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Choosing the Optimal Tool for Fiscal Adjustment or Living under Fiscal Constraints: Panel Evidence from Selected OECD Countries

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Abstract
This article examines the long-run two-way causal relationship between government revenues and spending and their interaction with the yearly change in public debt for eighteen OECD countries by using annual data for 1976-2017 period. The empirical literature has mainly focused on the long run relationship between government expenditure and revenues or other single country time series while only a few studies have used panel causality analysis and none have investigated the link with the evolution of public debt ratios. The purpose of this paper is to present a dynamic model identifying the underlying relationships constituting the fiscal policy set-up in sample countries. We apply a robust dynamic panel causality methodology based on SUR systems and Wald tests with country specific bootstrap critical values. The study also aims to provide the basis for recommendations on the policy response to public finance challenges stemming from exogenous shocks like the global pandemic that began in 2020. By developing an enhanced analysis of the long-term causal relationship between taxation, spending and their interaction with changes in public debt, the study not only provides fresh insights into the sustainability and optimal design of fiscal adjustment efforts but also offers a country-specific schematization as a guide for policymaking.

Keywords: Fiscal Policy, Government Revenue and Taxation, Government Expenditure, Public Debt, Bootstrap Panel Granger Causality

JEL Classification : E60, E62, H20, H50, H60

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1. Introduction

The propensity of governments to generate budget deficits in response to shocks (such as the COVID-19 pandemic) or demand by voters and special interest groups increases the burden of real debt imposed on future generations. Some see salvation in the imposition of deficit reduction. These deficit limits, the so-called fiscal rules, defined as "trade off commitment to not overspend and flexibility to react to shocks" (Halac and Yared, 2018: 2305) show no evidence of contributing to reducing public indebtedness. Historically, most fiscal adjustments have failed to reduce the debt-to-GDP ratio (Alesina and Ardagna, 2010) as the design failed to take adequate account of the optimal combination of revenue and spending measures in the particular circumstances of the country in question. There are two reasons for this. First, governmental provision of public goods is "pre-dominantly influenced by the preferences of median voters" -as there is a constraint of electoral policies- (Matsunaga and Yamauchi, 2004: 232). The second reason is long-term structural problems like institutional constraints, and inability to adhere to rules-based policy frameworks (Jimenez, 2017: 30-32). The relevant circumstances comprise a mixture of economic structure and the political environment. The limits of fiscal sustainability vary over time in line with changes in the structure of economies (Hausmann and Sturzenegger, 2007).

The purpose of this paper is to present a dynamic model identifying the underlying relationship between government taxation and spending revealing how fiscal policy was set-up in eighteen OECD countries over the period 1976-2017. This paper makes a novel contribution in analyzing the long-term relationship of government taxation and spending to GDP and their interaction effects on the change in the debt to GDP ratio to provide insights about the sustainability and optimal design of fiscal adjustment (Ewin et al., 2006).

The theory builds upon the views developed by scholars from the public economics literature but ultimately the relationship between government taxation and spending is an empirical question. Most of the empirical literature has focused on the long run relationship between government spending and revenues using U.S. federal time series data (Young, 2009) or other single country time series. Fewer studies have used panel data analysis, and none have investigated the link with the evolution of public debt ratios (Afonso and Rault, 2009b; Shastri et al., 2017). This last relationship – i.e. between fiscal adjustment efforts and public debt ratios – is the focus of an important study based on a stylized single-country (small open economy) model in the specific context of the Great Recession as experienced in the European Monetary Union (Castro et al., 2015). We aim in this paper to contribute to this literature by exploring the causal links – spanning multiple countries and time periods – between adjustments, whether biased to the revenue or expenditure side, and public debt ratios. In order to overcome the potential problems of both cross-sectional dependence and heterogeneity conditions and to avoid the need to formulate a joint hypothesis for the whole panel and to carry out pre-tests such as unit root and cointegration, the Kónya (2006) panel Granger causality methodology is applied. To our knowledge, this is the first time that a bootstrap panel Granger causality is applied to these three variables taken together.

Our empirical findings in some country cases provide some support for the view that fiscal adjustment motivated by concerns about public debt sustainability may prove counterproductive as the ensuing reduction in demand ends up increasing debt ratios (Banerjee and Zampoli, 2019). Yet the question of the advisability of undertaking fiscal adjustment – for all its importance and interest – lies beyond the scope of this study. Our paper will remain relevant whatever the outcome of these debates since we aim to enhance the analytical tools for evaluating approaches

to fiscal adjustment once a country has determined, for better or worse, to go down that road. The integration into the model of the annual change in the ratio of total public debt to GDP creates a dynamic linkage across policymaking periods (Battaglini and Coate, 2008) allowing cross-checking of the results.

With these intentions in mind, the present paper is divided into six sections. Section 2 begins with an overview of the literature on the intertemporal relationship between taxation, spending and debt to GDP ratios. Section 3 describes the criteria used for selecting our sample of eighteen OECD member countries; we follow Alesina, Favero and Giavazzi (2018, 2019), Gupta, Tovar Jalles, Mulas-Granados and Schena (2017) in adopting and extending the countries identified by the narrative approach developed by Devries, Guajardo, Leigh, and Pescatori (2011) and Romer and Romer (2010). In section 4, we explain the empirical methodology adopted to address our research question. Section 5 tests the validity of our methodology and analyses the econometric results. The final section concludes by summarizing the implications of our main findings.

2. Literature Review

There are two main reasons for the poor reputation of fiscal policy as an instrument for solving economic problems. First, politicians in many countries may use the 'populist' potential of fiscal expedients to secure re-election. A classic example would be reducing taxes to half their optimal level or maximizing public expenditures in the election period (maybe with the help of 'borrowing more without producing more' policies) with the aim of influencing citizens' voting intention. The resulting distortions (for the sake of securing electoral outcomes or rent-seeking) reflect a principal-agent problem with moral hazard issues also present. The principal-agent is one of the most common codified modes of social interaction. Much of the economic literature on problems of moral hazard (see Arrow, 1970) is concerned with the problems raised by agency – i.e. the relationship between two or more parties when one, designated as the agent, acts for, on behalf of, or as representative for the other, designated the principal (Ross, 1973: 134).

Government decisions to raise taxes or public expenditure (as opposed to reducing budget deficits and taxation) have been depicted in the framework of Buchanan (1972; 1975) and Public Choice Theory as entailing the risk of creating a *Leviathan state*. It is worth noting in passing that the use of this "Leviathan" label in a pejorative sense is a travesty of the source being alluded to – Thomas Hobbes's political treatise of that name published in 1651 famously , describing life without government as nasty, brutish and short. Hobbes took the name Leviathan from a passage in the biblical Book of Job in which Leviathan is referred as the 'King of Pride' and this extreme level of pride depicted as the source of war of all against all. Hobbes's Leviathan was thus defined as a monster inside the people rather than the monster state or government posited by the Public Choice School as a source of harm and corruption.

The second reason has to do with the Tanzi effect (Tanzi, 1977) as regards fiscal policy actions in an inflationary environment. Laws and regulations or bureaucracy need time to come into effect – and this delay, e.g. between the time a tax liability arises and the tax is collected, reduces the real tax proceeds collected by a government. Different schools of economic thought have proposed various solutions to this problem – from legal instruments to monetary policy tools. Although all such approaches have their pitfalls, especially when huge economic shocks and crises happen in a specific country or worldwide, an active fiscal policy response is usually in demand.

Theory aside, practical experience indicates that, in the field of the public finances, there are no policy solutions that are correct at all times and places. Most countries must therefore strive for

their own solutions as regards using fiscal policy to address economic imbalances. Such 'do-it-yourself' or 'trial-and-error' experiences can prove costly for citizens. As Arrow (1962) suggests, 'learning by doing' is an important and endogenous fact which underlies intertemporal and international shifts in the production function. He also points out that the education and research institutions created by societies enable such learning to take place more rapidly. The benefits of the trial-and-error process may be tapped not only from the lived experience of policymakers and societies but also by drawing lessons from historical experience when framing effective policies to be applied in the present and future.

In addition to decisions on spending and taxation, a third fiscal policy tool - government borrowing – has emerged as an effective means for overcoming crises and promoting recovery, provided it is used wisely and on a *ceteris paribus* basis. In last two decades, various shocks such as the 2007-08 financial crisis, the 2010-12 European sovereign debt crisis, and the COVID-19 pandemic have set a trend of expanding public debt relative to GDP. While there is no definitive safety threshold for public debt, the upper limit of the debt-to-GDP ratio for sustainability purposes in high-and middle-income countries has been reckoned to be 60 percent – as reflected in the 1992 Maastricht Treaty which set that level of public debt as the upper limit for the purpose of determining EU member states' eligibility to participate in the planned European monetary union. At present, this criterion is far exceeded, with average debt-to-GDP ratios expected to reach 100 percent in 2020 for the euro area (Haroutunian, Hauptmeier and Leiner-Killinger, 2020).

Ensuring debt sustainability rekindles the old question – conventionally labelled fiscal 'consolidation' or 'adjustment' (see Alesina, Favero and Giavazzi, 2019; Fatás, and Summers, 2018; Castro et al., 2015). The problem, however, is that there are no generally accepted views or conventions defining the concept and practice of fiscal consolidation as the design and implementation of fiscal adjustment involve numerous complex choices: these include decisions about the degree of fiscal policy tightening needed, the optimal speed of execution, the choice of tools – principally, the relative concentration on government expenditures or income – and how to use them (Sutherland et al., 2012). This complexity complicates governments' practical task of achieving prudent medium-term fiscal positions (Lledo and al., 2018), in particular because tightening fiscal policy (regardless of the relative emphasis on spending cuts or tax increase), even to an apparently modest degree, is liable to constrain aggregate demand (Ball et al., 2013; David and Leigh, 2018; OECD, 2012; Romer and Romer, 2010).

