et al. [145]; the latter is more appropriate for small sample sizes. Subsequently, the homogeneity of the cointegration coefficients across countries in the panel was assessed using the adjusted delta tilde test developed by Pesaran and Yamagata [146]. This test is crucial for identifying the presence of structural heterogeneity within the panel. The integration properties of the series were examined by the cross-sectionally augmented Dickey–Fuller (CADF) unit root test developed by Pesaran [147] to take into account cross-sectional dependence. In this respect, the characteristics of the variables were analyzed in both the time and cross-sectional dimensions.

In the causality analysis stage, the generalized panel Granger causality test developed by Emirmahmutoglu and Kose [85] was initially conducted. This method was chosen because it accommodates variables integrated at different levels and enables testing for causality both at the panel and individual country levels. As a complementary step, the Yilanci and Aydin [84] asymmetric bootstrap Granger causality test was also employed to distinguish between the positive and negative impacts of policy shocks and to examine the asymmetric causal relationships among the series. This test is one of the most prominent methods in the literature in terms of revealing asymmetric transition mechanisms through positive and negative components of the effects of EPU.

4. Empirical Analysis

This chapter presents the cross-sectional dependence analysis, unit root testing procedures, and causality test results.

4.1. Cross-Sectional Dependence Test

In econometric studies, testing for cross-sectional dependence among variables is essential as this can significantly affect the reliability and validity of the results [148]. Accordingly, the first step of the empirical investigation in this study involved applying a cross-sectional dependence test to examine potential interdependencies among the variables.

When testing for cross-sectional dependence, the choice of test depends on the relative dimensions of the panel. If the time dimension (T) is greater than the cross-sectional dimension (N), the LM test proposed by Breusch and Pagan [144] was used. Conversely, when N > T, the CD_{LM} test developed by Pesaran [148] was applied (see Equation (1)). In cases where N equals T, the CD_{LM2} test introduced by Pesaran [148] was preferred. Furthermore, to address potential bias under cross-sectional dependence, the bias-adjusted LM test proposed by Pesaran et al. [145] was also employed.

$$CD_{LM} = \sqrt{\frac{1}{n(n-1)}} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \left(T\check{\rho}_{ij}^{2} = \pi r^{2} - 1 \right) \quad (1)$$

If the probability value obtained from the test was below 0.05, the null hypothesis of "no cross-sectional dependence" was rejected, indicating the presence of statistically significant cross-sectional dependence among the variables at the 5% significance level [145]. The outcomes of the cross-sectional dependence analysis are reported in Table 3.

An inspection of the results presented in Table 3 reveals statistically significant cross-sectional dependence for all three variables under consideration, as indicated by the *p*-values obtained from the test statistics. Consequently, the study proceeded with econometric methods that explicitly account for cross-sectional dependence to ensure consistent and unbiased inferences.

Table 3. Results of cross-sectional dependence and homogeneity.

Cross-Sectional Dependence Tests								
	CD_{LM1}		CD_{LM2}		CD_{LM}		Bias-Adjusted CD Test	
	Test Stat.	***p* Value**	**Test Stat.**	***p* Value**	**Test Stat.**	***p* Value**	**Test Stat.**	***p* Value**
TR	123.376	0.0000	15.796	0.0000	15.651	0.0000	6.985139	0.0000
EPU	213.72	0.0000	29.7376	0.0000	29.591	0.0000	13.80475	0.0000
GR	350.04	0.0000	50.7730	0.0000	50.627	0.0000	18.58979	0.0000

4.2. Panel CADF Unit Root Test

Since the presence of cross-sectional dependence among the series was established, the second-generation panel CADF unit root test developed by Pesaran [147] was employed as it provides more reliable and robust inference in the presence of interdependencies across panel units. In econometric analyses, the assumption that cross-sectional units are unaffected by common shocks is often unrealistic, particularly in macroeconomic panels [147]. The CADF regression equation proposed by Pesaran [147] is presented in Equation (2).

$$y_{it} = (1 - \phi_i)\mu_i + \phi_i y_{i,t-1} + u_{it},\ i = 1, \ldots,\ N; t = 1, \ldots,\ T, \quad u_{it} = \gamma_i f_t + \varepsilon_{it} \tag{2}$$

In the CADF unit root test, individual CADF statistics can be computed for each cross-sectional unit, while the CIPS statistic provides an aggregate measure for the panel as a whole. The CADF test can be applied regardless of whether the time dimension exceeds the cross-sectional dimension or vice versa. The null and alternative hypotheses of the CADF unit root test are presented below [147]:

$$H_0 \ :\ \beta_i = 0 \ \textit{(The series is non-stationary.)} \tag{3}$$

$$H_1 \ :\ \beta_i < 0, i = 1, 2, \ldots,\ N_1,\ \beta_1 = 0, i = N_1 + 1, N_1 + 2, \ldots, N \ \textit{(The series is stationary.)} \tag{4}$$

The CIPS statistic, which represents the panel-level result, was calculated as the cross-sectional average of the individual t-statistics obtained for each cross-sectional unit [147].

$$CIPS(N,\ T) = t - bar = N^{-1}\sum_{i=1}^{N} t_i(N,\ T) \tag{5}$$

The results of the unit root test are presented in Table 4.

Table 4. Results of second-generation Pesaran CIPS unit root test.

Variables	**Constant**			
	Level		**First Differences**	
	t st.	**Prob.**	**t st.**	**Prob.**
TR	−1.79325	≥0.10	−2.68999 ***	<0.01
EPU	−1.88931	≥0.10	−2.78792 ***	<0.01
GR	−0.96781	≥0.10	−3.41488 ***	<0.01

*** denotes statistical significance at 1% level, indicating rejection of the null hypothesis.

The results of the CADF unit root test indicate that none of the series is stationary in levels, as the CIPS statistics fail to reject the null hypothesis. However, once first differences are taken, the null hypothesis is rejected, confirming stationarity in all series at their first differences.

As the second stage of the analysis, the slope homogeneity tests proposed by Pesaran and Yamagata [146] were conducted. The outcomes are presented in Table 5.

Table 5. Homogeneity test results.

Test	Test Statistic	Prob.
$\tilde{\Delta}$	−1.037	0.850
$\tilde{\Delta}_{\text{adj.}}$	−1.127	0.870

According to the results, both the $\tilde{\Delta}$ statistic (−1.037) and the adjusted $\tilde{\Delta}$ statistic (−1.127) exhibit high probability values (0.850 and 0.870, respectively). Based on these outcomes, the null hypothesis of coefficient homogeneity cannot be rejected at the 5% significance level. This suggests that, within the context of the variables analyzed, the long-run relationship coefficients do not significantly differ across G7 countries, indicating the presence of a homogeneous structure. Accordingly, the countries in the panel appear to respond in a similar manner to long-term economic dynamics.