The public economics literature stresses the importance of identifying the causal pattern between government revenues and expenditures, because the direction of granger causality provides insights into how a country has managed its budget deficit and the likely future path for its public finances (Ewin et al, 2006). In contrast to our model, the links between government taxation, spending, and debt ratio changes are not considered by most of the literature. Instead, the models which aim to assess the reciprocal impact of government taxation and spending are confined to four hypotheses: first, the *Tax and Spend* that is government revenues cause variations in government expenditures. The 'Tax and Spend Hypothesis' (Friedman, 1978) assumes that any increase in government taxation increases the spending side. Therefore, according to this hypothesis, increasing taxes lead to more spending, this implies that decreasing taxes is the appropriate solution to decrease budget deficits. A variant of this hypothesis – the fiscal illusion – (Buchanan and Wagner, 1978) is a negative causal relationship where tax decreases (increases) may lead the public to demand for more (less) government spending on the grounds that government expenditures are cheap (expensive). The fiscal illusion literature argues that certain features of the tax structure such as the balance between direct and indirect taxation affect

taxpayer's perceptions of their tax burden causing them to underestimate (overestimate) how much they are paying for public goods. Using quarterly US data from 1959 to 2007, Young (2009) finds almost no evidence of the fiscal illusion hypothesis.

The second hypothesis is *the Spend and Tax* which states that government spending cause variations in taxation. A more powerful 'Spend and Tax Hypothesis' (Roberts, 1978; Peacock and Wiseman 1979) essentially the 'displacement effect', assumes that any temporary increase in government spending provided in times of economic and political shocks alter public attitudes towards the size of government and results in a permanent increase in government spending and therefore in the level of taxation. Under the conditions applying to the optimal tax smoothing model of Robert Barro (1979), the tax rate adjusts to the permanent level of anticipated public spending. Since, in this framework, higher spending now leads to higher taxation later, this hypothesis points to spending cuts as the most effective way to reduce budget deficits.

The third hypothesis is the *Fiscal Synchronization* meaning that the relation is bidirectional. The 'Fiscal Synchronization' hypothesis (Musgrave, 1966; Meltzer and Richard, 1981) is based on a two-way relationship between government revenue and expenditure. Changes in spending and taxation are decided simultaneously by the government reflecting voters' preferences as between public services and redistribution. Therefore, to reduce budget deficits, both spending cuts and tax increases are necessary.

The fourth hypothesis is the *Institutional Separation or Fiscal Independence* where no relation between taxation and spending is observed. The 'institutional separation' or fiscal independence hypothesis assumes that both government income and expenditure mechanisms act independently. Some accounts of this hypothesis identify its main underpinning as the institutional separation of the executive and legislative branches of government (Wildavsky, 1988; Baghestani and McNown, 1994).

All four of the hypotheses described above find some support. Which of these four possibilities prevails in specific cases depends on countries' tax systems, the degree of tax aversion in their populations, and on how voter redistribution preferences are articulated around the political process (Furstenberg, Green and Jeong, 1986).

To the extent that budget deficits need to be reduced, the question is the sustainability of the path of fiscal policy and the feasibility of either cutting expenditures or increasing revenues. Studies such as Alesina and Perotti (1995) draw clear-cut conclusions in favor of expenditure-based adjustments. They found that successful fiscal adjustments are those that not only have prioritized spending reductions in general but also, in particular, have "cut" into sensitive spending on transfers and the public payroll – as opposed to merely curtailing public investment. Alesina and Ardagna (2010), Guajardo, Leigh and Pescatori (2014), Alesina, Favero, and Giavazzi (2018 and 2019) and Molnár (2012) also support the "spend-tax" perspective. Devries, Guajardo, Leigh, and Pescatori (2011) argue that this result may also be due to expansionary monetary policy. Adjustments relying mainly on tax increases, in particular income taxes, are criticized in this literature as likely to deter labor market participation and therefore impair potential economic growth. But none of these papers, contrary to ours incorporate the change in the debt to GDP ratio into the analysis to cast light on optimal approaches to restore fiscal balances.

3. Data sources and basic statistics

3.1. Data sources

The database that we use for this specific model consists of a balanced panel of eighteen OECD countries over 1976-2017. The data consist of government revenue (REV), government expenditure (EXP) as well as the yearly change in public debt (DEBT), all expressed as a share of GDP. By not taking the cumulative debt stock/ratio, we exclude the possible effects associated with the previous year's policies and eliminate long-term accumulation of past policies as it veils the relevant year's effects. The data sources are the IMF's Fiscal Monitor, Global Debt Database and World Economic Outlook (October 2018); the OECD and the Turkish Treasury and Finance Database (Table 1).

Table 1 - Identification of the Variables

Variable Name	Definition	Source
REV	Total Government Revenue/GDP	*IMF, OECD Databases**
EXP	Total Government Expenditure/GDP	
DEBT	Change in Total Public Debt/GDP	

***** OECD Stat, IMF's Fiscal Monitor, Global Debt Database and World Economic Outlook (October 2018). Missed data for Turkey are checked with previous year values and derived directly from the official Turkish Treasury and Finance website (https://www.treasury.gov.tr/public-finance-statistics).

We have selected countries according to the fiscal consolidation narrative approach (Romer and Romer, 2010; Devries, Guajardo, Leigh, and Pescatori, 2011; Alesina, Favero and Giavazzi, 2019) reflecting policy makers' intentions and actions on approved budget plans. For sake of comparison, our dataset combines the Devries, Guajardo, Leigh, and Pescatori (2011) database updated by Gupta, Tovar Jalles, Mulas-Granados and Schena (2017) covering seventeen advanced economies between 1978 and 2015 and from the Amaglobeli, D., V. Crispolti, E. Dabla-Norris, P. Karnane and F. Misch (2018) database covering 23 countries. For Israel which is not covered by any of these databases, we used IMF, OECD surveys and press reports. We have also selected OECD member countries whose public debt grew markedly following the 2008-10 Global Financial Crisis (IMF 2016) and/or the 2010-12 European sovereign debt crisis. Countries meeting this criterion include Australia, France, Greece, Ireland, Italy, Japan, Portugal, Spain, France, the United Kingdom and the United States. Eight of our eighteen countries are part of Europe's Economic and Monetary Union and are therefore bound by the 2012 Fiscal Stability Treaty. We substituted some of the countries (Austria, Belgium, Denmark and Finland) selected by Devries, Guajardo, Leigh, and Pescatori (2011) by countries such as Korea, Israel, Mexico, and Turkey where, at the time of their study, there was little call for long-term fiscal consolidation in the period 2006-11 (OECD, 2011) but which have since shown signs of needing more active fiscal policy. To make the conclusions as robust as possible, we have excluded from our selection countries with either a heavy economic dependence on oil, or with small land areas and relatively low populations. Table 2 lists the countries covered in this analysis.

Table 2 - Fiscal Consolidation Years, 18 OECD Countries, 1976-2017

Countries	Fiscal consolidation years, 18 OECD Countries, 1976-2017.
Australia	1985-88, 1994-99, 2010-12, 2014-15
Canada	1984-97, 2010-15
France	1979, 1987, 1989, 1991-92, 1995-97, 1999-2000, 2011-15
Germany	1982-1984, 1991-95, 1997-2000, 2003-04, 2006-07, 2011-12
Greece	1990-92, 1994-97, 1999-2000, 2004-07, 2010-15
Ireland	1982-88, 2009-15
Israel	1985, 2010-14
Italy	1991-98, 2004-07, 2010-15
Japan	1997-98, 2003-07
Korea, Republic of	1976, 1986-89, 1997-98, 2006
Mexico	1983-87, 1989, 1995-2000, 2009-14
Netherlands	1981-88, 1991-93, 2004-05, 2011-13, 2015
Portugal	1983, 2000, 2002-03, 2005-07, 2010-15
Spain	1983-84, 1989-90, 1992-97, 2009-15
Sweden	1984, 1993-98, 2011, 2015
Turkey	1985-86, 1991-94, 1998-99, 2001, 2003-05, 2010-13
United Kingdom	1979-82, 1994-99, 2010, 2012, 2014-15
United States	1978, 1980-81, 1985-86, 1988, 1990-98, 2011, 2013-15

Sources: Amaglobeli, D., V. Crispolti, E. Dabla-Norris, P. Karnane and F. Misch (2018); Gupta, Tovar Jalles, Mulas-Granados and Schena (2017) and Authors's calculations.

3.2. Summary statistics

The descriptive statistics, computing with STATA, are reported in Table 3, they show that the annual average REV for all eighteen countries over the full period studied is approximately 36 percent, while the numbers for EXP and DEBT are, respectively, 40 percent and 3 percent.

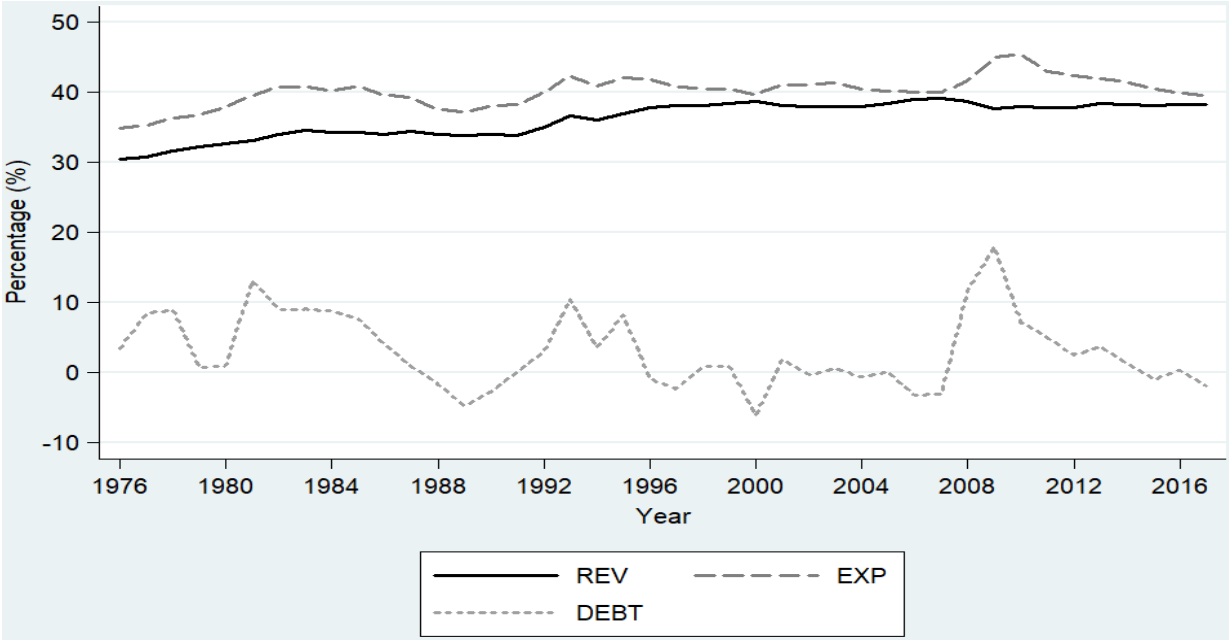
Table 3 - Descriptive Statistics for the Panel Data Set, 1976-2017, in percentage

Variable	Observations		Mean	Std. Dev.	Min	Max
REV	756	*Fully Balanced Panel Data Set*	36.08621	10.69572	9.655834	60.5472
EXP	756		40.11162	11.66986	11.4928	71.8412
DEBT	756		2.978669	11.55646	-31.06834	83.77327

Source: IMF's Fiscal Monitor, Global Debt Database and World Economic Outlook (October 2018); Turkish Treasury and Finance website.

Figure 1 shows how all countries' average REV, EXP and DEBT developed year-by-year during the period under study. There seems to be a same-way directional relationship for all variables for most of the time. This might signify that these three variables may have some statistical meaning (significance) when taken together.

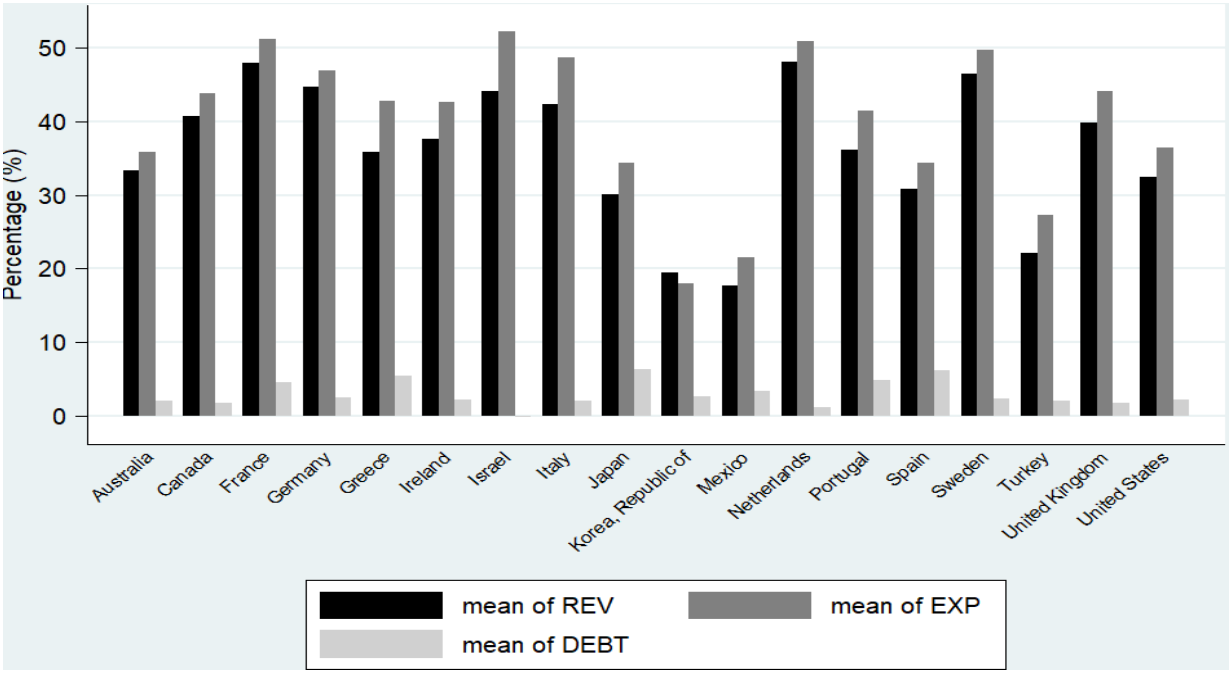
Figure 1 - Government Revenue, Expenditure and Public Debt of All Countries, 1976 to 2017 (All-countries Average)



Source: IMF's Fiscal Monitor, Global Debt Database, World Economic Outlook (October 2018); OECD and Turkish Treasury and Finance Database.

Extending the analysis to a country-based approach-, Figure 2 below and Table A.1 (Appendix A) show that debt changes in Greece, Portugal, and Spain have been huge, inconsistent and volatile (see also Figure B.1 in Appendix B). In addition, Japan and relatively France display more pronounced changes in public debt ratios over the period – unlike Ireland and Italy.

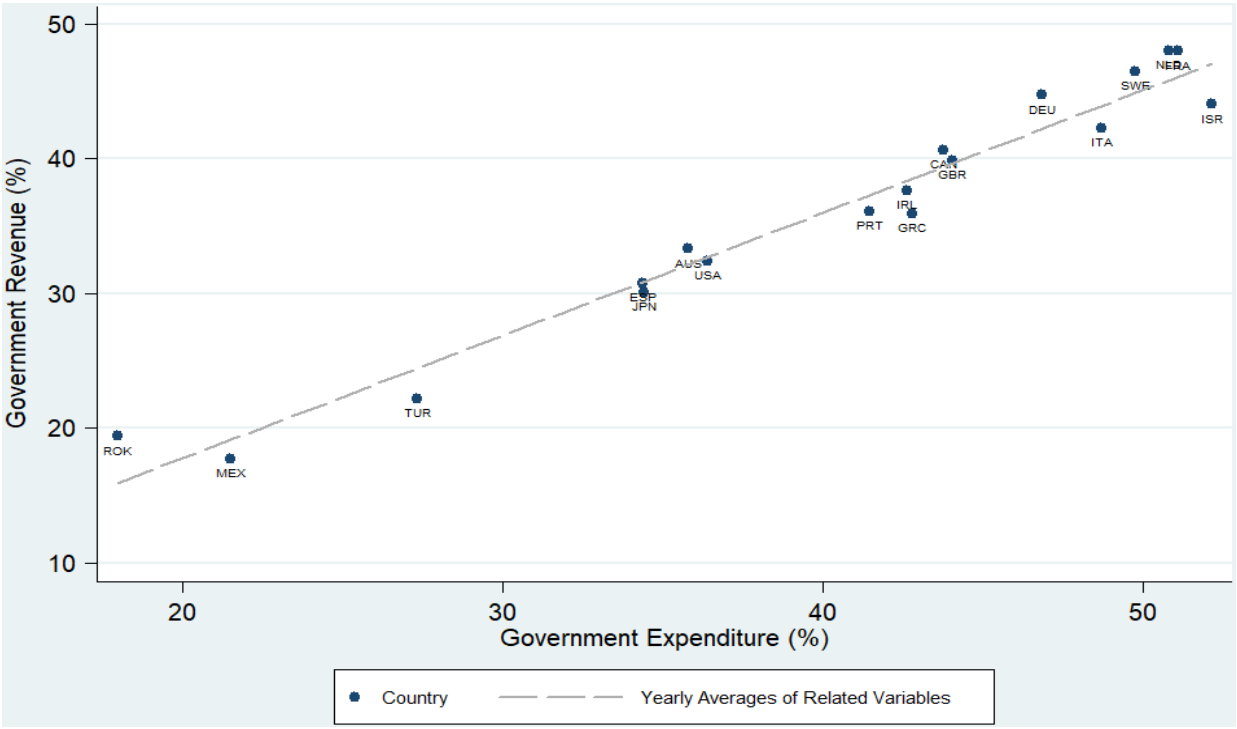
Figure 2 - Government Revenue, Expenditure and Public Debt of All Selected OECD Countries, 1976 to 2017 (All-years Average)



Source: Data derived from IMF's Fiscal Monitor, Global Debt Database and World Economic Outlook (October 2018); OECDStat and Turkish Ministry of Treasury and Finance Database.