4.3. Emirmahmutoglu and Kose Causality Test Results

In this study, the causal relationships among the series were examined using the panel Granger causality test developed by Emirmahmutoglu and Kose [85]. Similar to the Westerlund [149] cointegration test, this approach allows for heterogeneity across cross-sectional units and accounts for cross-sectional dependence. Moreover, since the test is fundamentally based on the Toda and Yamamoto [150] causality framework, it offers two major advantages: it can be applied to non-stationary series without requiring pre-testing for unit roots or cointegration, and it allows for different lag structures across units.

To elaborate on the first advantage of this test, it allows for the inclusion of both I (0) and I (1) series within the same model, meaning that—unlike standard causality tests—it does not require the series to be stationary. Regarding the second advantage, it is applicable regardless of whether a cointegration relationship exists among the variables. As a result of these strengths, the test asymptotically prevents biased results that may arise from incorrect model specification. Additionally, this test ensures that lag lengths are differentiated for each country and helps to preserve long-run information as the series are modeled with level values [85].

The VAR model developed by Emirmahmutoglu and Kose [85] is summarized in Equations (6) and (7):

$$x_{i,t} = \mu_i^x + \sum_{j=1}^{k_i+d\ max_i} A_{11,\,ij} x_{i,\,t-j} + \sum_{j=1}^{k_i+d\ max_i} A_{12,\,ij} y_{i,\,t-j} + u_{i,t}^x \quad (6)$$

$$y_{i,t} = \mu_i^y + \sum_{j=1}^{k_i+d\ max_i} A_{21,\,ij} x_{i,\,t-j} + \sum_{j=1}^{k_i+d\ max_i} A_{22,\,ij} y_{i,\,t-j} + u_{i,t}^y \quad (7)$$

where $dmax_i$ denotes the maximum order of integration (i.e., the highest cointegration level) of the variables in the system for each cross-sectional unit i. The results of the Emirmahmutoglu and Kose [85] causality analysis are reported in Tables 6 and 7.

Table 6 presents the panel causality results between TR and EPU. The results of the Emirmahmutoglu and Kose [85] Granger causality test identified a unidirectional causal relationship from EPU to TR. This finding may be interpreted from multiple perspectives and warrants further discussion in broader economic and policy contexts.

Table 6. Emirmahmutoglu and Kose [85] causality test results (TR ≥ EPU, EPU ≥ TR).

	TR ≥ EPU		EPU ≥ TR	
	Statistics	**Prob. Value**	**Statistics**	**Prob. Value**
Average	18.356	0.191	23.460 *	0.053

* indicates statistical significance at 10% level.

Table 7. Emirmahmutoglu and Kose [85] causality test results (GR ≥ EPU, EPU ≥ GR).

	GR ≥ EPU		EPU ≥ GR	
	Statistics	**Prob. Value**	**Statistics**	**Prob. Value**
Average	23.560 *	0.052	25.567 **	0.029

** and * indicate statistical significance at the 5%, and 10% levels, respectively.

Mills et al. [151] argued that EPU increases the risk of firms being investigated and penalized by tax authorities and may positively affect tax revenue by reducing the possibility of tax evasion. Similarly, Dang et al. [23] determined that during periods of elevated policy uncertainty, governments may enhance tax collection by intensifying fiscal pressure on taxpayers. Moreover, Athira and Ramesh [82] demonstrated that firms operating in developed economies with strong governance practices and strict regulatory standards are less likely to engage in tax evasion under high EPU conditions. In contrast, Richardson et al. [152] argued that during periods of financial distress, strategies firms previously perceived as risky or costly may become more attractive and feasible as the potential benefits of tax avoidance increase. Under uncertain conditions, tax authorities may enforce tax laws less stringently, making aggressive tax positions appear less risky and more socially acceptable during financial downturns. Furthermore, firms may be more likely to engage in tax evasion as a means of mitigating risk in response to tighter financial constraints caused by EPU [44].

Table 7 presents the panel causality results between GR and EPU. Based on the Emirmahmutoglu and Kose [85] Granger causality test, a bidirectional causal relationship is identified between GR and EPU, suggesting that each variable exerts a statistically significant influence on the other across the panel. A number of studies have provided evidence that changes in EPU can lead to changes in GR, often in a negative direction [42,132]. Faced with heightened uncertainty, economic agents may alter their behavior and adopt a "wait-and-see" strategy and postpone all non-essential or irreversible decisions. This behavioral shift aims to minimize the cost of irreversible commitments and may result in an increase in precautionary savings [153]. Supporting this view, Gholipour [153] examined data from 19 countries over the period 1996–2016 and concluded that EPU negatively affects variables closely tied to growth—such as fixed capital investment, real estate activities, financial market operations, and patent applications—both in the short and long run. In times of elevated uncertainty, firms tend to act more cautiously, slowing down production and employment-related investments, which in turn adversely impact economic growth [28]. In line with these findings, Phan et al. [154] reported that heightened EPU from 2011 to 2012 in the United States led to a reduction of over 1% in real GDP and resulted in the loss of more than one million jobs. In contrast to the substantial body of research exploring the impact of EPU on economic growth, studies examining the reverse causal direction—the effect of GR on EPU—remain relatively limited. One possible explanation is that developed economies are generally closer to meeting stability and credibility criteria [155,156], and this can have an effect on reducing economic and political uncertainties. Moreover, it has been suggested that EPU in developed countries can spill over to other economies. For instance, several studies [157–160] have documented that EPU originating from highly de-

veloped economies—such as the United States and members of the European Union—can significantly influence uncertainty levels in other countries. On the other hand, Trung [161] argued that a country's exposure to uncertainty spillovers from major economies like the United States may depend on its financial and institutional quality. In a similar vein, Vural-Yavas [162] suggested that the private sector's ability to cope with EPU may be shaped by a country's macroeconomic fundamentals and competitive capacity.

4.4. Asymmetric Bootstrap Granger Causality Test

In addition to the symmetric panel causality test developed by Emirmahmutoglu and Kose [85], this study also employed the asymmetric panel causality approach proposed by Yilanci and Aydin [84] to provide a more comprehensive analysis of the causal dynamics among the variables. Yilanci and Aydin [84] extended the bootstrap panel causality test of Kónya [163] by incorporating the asymmetric causality framework introduced by Hatemi-J [121]. This extension allows for decomposition of the variables into positive and negative cumulative shocks and enables the identification of directional and sign-dependent causal relationships. Unlike traditional symmetric causality tests, which assume that the effects of positive and negative shocks are identical, the asymmetric causality test captures nonlinear transmission mechanisms and may uncover significant relationships that would otherwise remain undetected. By implementing both symmetric and asymmetric causality tests, the study aims to identify not only general causality patterns but also potential asymmetric and shock-specific effects across the panel units.

Table 8 presents the results of the asymmetric bootstrap Granger causality test by Yilanci and Aydin [84], examining the causal effects of positive and negative shocks in the G7 countries.

The table is structured into four panels:

- Panel A reports the causality test results between EPU and TR in response to negative shocks.
- Panel B reports the causality test results between EPU and TR in response to positive shocks.
- Panel C reports the causality test results between EPU and GR in response to negative shocks.
- Panel D reports the causality test results between EPU and GR in response to positive shocks.

In implementing the asymmetric panel Granger causality test developed by Yilanci and Aydin [84], we employed 10,000 bootstrap iterations to estimate the empirical distribution of the test statistics. This choice was made to enhance the statistical reliability and precision of p value estimation in the context of small samples and nonlinear structures. Bootstrap-based methods are inherently sensitive to the number of resamples, and increasing the number of iterations helps to reduce the risk of Type I and Type II errors [164,165].

Given that the test separately analyzes positive and negative shocks, its asymmetric nature requires a higher level of accuracy in identifying causality directions under structural heterogeneity. Prior empirical studies applying this methodology (e.g., [166,167]) have similarly opted for 10,000 iterations to obtain robust and stable results. Therefore, the same standard was followed in this study to ensure reproducibility and methodological consistency with the literature.

Panel A of Table 8 presents the results of the asymmetric bootstrap Granger causality test between total tax revenue (TR) and economic policy uncertainty (EPU) in response to negative shocks. The test assesses whether past negative shocks in one variable Granger-cause movements in the other. The findings indicate that no causal relationship was detected between TR and EPU as a result of negative shocks to tax revenue in any of

the countries analyzed. Similarly, negative shocks in EPU do not lead to any statistically significant causal relationship between EPU and TR in any of the G7 countries.

Table 8. Results of asymmetric bootstrap Granger causality test.

Panel A: EPU ↔ TR (Negative Shocks)								
	TR ↛ EPU (−)				**EPU ↛ TR (−)**			
	Wald Stat.	**Bootstrap Critical Values**			**Wald Stat.**	**Bootstrap Critical Values**		
		1%	**5%**	**10%**		**1%**	**5%**	**10%**
Canada	0.3704	53.7853	41.4541	33.8422	3.2608	38.0680	29.1052	24.5598
France	0.2707	49.3511	35.2300	29.9993	1.2750	41.3034	30.1170	24.5258
Germany	0.9422	29.8848	21.7606	16.8489	1.3817	41.5709	30.3605	24.6646
Italy	4.0738	41.2793	31.1926	26.7695	16.4687	93.5085	65.6788	57.5539
Japan	7.3202	36.1121	26.8210	22.0424	25.6018	59.9589	47.8799	40.3587
United Kingdom	5.5245	26.9806	19.7100	16.2552	1.6435	37.5866	27.8182	23.3733
United States	3.7762	24.8159	17.8115	14.5364	7.3730	55.7780	43.5501	35.9342
Panel B: EPU↔TR (Positive Shocks)								
	TR↛EPU (+)				**EPU↛TR (+)**			
	Wald Stat.	**Bootstrap Critical Values**			**Wald Stat.**	**Bootstrap Critical Values**		
		1%	**5%**	**10%**		**1%**	**5%**	**10%**
Canada	14.9412	32.2485	25.2226	21.8730	0.0192	31.7922	21.3604	17.0047
France	10.1387	34.0553	26.6535	23.8185	1.4213	41.6235	31.0373	25.9495
Germany	4.0263	39.9567	26.6094	21.0069	3.5435	41.2370	30.2036	26.2404
Italy	4.0263	36.6180	21.9407	17.9475	5.5037	75.7472	53.3679	44.7864
Japan	26.6721 **	31.1561	23.4368	20.7369	3.4013	31.4265	20.3176	16.6896
United Kingdom	4.8764	18.5913	15.6069	13.7906	0.0099	17.8450	13.1241	10.3935
United States	8.3752	23.8534	17.2866	14.8250	0.1421	19.2209	13.6862	9.9736
Panel C: EPU↔GR (Negative Shocks)								
	GR↛EPU (−)				**EPU↛GR (−)**			
	Wald Stat.	**Bootstrap Critical Values**			**Wald Stat.**	**Bootstrap Critical Values**		
		1%	**5%**	**10%**		**1%**	**5%**	**10%**
Canada	4.8346	41.3462	29.8509	24.4875	0.7945	9.4990	7.3169	5.8488
France	21.9120 *	38.4582	25.7192	21.304	1.3652	7.3031	5.0497	3.9383
Germany	29.4705	59.1719	41.1644	34.5909	2.7126	23.7505	16.2927	12.6039
Italy	6.3537	72.3561	49.1503	39.9926	22.333 **	30.6824	20.1109	17.2079
Japan	8.0736	45.7356	36.8591	31.8989	0.6433	12.8435	8.5051	7.0602
United Kingdom	7.4302	47.4352	33.1194	27.9910	9.1711	20.3487	15.9361	12.8763
United States	10.6455	44.2514	31.1628	26.0961	6.5173	19.0252	12.6941	10.5639
Panel D: EPU↔GR (Positive Shocks)								
	GR↛EPU (+)				**EPU↛GR (+)**			
	Wald Stat.	**Bootstrap Critical Values**			**Wald Stat.**	**Bootstrap Critical Values**		
		1%	**5%**	**10%**		**1%**	**5%**	**10%**
Canada	4.4434	17.0113	12.2359	9.7884	9.6631 **	13.0389	9.3350	7.7518
France	4.3112	25.2942	17.0117	13.8712	9.2798 *	12.1461	10.0547	8.5066
Germany	3.1944	29.3115	17.3964	14.0058	10.4577	26.3290	18.1227	15.3813
Italy	1.9434	19.2615	13.3099	11.5711	17.0119 **	19.1414	14.0860	12.1728
Japan	1.6553	57.0058	43.8260	37.5601	0.2176	44.6532	32.5808	26.2925
United Kingdom	0.0522	46.6898	31.1258	23.9321	8.0443	21.9631	14.7674	12.7138
United States	0.4727	28.0227	18.0347	13.8311	17.5909 *	26.5584	19.5241	16.3949

Note: * and ** show the statistical significance at the 1% and 5% levels, respectively. The critical values reported were obtained through 10,000 bootstrap iterations.