Particularly the PIIGS (this abbreviation is used to identify the five EU countries, namely; Portugal, Ireland, Italy, Greece and Spain that had large-scale debt problems in the post-crisis period of 2007-2008), but also in several other countries, debt/GDP ratios reached the second-highest levels seen in the past 130 years (see Cottarelli, 2012). As a means of restoring balance over shorter periods (or turning the structural deficit to a permanent surplus in the long-run), public debt (DEBT) is regarded as a powerful tool – but also a hazardous one. The advantages for countries of global integration and interdependency come together with some contagion hazards. Thus, change in public debt case is not only 'one country's problem' but affects 'others', for example through sentiment effects in debt capital markets. In general, the positive effect of superior economies of scale (which usually has sub-additive and natural monopoly features) inherent in state actions applies also to the use of public debt to, for example, fund infrastructure and other long-term investments (that strengthen capital levels) or improve the distribution of wealth and allocation of public goods.

Figure 3 - Government Revenue and Expenditure, 1976 to 2017 (Yearly Averages with a Reference Line for All Countries)



Source: IMF's Fiscal Monitor, Global Debt Database and World Economic Outlook (October 2018); OECD and Turkish Treasury and Finance Database.

Figure 3 illustrates further the long term behavior of REV and EXP for each country. The US and the UK ratios stand relatively close to the long term trend line (which is approximately 4 percentage negatively balanced in favor of EXP as described in Table 3 and Table A.1). This seems to indicate that the issue was mainly linked to *'cyclical debt'* rather than fiscal policy of public spending or income implemented during the 42-year period. Again, according to Figure 3; Turkey, Greece, Italy, Israel seems distinct from other countries given that they are far away from the reference line. On the basis of the Table A.1 ratios, these countries' fiscal positions are tilted by nearly 5-8 percent of GDP in favor of EXP. These numbers are higher than the long term average of all sample countries (which is 4 percent in favor of EXP). The same table also highlights the particularly high level of risks to fiscal sustainability in Greece.

4. Methodology

Most studies, using time series analysis, have examined the long run relationship between government spending and revenues for a country over time such as Ewing et al. (2006). Relatively fewer studies used panel data analysis to investigate the relationship between revenues and spending across different countries over time. Table A.2 (see Appendix A) schematizes the empirical findings of selected multi-country studies. The results from these studies are mixed and do not yield a single theoretical baseline. The wide range of findings is due to different methodologies, the time periods analyzed, the specification of the model and the degrees of temporal aggregation. For instance Payne (2003), Ewing et al. (2006) and Young (2009), has focused on the long run relationship between government revenue and expenditure, and has used the Granger causality test either in a vector autoregressive framework or within an error correction system while Paleologou (2013), Shastri et al. (2017) and Gurdal et al. (2020) choose different methodologies and found opposite or different results.

The results of empirical studies of public expenditure and debt are also mixed. The public debt literature suggests that government expenditure is an important determinant of national debt (see Del Monte and Pennacchio, 2020). As outlined above, in theory, Barro (1979) suggests that deficits are modified to keep tax rates constant. This implies that government expenditure and public debt are positively correlated. Gupta et al. (2001) and Tanzi and Davoodi (2002) also showed that high government spending increases borrowing limits. Similarly, the relationship between tax revenue and public debt is mostly investigated in the framework of the concept of 'tax smoothing'. The volatility of tax revenues is costly because taxes are distortionary and generate reductions in output that increase nonlinearly with the tax-to-output ratio. Raising tax revenues could even exhaust the economy's short-term fiscal capacity, leading to a slowdown and taking the economy on the downward part of the Laffer curve. Hence governments would choose to finance wars, or social programs in a bad recession, by increased borrowing in order to smooth the profile of tax revenues over time (see Casalin et al., 2020). The existence of nonlinearities and mixed results in the empirical literature highlights the scope for further research on the relationship between these variables.

In this study, we apply the panel causality methodology for all of our three variables which was introduced by Kónya (2006), a panel Granger causality approach based upon the SUR (Seemingly Unrelated Regressions). This method allows us to overcome the potential problems of both cross-sectional dependence and heterogeneity conditions and avoids the need to formulate a joint hypothesis for the whole panel and to carry out pre-tests such as unit root and cointegration. The panel data regressions – *pursuant to the theory of Kónya (2006)*- are estimated using the GAUSS statistical package with the codes developed by Kar, Nazlıoğlu, and Ağır (2011) and Menyah, Nazlıoğlu, and Wolde-Rufael (2014). A large literature (see Baltagi and Pesaran, 2007) has focused on the risk inherent in panel data studies of the codependency of individual units, with consequences for the estimation and interpretation of the parameters. Several tests for error cross-sectional dependence have been developed, starting from replacing in the score vector the parameter estimates from the restricted model under the null hypothesis and verifying whether the null vector is adequately close to zero – as under the null, the test statistic can be used on the residuals from individual-specific OLS regressions. In order to obtain results that are as robust as possible, we employ four of these tests starting with the Breusch and Pagan (1980) Lagrange multiplier (LM) test; the Pesaran (2004) cross-sectional dependence test; the Pesaran (2004) two-way cross-sectional dependence; and the Pesaran, Ullah, and Yamagata (2008) test.

4.1. Testing cross-sectional dependence

When the panel data model specification is given by:

$$Y_{it} = \alpha_i + \beta_i X_{it} + \mu_{it} \qquad for\ i = 1, 2, 3, \ldots, N;\ t = 1, 2, 3, \ldots, T \tag{1}$$

where i indexes the cross-sectional units and t the time series observations, Y_{it} is the dependent variable, X_{it} the explanatory variables' k x 1 vector, α_i and β_i are the individual intercepts and slope coefficients which are authorized to differ across states. The null hypothesis of cross-sectional independence, written as H_0: $Cov\ (\mu_{it}, \mu_{jt}) = 0$ for all t and $i \neq j$ is tested against the hypothesis of cross-sectional dependence H_1: $Cov\ (\mu_{it}, \mu_{jt}) \neq 0$ for at least one pair of $i \neq j$ (where i and j indicates the cross-sectional units of the panel). The Breusch and Pagan (1980) Lagrange multiplier test statistic (CD_{BP}) is calculated as:

$$CD_{BP} = \mathrm{T} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \tag{2}$$

where $\hat{\rho}_{ij}^2$ is the average of the squared pair-wise correlation coefficients of the residuals obtained from the individual Ordinary Least Squares (OLS) estimate of Equation (1). The LM statistic is valid for the panel under the null hypothesis which has an asymptotic chi-square distribution with $N\ (N\ 1)/2$ degrees of freedom. Pesaran (2004) shows that the CD_{BP} test statistic is not applicable when $N \rightarrow \infty$ and suggests using a scaled version of the CD_{BP} - the CD_{LM} test:

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T\hat{\rho}_{ij}^2\text{-}1) \tag{3}$$

With the condition of no cross-sectional dependence null hypothesis, $T \rightarrow \infty$ and $N \rightarrow \infty$, the CD_{LM} test demonstrates an asymptotically distribution. But with a large N, the CD_{LM} test is subject to significant size deformations leading Pesaran (2004) to propose an alternative test built on the pair-wise correlation coefficients rather than their squares – the (CD) test:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \tag{4}$$

The CD statistic is based on regular product-moment correlation coefficients, and has exactly mean zero for fixed values of either N or T under heterogeneous dynamic panel data models subject to multiple breaks in their slope coefficients and error variances – provided that the unconditional means of Y_{it} and X_{it} are time-invariant and their innovations are symmetrically distributed (Pesaran, 2004). However, the CD test is not powerful enough to detect positive and negative correlations in the residuals, and therefore fails to detect the alternative hypothesis. Pesaran, Ullah, and Yamagata (2008) offers a bias-adjusted version of the LM test – the LM_{adj} test – that applies the exact mean and variance of the LM statistic, and which is valid under powerful exogenous regressors and normal errors:

$$LM_{adj} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \frac{(T-k)\hat{\rho}_{ij}^2 - u_{Tij}}{\sqrt{v_{Tij}^2}} \quad (5)$$

where *k* stands for the regressor numbers, u_{Tij} the exact mean and v_{Tij}^2 the variance of *(T-k)* $\hat{\rho}_{ij}^2$.

4.2. Testing slope homogeneity

Next, we test the hypothesis of slope homogeneity as the slope coefficients of the REV, EXP, and DEBT may be country specific. Cross-country homogeneity across our sample of eighteen countries is unlikely given the different state of their respective economies. Ignoring this form of heterogeneity will result in biased estimation and inference and impair the panel causality test's robustness (Granger, 2003; Breitung, 2005; Pesaran and Yamagata, 2008). To test slope homogeneity, we employ the Pesaran and Yamagata (2008) delta ($\tilde{\Delta}$ and $\tilde{\Delta}$adj) tests. Pesaran and Yamagata (2008) emphasize that the F test and the Swamy (1970) test are suitable for panels in which *N* is relatively small compared to *T*. The standard F test is one of the most common methods to test the null hypothesis H_0: $\beta_i = \beta$ for all *i* against heterogeneity hypothesis H_1: $\beta_i \neq \beta_j$ for a non-zero fraction of pair-wise slopes for $i \neq j$. This condition requires strictly exogenous explanatory variables and homoscedastic error variances. On the other hand, Swamy (1970) test allows for cross-sectional heteroscedasticity:

$$\tilde{S} = \sum_{i=1}^{N} \left(\hat{\beta}_i - \hat{\beta}_{WFE}\right)' \frac{X_i' M_\tau X_i}{\hat{\sigma}_i^2} \left(\hat{\beta}_i - \hat{\beta}_{WFE}\right) \quad (6)$$

where $\hat{\beta}_i$ is the pooled OLS estimator and $\hat{\beta}_{WFE}$ is the weighted fixed effect pooled estimator of Equation (1); M_τ is an identity matrix of order *T* and $\hat{\sigma}_i^2$ is the estimator of σ_i^2. Pesaran and Yamagata (2008) propose a standardized version of Swamy's test of slope homogeneity ($\tilde{\Delta}$ test) and define the standardized dispersion statistic as:

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - k}{\sqrt{2k}}\right) \quad (7)$$

Under the condition of normally distributed error terms, this test is applicable when $(N, T) \to \infty$ without any restraints on the relative expansions of both *N* and *T*. As long as $\sqrt{N}/T \to \infty$ and with the given conditions, the $\tilde{\Delta}$ test has an asymptotic standard normal distribution under the null hypothesis. The $\tilde{\Delta}$ test is adjusted under the normally distributed errors by using the mean and variance bias-adjusted version as follows:

$$\tilde{\Delta}_{adj} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - E(\tilde{Z}_{it})}{\sqrt{var(\tilde{Z}_{it})}}\right) \quad (8)$$

where the mean $E(\tilde{Z}_{it}) = k$, and $var(\tilde{Z}_{it}) = 2k(T-k-1)/(T+1)$.