Panel B of Table 8 presents the asymmetric bootstrap Granger causality results between total tax revenue (TR) and economic policy uncertainty (EPU) in response to positive shocks. The results reveal that positive shocks in TR lead to a statistically significant causal relationship from TR to EPU in Japan, indicating that increases in tax revenue have predictive power over EPU in that country. However, no evidence of causality was found from EPU to TR in any of the countries as a result of positive shocks in EPU, suggesting that upward changes in policy uncertainty do not significantly affect tax revenue across the G7 economies. In their study, Istiak and Serletis [116] argued that a transparent tax system and a predictable set of fiscal and monetary policies can reduce the risk associated with EPU. Clearly, predictable fiscal measures and an optimal tax structure play a critical role in enhancing the credibility of government policies. In line with this view, Saxegaard et al.'s [168] analysis focusing on Japan emphasized that reliable and stable government strategies can reduce policy uncertainty and, in turn, have a positive impact on macroeconomic performance. Therefore, stability in tax systems, which enables predictable tax revenue, should be regarded as a contributing factor in mitigating EPU. In this context, specific reform steps aimed at reducing tax-related uncertainty in Japan warrant attention. Uncertainty should be particularly avoided in the formulation and implementation of consumption tax regulations in order to enhance stability and increase the predictability of the tax system. Japan is often viewed as having underutilized fiscal potential due to its relatively low consumption tax rates and a broad tax base [169]. Consequently, several substantial reforms have been made to Japan's consumption tax regime since the late 1990s. These include rate increases from 3% to 5% in April 1997, from 5% to 8% in April 2014, and from 8% to 10% in October 2019, each of which was preceded by sparking debates and implementation delays [170]. Such uncertainty surrounding tax policy has been associated with surges in the EPU index and has negatively impacted the investment and consumption decisions of households and businesses [171,172]. The International Monetary Fund [173] has similarly emphasized that indecision over the timing and structure of consumption tax reforms has been a major contributor to Japan's elevated policy uncertainty, underscoring the importance of a more transparent and rules-based tax policy framework.

Panel C of Table 8 presents the results of the asymmetric bootstrap Granger causality test between economic growth (GR) and economic policy uncertainty (EPU) in response to negative shocks. The findings indicate a statistically significant causal relationship from GR to EPU in France as a result of negative shocks in economic growth. The results suggest that downturns in growth have predictive power over EPU in that country. Additionally, negative shocks in EPU lead to a significant causal relationship from EPU to GR in Italy, implying that rising uncertainty adversely affects economic growth in Italy. According to the analysis, France and Italy appear to diverge from the rest of the group.

This divergence warrants deeper consideration. As Eurozone members, Germany, France, and Italy collectively account for a significant share—approximately 50%—of the Eurozone's GDP. This structural centrality increases the likelihood that heightened EPU in one of these countries may spill over to other member states [174]. In particular, Italy, the third-largest economy in the Eurozone, is notably vulnerable to domestic policy-related uncertainties. Furthermore, Italy's distinctive result—where negative shocks in EPU Granger-cause a decline in economic growth—can be attributed to several structural and institutional factors. Italy faces persistent vulnerabilities stemming from political instability, frequent changes in government coalitions, and policy discontinuities, all of which elevate uncertainty for investors and economic agents [175–177]. As emphasized by Anzuini et al. [178], public spending and tax revenues constitute a large share of Italy's GDP, meaning that any instability in fiscal policy strongly influences the decisions of economic agents. Moreover, Italy's persistently elevated public debt limits its fiscal flexibility and

undermines investor confidence, which in turn heightens the vulnerability of its economic growth to uncertainty-related shocks [179–181]. The tightening of financing conditions during uncertain periods—especially affecting credit access for the real economy—further amplifies the adverse impact of policy uncertainty on growth [182]. These factors collectively suggest that, relative to other G7 economies, Italy is structurally more exposed to the real economic consequences of rising policy uncertainty, resulting in a more pronounced and statistically significant causal pathway from EPU to GR during negative shocks. Smith [183] observed that EPU has significantly adverse effects on capital inflows and financial development in France, while Hamza et al. [184] reported that French SMEs reduce investment in response to EPU. In the United States, Gulen and Ion [34] demonstrated that policy uncertainty led to sharp declines in corporate investment, particularly during the 2007–2009 financial crisis. Additionally, U.S.-based EPU has been shown to exert broader effects across developed economies. For example, Aor et al. [185] calculated that a U.S. monetary policy uncertainty shock resulted in a 1.2% GDP decline in other developed markets, whereas emerging markets experienced a smaller decline of 0.65%. Similarly, Stockhammar and Österholm [186] found that U.S. policy uncertainty negatively affected Swedish GDP growth through reduced investment and exports. These findings underscore the systemic importance of specific G7 economies—particularly France, Italy, and the U.S.—and validate the country-level heterogeneity observed in the empirical results.

Panel D of Table 8 reports the results of the asymmetric bootstrap Granger causality test between economic growth (GR) and economic policy uncertainty (EPU) in response to positive shocks. The analysis indicates no significant causal relationship between GR and EPU in any of the countries following positive shocks in GR. However, in response to positive shocks in EPU, significant causality from EPU to GR was identified in Canada, France, Italy, and the United States. In line with this, there are perspectives in the literature suggesting that increasing EPU may have a positive impact on GR. For instance, Bar-Ilan and Strange [187], Alexopoulos and Cohen [86], and Bloom [188] argued that rising uncertainty can alter firm behavior. In response to heightened uncertainty, firms may adopt more innovative strategies and increase their research and development (R&D) investments as a precaution against potential future risks. This may in turn positively influence long-term growth potential. Considering that all seven countries in the analysis exhibited high levels of R&D expenditures in 2024 [189], it would be appropriate to explore this dynamic in greater detail on a country-by-country basis.

5. Conclusions

This study analyzes the interaction between total tax revenue, EPU, and economic growth in the context of G7 countries, with particular emphasis on the causal linkages between these variables. While traditional Granger causality tests in the literature typically rely on symmetric assumptions, this study employed both the asymmetric bootstrap Granger causality test developed by Yilanci and Aydin [84] and the panel Granger causality test developed by Emirmahmutoglu and Kose [85] to analyze the causal relationships among the variables within a panel data framework. Enabling the identification of country-specific dynamics and yielding more robust and reliable findings compared to conventional approaches, these methods incorporate both heterogeneity and structural asymmetries. Accordingly, this study offers a more in-depth and innovative methodological contribution to the literature.

The results from the Emirmahmutoglu and Kose [85] test revealed a unidirectional causal relationship from EPU to TR and a bidirectional causal relationship between GR and EPU. Conversely, the asymmetric bootstrap Granger causality test detects no significant causal link from EPU to TR in response to either positive or negative shocks. The absence

of causality in the asymmetric test suggests that the general causal relationship identified by the Emirmahmutoglu and Kose [85] test may not be driven by asymmetric responses to shocks but rather by aggregate or structural linkages unaffected by the direction of the shocks.

These findings offer a nuanced evaluation of the study's hypotheses. The results from the symmetric panel causality test [85] reveal a unidirectional causal relationship from EPU to total tax revenue (TR), providing support for H1. Additionally, the same test identifies a bidirectional causal relationship between EPU and economic growth (GR), which partially supports H2, though the directionality suggests mutual influence rather than a purely unidirectional effect. However, the asymmetric bootstrap causality test [84] does not detect any significant causal effects of either positive or negative EPU shocks on TR. As a result, H3 is not supported by the asymmetric test results. In addition, there is no causal relationship between EPU and GR because of negative EPU shock for all G7 countries. However, in response to positive shocks in EPU, significant causality from EPU to GR was identified in Canada, France, Italy, and the United States, so H4 is partially supported for these countries by the asymmetric test results.