4.3. The bootstrap panel granger causality test

We adopt Chu, Chang and Sagafi-nejad (2016: 34) formulation of the Kónya (2006) bootstrap panel Granger causality:

$$\begin{cases} y_{1,t} = \alpha_{1,1} + \sum_{l=1}^{p_1} \beta_{1,1,l} y_{1,t-l} + \sum_{l=1}^{p_1} \delta_{1,1,l} x_{1,t-l} + \varepsilon_{1,1,t} \\ y_{2,t} = \alpha_{1,2} + \sum_{l=1}^{p_1} \beta_{1,2,l} y_{2,t-l} + \sum_{l=1}^{p_1} \delta_{1,2,l} x_{2,t-1} + \varepsilon_{1,2,t} \\ \vdots \\ y_{N,t} = \alpha_{1,N} + \sum_{l=1}^{p_1} \beta_{1,N,l} y_{N,t-l} + \sum_{l=1}^{p_1} \delta_{1,N,l} x_{N,t-1} + \varepsilon_{1,N,t} \end{cases} \quad (9)$$

Where *y* refers to the dependent variable, *j* to the country *(j=1,…,N), t* to time *(t=1,…,T)* and *l* to the lag. $\varepsilon_{1,1,t}$ is white-noise error. When *y* refers to REV, *x* will either represent EXP or DEBT variable. We repeat the evaluation process by taking EXP and then DEBT as the dependent variable. So, all dependent variables become an independent variable. Our panel set will transform into the following equation:

$$\begin{cases} x_{1,t} = \alpha_{2,1} + \sum_{l=1}^{p_2} \beta_{2,1,l} y_{1,t-l} + \sum_{l=1}^{p_2} \delta_{2,1,l} x_{1,t-l} + \varepsilon_{2,1,t} \\ x_{2,t} = \alpha_{2,2} + \sum_{l=1}^{p_2} \beta_{2,2,l} y_{2,t-l} + \sum_{l=1}^{p_2} \delta_{2,2,l} x_{2,t-1} + \varepsilon_{2,2,t} \\ \vdots \\ x_{N,t} = \alpha_{2,N} + \sum_{l=1}^{p_2} \beta_{2,N,l} y_{N,t-l} + \sum_{l=1}^{p_2} \delta_{2,N,l} x_{N,t-1} + \varepsilon_{2,N,t} \end{cases} \quad (10)$$

Each equation has different predetermined variables with the only potential link between the individual regressions to be found in the error terms which might be contemporaneously correlated. This set of equations are a SUR system. The use of the country specific bootstrap critical values means that y_t and x_t do not need to be stationary: they designate the levels of REV, EXP, and DEBT regardless of their time-series properties. The bootstrap distribution of each test statistic is derived from 10,000 replications. With this methodology:

- One-way causality occurs from ***X*** to ***Y*** if not all $\delta_{1,i}$ are zero, but all $\beta_{2,i}$ are zero,

- One-way causality occurs from $\boldsymbol{Y}$ to $\boldsymbol{X}$ if all $\delta_{1,i}$ are zero, but not all $\beta_{2,i}$ are zero,
- Two-way causality occurs both from $\boldsymbol{X}$ and $\boldsymbol{Y}$ if neither $\delta_{1,i}$ nor $\beta_{2,i}$ are zero,
- No causality occurs between $\boldsymbol{X}$ and $\boldsymbol{Y}$ if all $\delta_{1,i}$ and $\beta_{2,i}$ are zero.

We follow Kónya (2006) in assuming four maximal lags ranging from 1 to 4. As Kónya explains, the robustness of the causality test results depends on the adopted lag structure as too few lags means omitting variables and producing bias in the regression coefficients, while too many will introduce specification error and ambiguity in the results. We estimate Equations 9 and 10 for each possible pair of *ly*1, *lx*1, *ly*2, and *lx*2, respectively and choose the combinations which minimize the Schwarz Bayesian Criterion (SC).

5. Empirical results

Table 4 reports that the hypothesis of no cross-section dependency is rejected at 1% level of significance in all tests. This evidence of cross-sectional dependency means that a shock in one country can affect other countries in the sample as for instance during the European sovereign debt crisis. The results of the slope homogeneity ($\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$) tests support country-specific heterogeneity as for both tests, the null hypothesis of slope homogeneity is rejected at all significance levels.

Table 4 - Cross-Sectional Dependence and Homogeneity Results, 1976-2017

Cross-Sectional Dependence Tests	Test Statistics	P-values
CD_{BP} (Breusch and Pagan, 1980)	1534.062***	0.000
CD_{LM} (Pesaran, 2004)	78.950***	0.000
CD (Pesaran, 2004)	35.239***	0.000
LM_{adj} (Pesaran et al., 2008)	78.474***	0.000
Homogeneity Tests	*Test Statistics*	*P-values*
$\tilde{\Delta}$	3.359***	0.000
$\tilde{\Delta}_{adj}$	3.527***	0.000
Number of Countries		18
Average Time	42 (Fully Balanced Panel, Min and Max (Ti): 42)	

Notes: Null hypothesis means that there is no cross-sectional dependence, the alternative hypothesis assumes that there is cross-sectional dependence. *** indicates rejection of the null hypothesis at 1 % level of significance.

The heterogeneity of the countries' fiscal positions is visible in Table A.1 and Table 4 which also confirmed by our panel Granger causality results below. Table 5 (first column) shows the effects of long-run EXP on REV. The spend-tax hypothesis typified by a statistically significant one-way causality is indicated for France, Israel, Italy, Japan, the Korean Republic, Mexico, and Spain. The whole-period average EXP stands between 42 percent and 48 percent and the equivalent average REV between 49 percent and 51 percent (see Table A.1): this shows that EXP has shifted REV to a higher level in these cases, particularly France. The Granger causation is more significant for Korea and Japan. In the case of Korea, this result taken together with Figure B.1 (Appendix B) flashes that for most of the 42 years period, REV and EXP hardly diverge even after a big shock such as the 1997 financial crisis, illustrating that the Korean authorities are making cautious use of their resources. This is confirmed by the low level of whole-period average REV and EXP and their positive difference (also shown in Table A.1) – implying a negative fiscal consolidation or stimulus. For France, Israel and Italy, Figure B.1 makes clear that EXP has been higher for the entire period. For France, every time there is a shock as for instance in the 1990s or the 2000s, EXP rises; for Israel, EXP was above REV in the 1980s then REV and EXP were moving down

closer to each other; for Italy, the same trend is observed except that REV and EXP got closer in the 1990s which may imply adjustments of fiscal behaviour in the run-up to the launch of EMU following the Maastricht treaty. As for Japan, the first and second column of Table 5 reveal a statistically significant two-way causality between REV and EXP typical of the fiscal synchronization hypothesis meaning that spending cuts and tax increases are necessary to control the budget deficit.

Table 5 - Bootstrap Panel Granger Causality between Government Revenue and Expenditure, 1976-2017

Countries	H_0: EXP does not cause REV				H_0: REV does not cause EXP			
		Bootstrap Critical Values				Bootstrap Critical Values		
	Statistic	1%	5%	10%	Statistic	1%	5%	10%
AUSTRALIA	6.302	107.957	63.773	47.569	5.399	62.039	38.426	28.559
CANADA	66.476	131.748	85.091	67.161	1.011	113.791	77.933	62.944
FRANCE	94.489*	155.945	110.37	89.099	0.215	126.838	87.954	70.463
GERMANY	75.127	161.525	116.762	95.56	3.01	103.773	67.493	52.032
GREECE	39.655	160.592	113.324	91.522	0.571	118.638	81.433	64.339
IRELAND	13.723	144.292	106.125	88.324	3.625	117.434	80.273	63.794
ISRAEL	72.835*	128.93	86.039	67.399	18.898	76.111	44.617	32.934
ITALY	74.178*	121.242	78.02	59.765	18.775	66.09	37.919	27.151
JAPAN	106.079***	99.84	59.896	44.276	46.964**	68.98	37.861	27.03
KOREA, REP.	72.765**	104.026	63.188	45.385	6.648	59.081	34.7	24.969
MEXICO	59.923*	123.776	74.282	54.728	0.273	64.232	37.935	27.478
NETHERLANDS	0.858	123.116	77.35	54.726	2.817	62.802	33.435	23.041
PORTUGAL	23.086	78.5	42.998	28.635	0.141	40.923	20.38	13.976
SPAIN	29.465*	83.832	43.341	28.886	1.352	47.646	23.071	14.943
SWEDEN	32.922	142.801	92.559	67.489	1.063	84.507	45.883	31.322
TURKEY	57.083	147.717	97.999	73.976	1.589	109.228	69.389	53.275
UK	31.933	134.115	88.675	67.976	1.055	67.957	40.986	30.264
USA	40.521	135.129	91.448	71.688	2.113	66.406	42.445	32.254

Notes: ***, **, and * indicate the rejection of the null hypothesis at 1, 5, and 10 percent levels of significance, respectively. Panel system is estimated by using 1 to 4 lags and then choosing the combinations which minimize the Schwarz Bayesian Criterion. Critical values are based on 10,000 bootstrap replications.