These mixed findings indicate that while aggregate policy uncertainty appears to influence fiscal and economic outcomes at a broad level, this relationship may not be mediated through asymmetric shock transmission channels. Thus, the role of structural and country-level dynamics may outweigh short-run asymmetries in explaining how uncertainty affects tax revenue and growth in G7 economies.

EPU can influence tax revenue through both direct and indirect mechanisms. The findings of this study demonstrate that elevated levels of EPU tend to reduce tax collection and pose a potential threat to fiscal sustainability. Given that tax revenue is closely linked to the economic decisions of both individuals and firms, rising uncertainty often results in downward pressure on tax receipts. In particular, under high levels of uncertainty, corporate income taxes may be negatively affected as firms tend to postpone or cancel long-term investment decisions. In uncertain environments, companies may act cautiously in response to the possibility of changing tax burdens or regulatory frameworks and thus develop strategies to minimize taxable profits. Moreover, firms may prefer to preserve cash reserves, which precipitates delays in investment and expansion plans. Ultimately, such behavior leads to a decrease in tax revenue by narrowing the corporate tax base.

From the perspective of consumption-based taxation, EPU is likely to exert a negative influence on consumer confidence, thereby reducing household spending. Heightened uncertainty may lead individuals to adopt more cautious consumption behavior and increase precautionary savings. Accordingly, consumption-related tax revenue may decline. Moreover, the empirical findings indicate that EPU also affects the tax compliance behavior of both individuals and firms. Specifically, high EPU levels may lead to a decrease in tax revenue by increasing tax avoidance and evasion tendencies. In this context, uncertain policy environments can undermine public trust in the tax system and negatively affect the motivation to comply with tax obligations among economic agents.

The analysis also reveals that the interaction between EPU, economic growth, and tax revenue differs across G7 countries. For instance, in Japan, a causal relationship is observed from tax revenue to EPU, whereas in Italy and France, there is evidence of causality from economic growth to EPU. In particular, Italy stands out as the only G7 country where negative shocks in EPU are found to significantly reduce economic growth. This finding reflects the country's heightened vulnerability to policy uncertainty due to persistent structural challenges, such as a chronically high public debt burden, political instability, and limited fiscal maneuverability. Previous studies have shown that these factors amplify the effects of uncertainty on the real economy by constraining public investment capacity

and dampening investor confidence. As a result, Italy's growth dynamics appear more sensitive to EPU shocks than those of other advanced economies.

In the case of Japan, the results underscore the importance of a stable and transparent tax framework. The finding that increases in tax revenue Granger-cause changes in EPU suggests that predictability in fiscal outcomes contributes to perceptions of policy stability. However, Japan has experienced episodes of prolonged uncertainty surrounding consumption tax reforms, particularly in relation to the timing and magnitude of rate increases. For example, consumption tax rates were raised from 3% to 5% in 1997, from 5% to 8% in 2014, and from 8% to 10% in 2019—each accompanied by significant political debate and delays [170]. These episodes of uncertainty have been linked to volatility in the EPU index and diminished investor confidence. Therefore, it is imperative that Japan adopts a more predictable tax policy framework—particularly with regard to consumption taxes—in order to reduce EPU and its adverse economic effects.

These findings suggest that the nature and direction of such relationships vary depending on institutional structures, fiscal policies, and economic dynamics specific to each country.

In light of the findings, the following policy recommendations are proposed.

- Tax policy stability should be ensured to enhance predictability. For the stability of tax revenue, it is crucial that governments implement long-term and predictable tax policy. Frequently changing tax rates and regulations can undermine investor and consumer confidence and negatively impact tax collection.
- Efforts to reduce EPU should be implemented. Governments can lower EPU levels by adopting reforms that enhance transparency and strengthen investor confidence.
- Measures should be taken to promote voluntary tax compliance. To reduce the likelihood of tax evasion and tax avoidance, more effective tax auditing mechanisms should be established, and compliance should be actively encouraged through appropriate incentives and enforcement strategies.
- Policies that support economic growth should be implemented. Economic growth plays a crucial role in the sustainability of tax revenue, and thus, it must be actively promoted. Growth-friendly tax policies and incentive schemes can help broaden the tax base and ultimately enhance public revenue.
- Crisis management strategies should be developed to address potential risks. During periods of low economic growth, governments may need crisis management strategies to mitigate the adverse effects of EPU.
- In the case of Italy, strengthening fiscal credibility and reducing political uncertainty are essential for mitigating the adverse effects of EPU on economic growth. Given Italy's high public debt burden and recurrent political instability, credible medium-term fiscal frameworks and enhanced expenditure oversight should be prioritized. Institutional reforms aimed at improving government continuity and transparency can reduce investor uncertainty and protect growth from policy-related disruptions.
- In the case of Japan, stabilizing the tax system—particularly with respect to consumption tax regulations—can reduce EPU and improve fiscal predictability. Japan's past increases in consumption tax rates (1997, 2014, 2019) were marked by political delays and indecision, which fueled uncertainty and hindered economic decision-making [170]. To avoid similar outcomes, future tax reforms should follow a transparent, rules-based framework with clear timelines and communication strategies. This would strengthen the predictability of tax revenues and reduce policy-induced uncertainty.

This study is subject to several important limitations that should be acknowledged. First, although the findings and policy recommendations are derived within the context of G7 countries, conducting similar analyses for developing economies with different institu-

tional and fiscal structures would enhance the generalizability of the results. Second, while our methodological approach focuses on identifying directional causality among economic policy uncertainty (EPU), economic growth (GR), and total tax revenue (TR), the models do not account for the full range of macroeconomic determinants—such as consumption, investment, foreign trade, energy prices, or exchange rates—that are known to influence growth and fiscal outcomes. This is a methodological choice aligned with the nature of Granger causality analysis, which aims to detect predictive relationships rather than estimate structural effects. Nevertheless, future research could benefit from expanding the model framework to include additional variables using multivariate causality or structural modeling techniques. Third, a more detailed examination of how EPU affects specific types of taxes (e.g., corporate income tax, VAT, excise taxes) could provide more targeted insights for policymakers. Fourth, while our analysis covers the period from 1997 to 2021—the most recent interval with fully balanced panel data for all G7 countries—future studies may leverage updated datasets to validate the temporal robustness of our findings. Fifth, while this study focuses on identifying predictive causal directions, it does not explicitly address potential endogeneity concerns such as the reverse influence of tax policy on policy uncertainty. Future research could enhance causal inference by employing instrumental variable techniques, structural equation modeling, or SVAR frameworks to better isolate exogenous variation and account for potential feedback effects. Finally, the study focuses on domestic causal linkages and does not examine how the effects of EPU may vary across time or between countries, nor does it consider potential cross-border spillover effects. Future research could explore how the strength and direction of these relationships change during different economic periods or under varying country-specific conditions. Given the high degree of economic and financial integration among G7 economies, uncertainty in one country may influence capital flows and policy responses in others. Further studies could address this limitation by incorporating indicators of international capital mobility or cross-country uncertainty differentials, as well as by controlling for global shocks or exchange rate volatility. Such enhancements would provide a more comprehensive understanding of how EPU propagates across borders in an increasingly interdependent global economy.

This study provides beneficial insights for policymakers by revealing the complex interplay between EPU, economic growth, and tax revenue. Ultimately, establishing a more predictable and stable tax and economic policy framework is a critical requirement for ensuring long-term fiscal sustainability.

Author Contributions: Conceptualization, E.S., M.U.S., and A.O.; methodology, E.S., M.U.S., and A.O.; software, E.S., M.U.S., and A.O.; validation, E.S., M.U.S., and A.O.; formal analysis, E.S., M.U.S., and A.O.; investigation, E.S., M.U.S., and A.O.; resources, E.S., M.U.S., and A.O.; data curation, E.S., M.U.S., and A.O.; writing—original draft preparation, E.S., M.U.S., and A.O.; writing—review and editing, E.S., M.U.S., and A.O.; visualization, E.S., M.U.S., and A.O.; supervision, E.S., M.U.S., and A.O. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

EPU	Economic Policy Uncertainty
GDP	Gross Domestic Product
WUI	World Uncertainty Index
VAT	Value-Added Tax
TR	Tax Revenue
GR	Economic Growth
OECD	The Organisation for Economic Cooperation and Development
LM	Lagrange Multiplier
LM adj.	Adjusted Lagrange Multiplier
CADF	Cross-Sectionally Augmented Dickey–Fuller
CD	Cross-Sectional Dependence
CD_{LM}	Cross-Sectional Dependence Lagrange Multiplier
CIPS	Cross-Sectionally Augmented Im–Pesaran–Shin
SMEs	Small and Medium-Sized Enterprises

Appendix A

Appendix A.1. Economic Policy Uncertainty (EPU) Time Series Plots

This section presents the EPU time series plots for each of the G7 countries over the study period. These plots offer visual insights into the volatility, trends, and structural shifts in policy uncertainty across the sample.

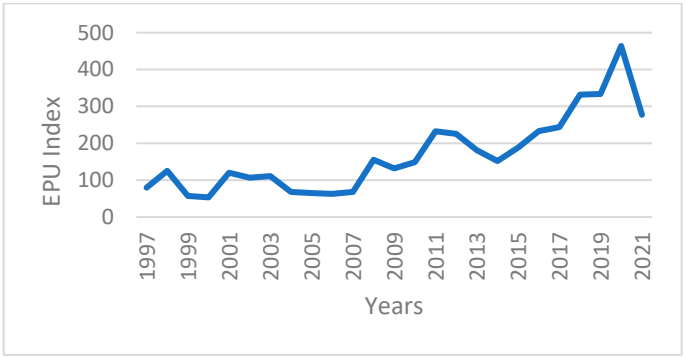


Figure A1. EPU index—Canada.

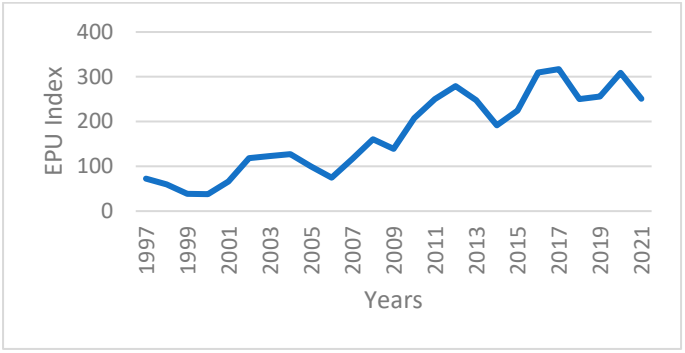


Figure A2. EPU index—France.

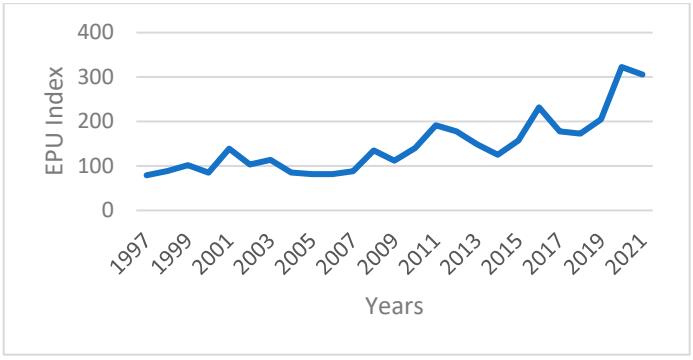


Figure A3. EPU index—Germany.

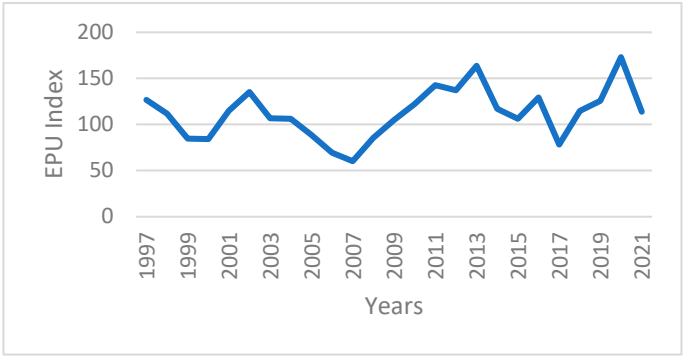


Figure A4. EPU index—Italy.

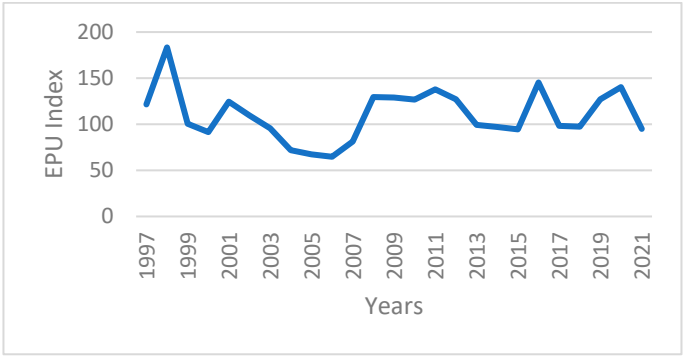


Figure A5. EPU index—Japan.