In the short-run, fiscal consolidation policies tend to increase the public debt-to-GDP ratio (Castro et al., 2015) as the denominator drops faster than the numerator. This is clearly demonstrated by the budget deficit limit implemented in Italy in 2012, the public debt-to-GDP ratio has increased by around 16 percentage points in three years (Bagnai, Granville and Mongeau Ospina, 2017: 530). In the medium and long term, such negative effects tend to ease, and DEBT is mainly driven by the tax- or spending-based consolidation plan (Castro et al., 2015). In Table 6, two countries (namely Japan and Turkey) point to a significant relationship from DEBT to REV. For Turkey this seems to imply that any change in DEBT might prompt a rise or a fall in REV. In the case of Japan, the relationship is a two-way causality between DEBT and REV. For Italy, as mentioned, the relationship goes from REV to DEBT implying that any change in REV prompts a change in DEBT. Italy is facing since 2011 a high fiscal sustainability risk in the medium term, its debt ratio has grown cumulatively since the European sovereign debt crisis of 2010-2012 accentuated by the lack of synchronization and concordance of business and financial cycles that is characteristic of the Euro Area (Granville and Hussain, 2017).

Table 6 - Bootstrap Panel Granger Causality between Government Revenue and Public Debt, 1976-2017

Countries	H_0: DEBT does not cause REV				H_0: REV does not cause DEBT			
		Bootstrap Critical Values				Bootstrap Critical Values		
	Statistic	1%	5%	10%	Statistic	1%	5%	10%
AUSTRALIA	6.226	65.896	36.176	24.028	0.307	14.498	8.163	5.549
CANADA	5.446	86.552	55.082	40.651	0.54	13.632	7.765	5.221
FRANCE	15.112	90.616	62.366	47.664	3.856	13.972	7.298	5.106
GERMANY	8.425	108.074	72.885	56.843	0.125	15.366	8.404	5.914
GREECE	30.317	103.412	71.565	57.683	1.299	12.319	6.511	4.533
IRELAND	1.403	81.424	52.336	38.794	0.459	16.193	9.408	6.572
ISRAEL	11.849	71.644	44.022	30.984	6.182	18.33	10.057	6.915
ITALY	1.011	125.621	82.583	63.353	15.538**	16.286	8.831	6.225
JAPAN	82.078**	121.114	79.782	62.086	6.225*	12.827	7.206	5.045
KOREA, REP.	6.224	116.334	78.38	60.475	0.57	12.704	7.186	4.976
MEXICO	15.062	104.238	66.618	48.41	0.017	13.954	7.976	5.439
NETHERLANDS	2.502	67.602	36.479	23.984	0.238	14.633	7.961	5.46
PORTUGAL	0.072	86.95	54.943	40.929	0.579	15.093	8.272	5.759
SPAIN	0.001	86.429	55.476	41.198	0.135	16.626	8.881	6.199
SWEDEN	15.921	97.647	59.752	41.588	0.004	16.172	8.937	6.201
TURKEY	63.851**	102.129	63.236	46.301	0.017	18.559	9.766	6.639
UK	3.89	117.583	76.845	57.31	4.104	15.994	8.932	6.152
USA	29.766	82.988	51.811	38.607	0.023	14.488	8.221	5.654

Notes: ***, **, and * indicate the rejection of the null hypothesis at 1, 5, and 10 percent levels of significance, respectively. Panel system is estimated by using 1 to 4 lags and then choosing the combinations which minimize the Schwarz Bayesian Criterion. Critical values are based on 10,000 bootstrap replications.

In Table 7, both Japan and Greece's DEBT appears as driving EXP due to high debt levels. In the case of Greece, despite the size of the fiscal consolidation plan and the debt relief measures taken by the European Commission, European Central Bank (ECB) and International Monetary Fund (IMF) following the 2010-12 European sovereign debt crisis, economic growth is lethargic and Greece's public debt continues to represent a high sustainability risk standing at 181 percent in 2018 (IMF, 2018a). In Japan, medium term debt sustainability risks are high too (the debt to GDP ratio reached 250 percent in 2019). While the debt is financed mainly by domestic borrowings eased by aggressive monetary easing, the IMF warned that Japan's public debt is unsustainable under ongoing fiscal policies (IMF, 2018b).

On the other hand, EXP causes changes in DEBT with high statistical significance levels for Italy and lower levels for the UK. Lliedo et al. (2008:7-8) remark that for expenditure-based programs to be effective, the bounds should be set in levels and growth rates and not as ratios of GDP as they tend to be procyclical. Therefore, to ensure debt sustainability, expenditure-based programs should also consider the revenue side in order for such programs to achieve desired goals on debt dynamics and fiscal sustainability. In our empirical case (for Italy and partially for the UK), either because of the setting up of the rules or the discretionary application of fiscal policies, public spending cuts cause debt accumulation, weakening efforts to improve fiscal sustainability in the long run. In the case of the UK economy, Brexit might create an extra uncertainty in public sector's debt ratios, expenditure and revenue values for the future (see Bloom et al., 2018).

Table 7 - Bootstrap Panel Granger Causality between Government Expenditure and Public Debt, 1976-2017

Countries	H_0: DEBT does not cause EXP				H_0: EXP does not cause DEBT			
		Bootstrap Critical Values				Bootstrap Critical Values		
	Statistic	1%	5%	10%	Statistic	1%	5%	10%
AUSTRALIA	0.105	52.873	30.848	21.46	0.274	16.581	9.179	6.239
CANADA	14.88	106.172	64.327	46.193	0.157	18.692	11.134	7.757
FRANCE	1.145	96.96	66.679	51.189	0.837	13.474	7.541	5.254
GERMANY	0.023	108.61	72.741	56.012	0.008	14.675	8.302	5.811
GREECE	80.68**	112.335	78.699	62.851	0.752	11.968	6.57	4.577
IRELAND	14.612	85.721	54.718	41.374	0.433	17.469	9.27	6.466
ISRAEL	17.59	76.151	44.46	31.607	6.787	19.892	10.802	7.663
ITALY	0.401	140.739	84.188	64.096	21.894***	14.011	7.625	5.237
JAPAN	64.051*	106.029	65.507	48.903	5.169	17.166	9.108	6.215
KOREA, REP.	1.682	77.353	46.904	33.918	0.092	16.66	8.776	6.177
MEXICO	0.79	96.948	54.396	36.924	0.25	28.576	16.948	11.795
NETHERLANDS	4.654	77.122	39.405	25.776	0.732	20.072	11.024	7.75
PORTUGAL	0.201	70.195	42.166	29.036	0.006	15.498	8.553	5.996
SPAIN	0.001	76.37	46.109	33.428	1.226	16.881	9.571	6.531
SWEDEN	7.73	82.527	47.621	33.325	0.363	17.636	10.169	7.136
TURKEY	11.384	74.738	43.643	31.376	0.185	18.926	11.365	7.894
UK	32.663	99.098	64.186	48.268	6.207*	15.944	8.862	6.218
USA	0.609	78.754	46.882	34.686	0.077	17.507	9.86	6.867

Notes: ***, **, and * indicate the rejection of the null hypothesis at 1, 5, and 10 percent levels of significance, respectively. Panel system is estimated by using 1 to 4 lags and then choosing the combinations which minimize the Schwarz Bayesian Criterion. Critical values are based on 10,000 bootstrap replications.

In Table 8, seven countries – France, Israel, Italy, Japan, the Korean Republic, Mexico, and Spain – have a significant sign from EXP to REV confirming the Spend-Tax hypothesis. Japan is diverging from this group with a bidirectional causality between EXP and REV. This is consistent with the Fiscal Synchronization hypothesis. The other eleven countries fit the Institutional Separation (Fiscal Independence) as no link is evidenced between EXP and REV.

Table 8 - Summary for the Direction of Bootstrap Panel Causality for All Tests, 1976-2017

Countries	EXP/REV		DEBT/REV		DEBT/EXP	
AUSTRALIA						
CANADA						
FRANCE	→					
GERMANY						
GREECE					→	
IRELAND						
ISRAEL	→					
ITALY	→			←		←
JAPAN	→	←	→	←	→	
KOREA, REP.	→					
MEXICO	→					
NETHERLANDS						
PORTUGAL						
SPAIN	→					
SWEDEN						
TURKEY			→			
UK						←
USA						

These results and further highlights on revenue-expenditure relationship versus public debt, are summarized in Table 9 below.