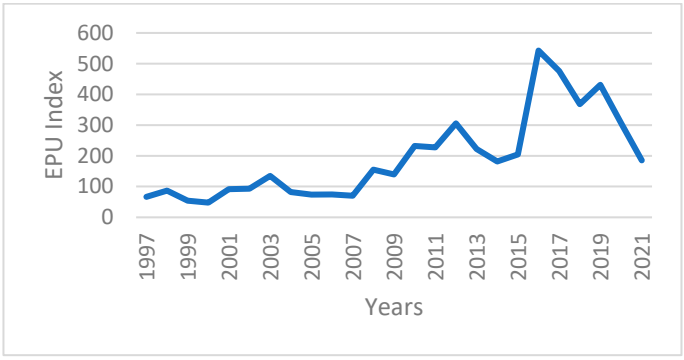


Figure A6. EPU index—United Kingdom.

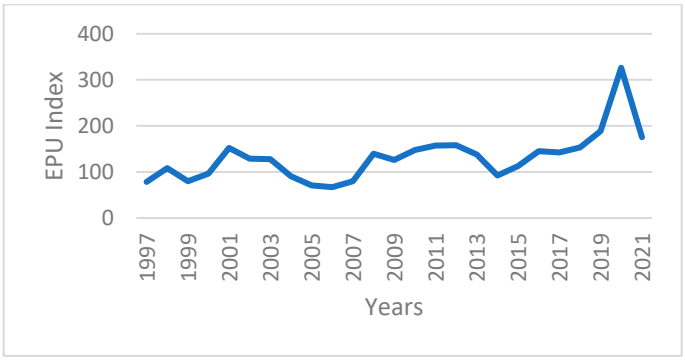


Figure A7. EPU index—United States.

Appendix A.2. Tax Revenue (% of GDP) Time Series Plots

This section provides the time series of total tax revenue as a percentage of GDP for the G7 countries, as reported by the OECD [139]. These graphs help illustrate national trends in public revenue collection.

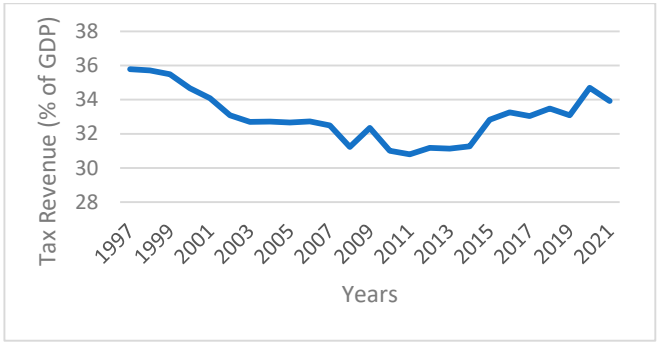


Figure A8. Tax revenue—Canada.

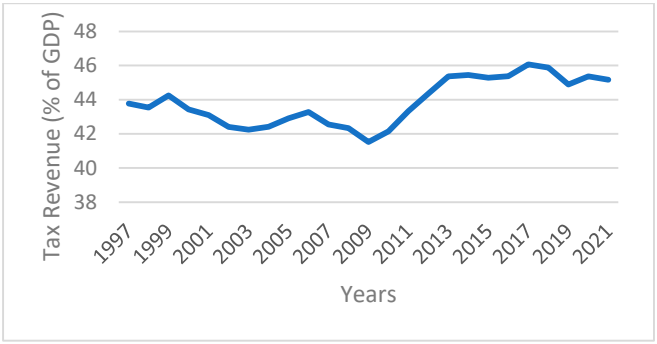


Figure A9. Tax revenue—France.

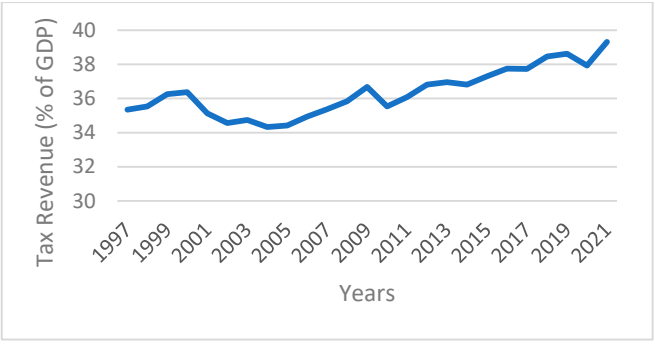


Figure A10. Tax revenue—Germany.

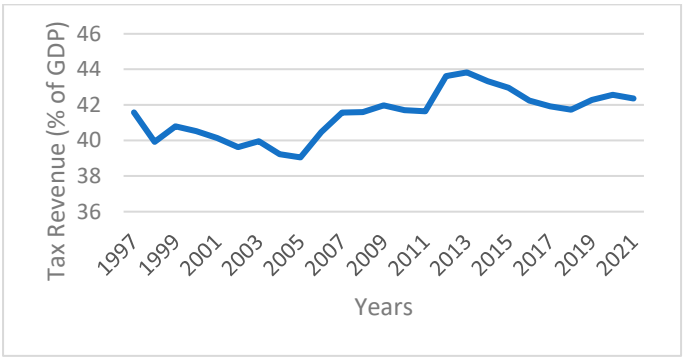


Figure A11. Tax revenue—Italy.

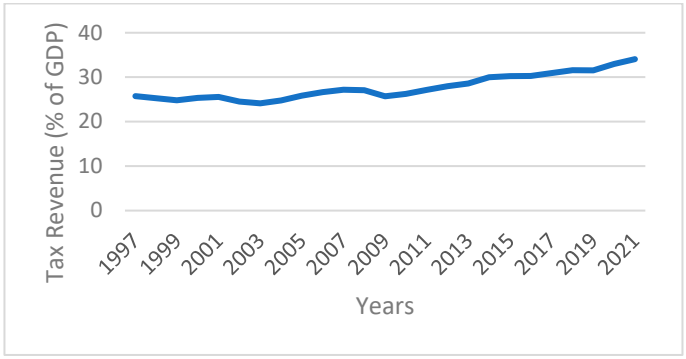


Figure A12. Tax revenue—Japan.

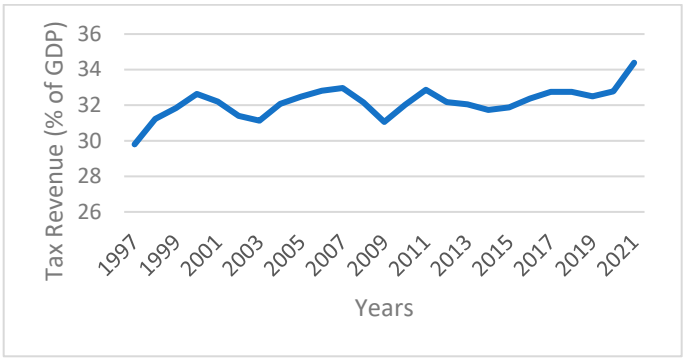


Figure A13. Tax revenue—United Kingdom.