Table 9 - List of Countries by Long-Term Cause and Effect Relationship

Countries	Empirical Evidence	Interpretation of results supported by Figure B.1 (see Appendix B)
AUSTRALIA	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
CANADA	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
FRANCE	EXP→REV	Spend-tax Hypothesis with medium term high sustainability risk
GERMANY	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
GREECE	DEBT→EXP	Debt-driven Expenditure Structure (Same-way interaction on DEBT and EXP); medium term high sustainability risk
IRELAND	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
ISRAEL	EXP→REV	Spend-tax Hypothesis (Same-way interaction on EXP and REV)
ITALY	EXP→REV, REV→DEBT, EXP→DEBT	Spend-tax Hypothesis (with mixed effects); Revenue and Expenditure Related Debt (Same-way interaction on EXP and DEBT, mixed with REV); medium term high sustainability risk
JAPAN	REV↔EXP, DEBT↔REV, DEBT→EXP	Fiscal Synchronization; Debt-Revenue Cycle (with mixed effects); Debt-Driven Expenditure (Same-way interaction on DEBT and EXP)
KOREA, REP.	EXP→REV	Spend-tax Hypothesis with tight and fiscal policy
MEXICO	EXP→REV	Spend-tax Hypothesis (with mixed effects)
NETHERLANDS	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
PORTUGAL	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
SPAIN	EXP→REV	Spend-tax Hypothesis (Same-way interaction till 2008 Crisis then opposite way on EXP and REV)
SWEDEN	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP
TURKEY	DEBT→REV	Debt-driven Revenue Structure (Unstable DEBT policies cause lower REV levels)
UK	EXP→DEBT	Expenditure Related Debt (Same-way interaction on EXP and DEBT); medium term high sustainability risk
USA	REV ↮ EXP, REV ↮DEBT, EXP ↮ DEBT	Institutional Separation (Fiscal Independence); Long-term DEBT structure is not highly correlated with REV and EXP

It is hard to predict what will occur in an organization (or a country) because a small predictive error might create a *snowball effect* affecting the accuracy of all our predictions in aggregate. On the other hand, chaos theory's *butterfly effect* points to the interdependence of countries in given conditions or, in more general, the effect of small changes having larger consequences from the bird's-eye view (Millett, 1998). As an 'a priori' statement, when it comes to economic shocks or crises it is widely accepted that globalization creates various butterfly effects in open economies rather than creating snowball effects limited to specific countries. The countries considered in this study may be vulnerable to both these effects as a function of their economic inter-connectedness. For example, the fiscal crises experienced by the PIIGS countries in the early 2010s may be predicted for other countries.

6. Concluding remarks

In this article, using a balanced panel of eighteen countries for the period 1976-2018, we apply a dynamic fiscal policy model to investigate the long-run causal link between the ratios of government revenue and spending to GDP and their interaction effects on the change in the debt to GDP ratio. The selected countries are relatively well-integrated and powerful economies from around the world as reflected for example in their all being members of the Organisation for Economic Co-operation and Development (OECD), making them high and upper-middle income economies according to the World Bank's World Development Indicators (WDI). While half of them are EU member states (including the PIIGS countries), the others are countries that play an important role in global output as reflected in their membership of the G7 and/or G20. None of them are mainly oil-based economies or with small land areas and population.

The related literature has mainly focused on the long run relationship between government spending and revenues for a country over time, while fewer studies have used panel data analysis to investigate the relationship between revenues and spending across different countries over time – and none have investigated the link with the evolution of public debt ratios. This paper makes a novel contribution in demonstrating the direction of panel causality between spending, revenue and the public debt ratio. Thus establishing the direction of cause and effect reveals how fiscal policy is set-up in practice and on how sustainable fiscal consolidation is.

Our results support the spend-tax hypothesis for France, Israel, Italy, the Korean Republic, Mexico, and Spain; fiscal synchronization in the case of Japan; and the institutional separation (fiscal independence) hypothesis for the other 11 countries. The tax-spend hypothesis is strongly rejected. Both Japan and Greece's DEBT seems to cause EXP due to high debt-to-GDP ratios. Our finding as regards those two countries is supported by the IMF's judgment (IMF, 2018a) that public debt continues to represent a high sustainability risk (in Japan's case, assuming that present fiscal policies remain unchanged (IMF, 2018b)). EXP appears to cause the changes in DEBT with high significance levels for Italy and lower levels for the UK making their fiscal sustainability risk high in the medium term. Our finding for the UK runs contrary to Alesina, Favero and Giavazzi (2018), insofar as the UK is still characterized as presenting medium-term debt sustainability risk despite having applied a fiscal consolidation policy based on spending cuts. These findings suggest that the effects of expenditure-based adjustments are not so straightforward. This presents an interesting avenue for further research in light of significantly deteriorated fiscal balances due to COVID-19.

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References

Afonso A, Rault C (2009a). Spend and Tax: A Panel Data Investigation for the EU. *Economics Bulletin*. 29(4): 2542-2548.

Afonso A, Rault C (2009b). Bootstrap Panel Granger-Causality between Government Budget and External Deficits for the EU. *Economics Bulletin*. 29(2): 1036-1043.

Akram V, Rath BN (2019). Is there any evidence of tax-and-spend, spend-and-tax or fiscal synchronization from panel of Indian state? *Applied Economics Letters*. 26(18): 1544-1547.

Alesina A, Ardagna S (2010). Large Changes in Fiscal Policy: Taxes versus Spending. *Tax Policy and the Economy*. J. R. Brown. Chicago, University of Chicago Press. 24: 35-68.

Alesina A, Favero CA, Giavazzi F (2018). What do we know about the effects of austerity? *AEA Papers and Proceedings*. 108: 524-530.

Alesina A, Favero CA, Giavazzi F (2019). *Austerity: When it works and when it doesn't*. Princeton and Oxford, Princeton University Press.

Amaglobeli D, Crispolti V, Dabla-Norris E, Karnane P, Misch F (2018). Tax Policy Measures in Advanced and Emerging Economies: A Novel Database. *IMF working paper*. 110(May).

Arrow KJ (1962). The Economic Implications of Learning by Doing. *The Review of Economic Studies*. 29(3), 155-173.

Arrow KJ (1970). *Essays in the Theory of Risk-Bearing*. Markham Publishing Co, Chicago, 1970.

Baghestani H, McNown R (1994). Do Revenues or Expenditures Respond to Budgetary Disequilibria? *Southern Economic Journal*. 61(2): 311-322.

Bagnai A, Granville B, Mongeau Ospina CA (2017). Withdrawal of Italy from the euro area: stochastic simulations of a structural macroeconometric model. *Economic Modelling*. 64: 524-538.

Ball L, Furceri D, Leigh D, Loungani P (2013). The distributional effects of fiscal consolidation. *IMF working paper,* 151.

Baltagi BH, Pesaran MH (2007). Heterogeneity and cross section dependence in panel data models: theory and applications introduction. *Journal of Applied Econometrics*. 22(2): 229-232.

Banerjee R, Zampolli F (2019). What drives the short-run costs of fiscal consolidation? Evidence from OECD countries. *Economic Modelling,* https://doi.org/10.1016/j.econmod.2019.1001.1023.

Barro RJ (1979). On the determination of the public debt. *Journal of Political Economy*. 87(5): 940-971.

Battaglini M, Coate S (2008). A Dynamic Theory of Public Spending, Taxation, and Debt. *American Economic Review*. 98(1): 201-236.

Bloom N, Bunn P, Chen S, Mizen P, Smietanka P, Thwaites G, Young G (2018). Brexit and Uncertainty: Insights from the Decision Maker Panel. *Fiscal Studies*. 39(4): 555-580.

Bolat S (2014). The Relationship between Government Revenues and Expenditures: Bootstrap Panel Granger Causality Analysis on European Countries, *Economic Research Guardian.* 4(2): 2-17.

Breitung J (2005). A parametric approach to the estimation of cointegration vectors in panel data. *Econometric Reviews.* 24(2): 151-173.

Breusch TS, Pagan AR (1980). The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. *The Review of Economic Studies,* 47(January): 239-253.

Buchanan JM (1972). Before Public Choice, in *Explorations in the Theory of Anarchy*, edited by Gordon Tullock, Blacksburg, VA: Center for the Study of Public Choice.

Buchanan JM (1975). *The Limits of Liberty.* Indianapolis, IN: Liberty Fund Inc.

Buchanan JM, Wagner RE (1978). Dialogues concerning fiscal religion. *Journal of Monetary Economics.* 4(3): 627-636.

Casalin F, Dia E, Hallett AH (2020). Public debt dynamics with tax revenue constraints. *Economic Modelling.* 90: 501-515.

Castro G, Félix RM, Júlio P, Maria JR (2015). Unpleasant debt dynamics: Can fiscal consolidations raise debt ratios? *Journal of Macroeconomics.* 44(June): 276-294.

Chang T, Chiang G (2009). Revisiting the Government Revenue-Expenditure Nexus: Evidence from 15 OECD Countries Based on the Panel Data Approach. *Czech Journal of Economics and Finance.* 59(2): 165-172.

Chang T, Liu WR, Caudill SB (2002). Tax-and-spend, spend-and-tax, or fiscal synchronization: new evidence for ten countries. *Applied Economics.* 34(12): 1553-1561.

Cheng BS (1999). Causality between Taxes and Expenditures: Evidence From Latin American Countries, *Journal of Economics and Finance.* 23(2): 184-192.

Chu HP, Chang T, Sagafi-nejad T (2016). Globalization and Economic Growth Revisited: A Bootstrap Panel Causality Test. Contemporary Economic and Management Studies in Asia and Africa, *Cyrus Chronicle Journal.* 1(1): 30-44.

Cottarelli C (2012). Fiscal Policy in Advanced Economies: Fiscal Adjustment, Efficiency and Growth, https://www.imf.org/external/np/speeches/2012/031312.htm

David AC, Leigh D (2018). A new action-based dataset of fiscal consolidation in Latin America and the Caribbean. *IMF working paper,* 94(April).