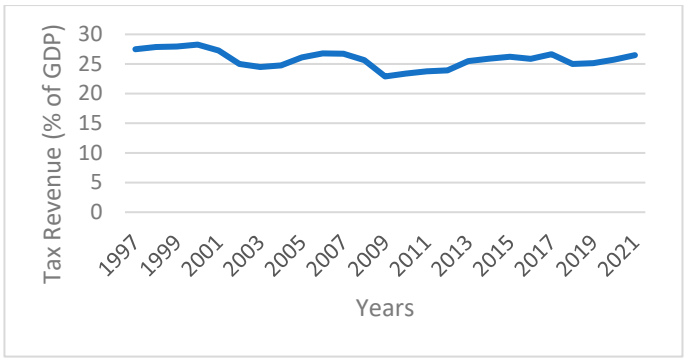


Figure A14. Tax revenue—United States.

Appendix A.3. Economic Growth (Annual % GDP Growth) Time Series Plots

This section displays annual GDP growth rates for the G7 economies. These plots highlight macroeconomic fluctuations, including recession and recovery periods, which may correlate with uncertainty and fiscal dynamics.

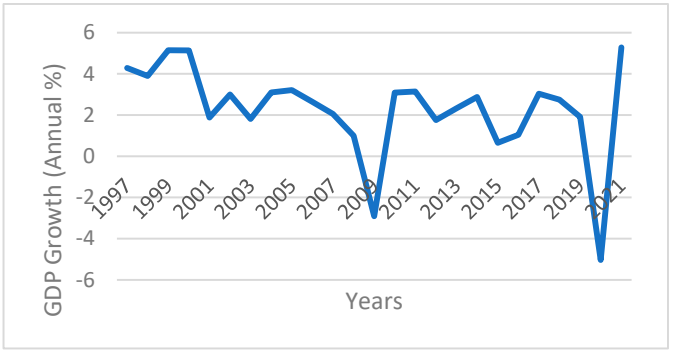


Figure A15. GDP growth—Canada.

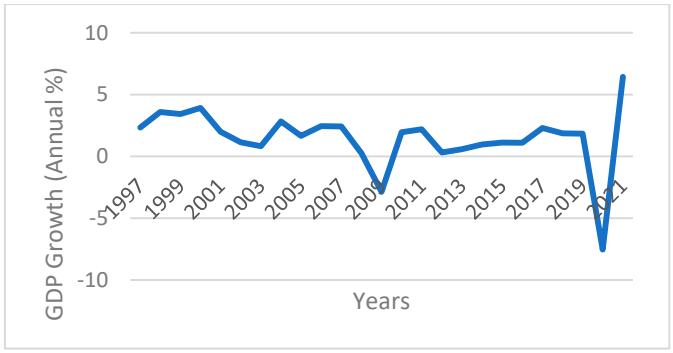


Figure A16. GDP growth—France.

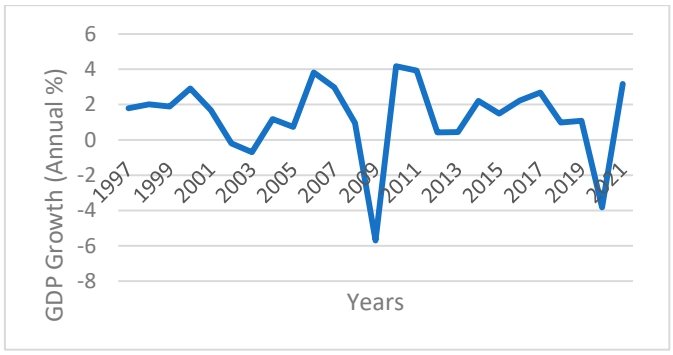


Figure A17. GDP growth—Germany.

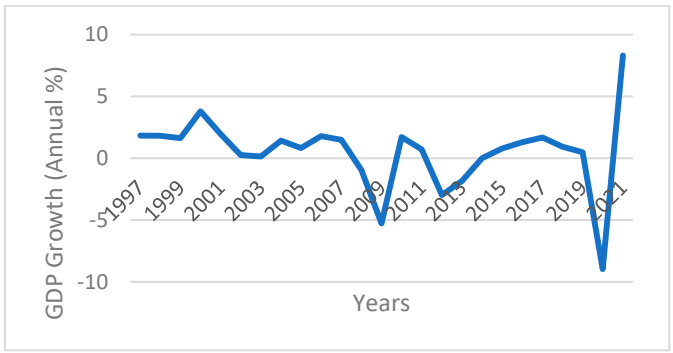


Figure A18. GDP growth—Italy.

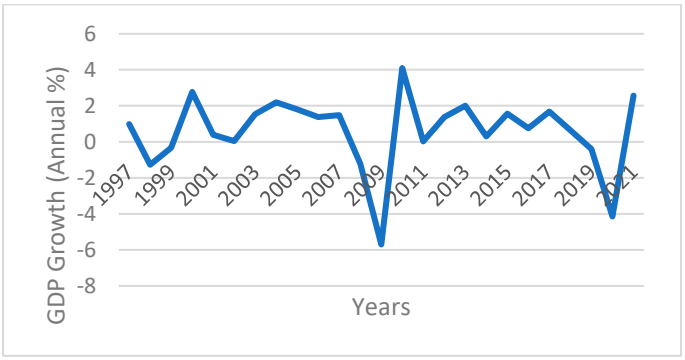


Figure A19. GDP growth—Japan.

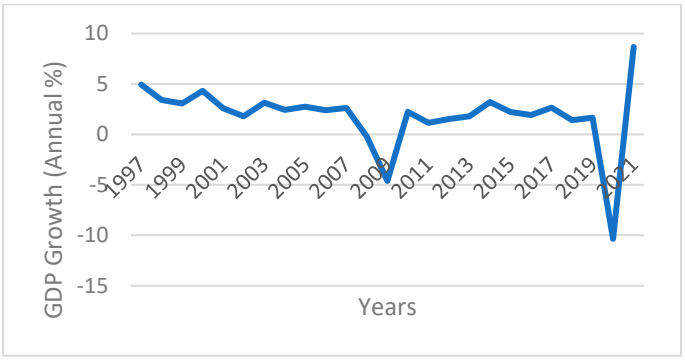


Figure A20. GDP growth—United Kingdom.

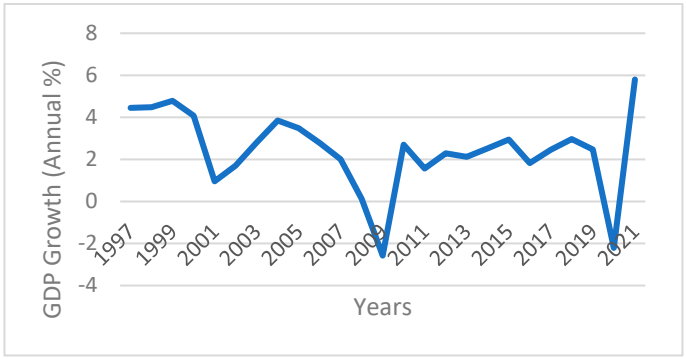


Figure A21. GDP growth—United States.

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