Del Monte A, Pennacchio L (2020). Corruption, Government Expenditure and Public Debt in OECD Countries. *Comparative Economic Studies.* 62, 739-771.

Devries P, Guajardo J, Leigh D, Pescatori A (2011). A New Action-based Dataset of Fiscal Consolidation. *IMF working paper,* 128.

Ewing BT, Payne JE, Thompson MA, Al-Zoubi OM (2006). Government Expenditures and Revenues: Evidence from Asymmetric Modeling. *Southern Economic Journal.* 73(1): 190-200.

Fatás A, Summers LH (2018). The permanent effects of fiscal consolidations. *Journal of International Economics.* 112: 238-250.

Friedman M (1978). The Limitations of Tax Limitation. *Policy Review.* 5(78): 7-14.

Furstenberg (von) G, Green RJ, Jeong HH (1986). Tax and spend, or spend and tax? *The Review of Economic and Statistics.* 68(2): 179-188.

Granger CWJ (1969). Investigation Causal Relations by Econometric Models and Cross spectra Methods. *Econometrica.* 37(3): 424-438.

Granger CWJ (2003). Some aspects of causal relationships, *Journal of Econometrics.* 112(1): 69-71.

Granville B, Hussain S (2017). Eurozone cycles: An analysis of phase synchronization. *International Journal of Finance and Economics.* 22(2): 83-114.

Guajardo J, Leigh D, Pescatori A (2014). Expansionary austerity? International evidence, *Journal of the European Economic Association.* 12(4): 949-968.

Gupta S, Davoodi H, Alonso-Terme R (2002). Does Corruption Affect Income Inequality and Poverty? *Economics of Governance.* 3(1): 23-45.

Gupta S, Tovar Jalles J, Mulas-Granados C, Schena M (2017). Governments and Promised Fiscal Consolidations: Do They Mean What They Say? *IMF working paper,* 39.

Gurdal T, Aydin M, Inal V (2020). The relationship between tax revenue, government expenditure, and economic growth in G7 countries: new evidence from time and frequency domain approaches. *Economic Change and Restructuring.* 54: 305-337.

Haroutunian S, Hauptmeier S, Leiner-Killinger N (2020). The COVID-19 crisis and its implications for fiscal policies. *Economic Bulletin.* 4: 76-79.

Hausman R, Sturzenegger F (2007). The missing dark matter in the wealth of nations and its implications for global imbalances. *Economic Policy.* 22(51): 470-518.

Hobbes T (1651). *Leviathan*. Cambridge, MA: Cambridge University Press.

International Monetary Fund, Debt: Use It Wisely (Fiscal Monitor). *World Economic and Financial Surveys.* Washington, D.C., IMF. October 2016.

International Monetary Fund, *Fiscal Monitor & Global Debt Database and World Economic Outlook,* https://www.imf.org/en/Data, October 2018.

International Monetary Fund, Greece 2018 article IV consultation and proposal for post-program monitoring –press release; staff report; and statement by the executive director for Greece. *IMF Country Report,* Washington D.C. 248, 2018a.

International Monetary Fund, Japan 2018 article IV consultation—press release; staff report; and statement by the executive director for Japan. *IMF Country Report,* Washington D.C. 333, 2018b.

Irandoust M (2018). Government spending and revenues in Sweden 1722–2011: evidence from hidden cointegration. *Empirica.* 45: 543-557.

Jimenez BS (2017). Institutional Constraints, Rule-Following, and Circumvention: Tax and Expenditure Limits and the Choice of Fiscal Tools during a Budget Crisis. *Public Budgeting & Finance.* 37(2): 5-34.

Kar M, Nazlıoğlu Ş, Ağır H (2011). Financial Development and Economic Growth Nexus in the MENA Countries: Bootstrap Panel Granger Causality Analysis. *Economic Modelling.* 28(1-2): 685-693.

Konukcu-Önal D, Tosun AN (2008). Government Revenue-Expenditure Nexus: Evidence from Several Transitional Economies. *Economic Annals.* 53(178-179): 145-153.

Kónya L (2006). Exports and Growth: Granger causality analysis on OECD countries with a panel data approach. *Economic Modelling.* 23(6): 978-992.

Liew VK (2004). Which Lag Length Selection Criteria Should We Employ? *Economics Bulletin.* 3(33): 1-9.

Lledo VD, Dudine P, Eyraud L, Peralta-Alva A (2018). How to select fiscal Rules: A Primer. *How to notes, IMF,* March 15(9).

Matsunaga Y, Yamauchi N (2004). Is the Government Failure Theory Still Revelant? A Panel Analysis Using US State Level Data. *Annals of Public and Cooperative Economics.* 75(2): 227-263.

Mehara M, Pahlavani M, Elyasi Y (2011). Government Revenue and Government Expenditure Nexus in Asian Countries: Panel Cointegration and Causality. *International Journal of Business and Social Science.* 2(7): 199-207.

Meltzer AH, Richard SF (1981). A Rational Theory of the Size of Government, *Journal of Political Economy.* 89(5): 914-927.

Menyah K, Nazlıoğlu S, Wolde-Rufael Y (2014). Financial Development, Trade Openness and Economic Growth in African Countries: New Insights from a Panel Causality Approach. *Economic Modelling,* 37: 386-394.

Millett B (1998). Understanding organisations: the dominance of systems theory. *International Journal of Organisational Behaviour.* 1(1): 1-12.

Molnár M (2012). Fiscal consolidation: What factors determine the success of consolidation efforts? *OECD Journal: Economic Studies.* 1: 123-149.

Musgrave RA (1966). Principles of Budget Determination. *Public Finance: Selected Readings.* A. H. Cameron and W. Henderson. New York, Random House: 15-27.

Mutascu M (2015). A Bootstrap Panel Granger Causality Analysis of Government Revenues and Expenditures in the PIIGS Countries. *Economics Bulletin.* 35(3): 2000-2004.

Mutascu M (2016). Government Revenues and Expenditures in the East European Economies: A Bootstrap Panel Granger Causality Approach. *Eastern European Economics.* 54(6): 489-502.

Narayan PK, Narayan S (2006). Government Revenue and Government Expenditure Nexus: Evidence from Developing Countries. *Applied Economics.* 38(3): 285-291.

OECD, Fiscal Consolidation: Targets, Plans and Measures. *OECD Journal on Budgeting*. 11(2): 13-67, 2011.

OECD, Fiscal Consolidation: How much is needed to Reduce Debt to a Prudent Level? *OECD Economics Department Policy Notes,* 11, April 2012.

OECD, Statistics Oecd.stat. http://stats.oecd.org/, October 2018 (accessed in September, 2020).

Owoye O (1995). The Causal Relationship between Taxes and Expenditures in the G7 Countries: Cointegration and Error Correction Models. *Applied Economics Letters*. 2(1): 19-22.

Paleologou SM (2013). Asymmetrics in the Revenue-Expenditure Nexus: A Tale of Three Countries. *Economic Modelling*. 30(C): 52-60.

Payne JE (1998). The Tax-Spend Debate: Time Series Evidence from State Budgets. *Public Choice*. 95(3-4): 307-320.

Payne JE (2003). A survey of the international empirical evidence on the tax-spend debate. *Public Finance Review*. 31(3): 302-324.

Peacock AT, Wiseman J (1979). Approaches to the Analysis of Government Expenditure Growth. *Public Finance Review*. 7(1): 3-23.

Pesaran MH (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *Cambridge Working Papers in Economics,* 0435, Faculty of Economics, University of Cambridge.

Pesaran MH, Ullah A, Yamagata T (2008). A bias-adjusted LM test of error cross-section independence. *The Econometrics Journal*. 11(1): 105-127.

Pesaran MH, Yamagata T (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*. 142(1): 50-93.

Roberts PC (1978). Idealism in Public Choice Theory. *Journal of Monetary Economics*. 4(3): 603-615.

Romer CD, Romer D (2010). The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks. *American Economic Review*. 100(3): 763-801.

Ross SA (1973). The Economic Theory of Agency: The Principal's Problem. *The American Economic Review*. 63(2): 34-139.

Shastri S, Giri AK, Mohapatra G (2017). Budget Deficit Sustainability and Revenue Expenditure Linkages in Major South Asian Economies. *Eurasian Journal of Business and Economics*. 10(19): 37-59.

Sutherland D, Hoeller P, Merola R (2012). Fiscal Consolidation: How Much, How Fast and by What Means? *OECD Economic Policy Papers*. 1: 1-31.

Swamy PAVB (1970). Efficient inference in a random coefficient regression model. *Econometrica*. 38(2): 311-323.

Tanzi V (1977). Inflation, Lags in Collection, and the Real Value of Tax Revenue. *IMF Staff Papers*. 24(1): 154-167.

Tanzi V, Davoodi H (2002). Corruption, Public Investment, and Growth. In *Governance, Corruption, and Economic Performance*, ed. George T. Abed and Sanjeev Gupta, 280-299. International Monetary Fund: Publication Services, Washington, DC.

Tashevska B, Trenovski B, Trpkova-Nestorovska M (2020). The Government Revenue-Expenditure Nexus in Southeast Europe: A Bootstrap Panel Granger-Causality Approach. *Eastern European Economics*. 58(4): 309-326.

Turkish Ministry of Treasury and Finance Database, *Public Finance Statistics,* October 2018, https://www.treasury.gov.tr/public finance-statistics, (accessed in September, 2020).

Wagner RE (1976). Revenue Structure, Fiscal Illusion, and Budgetary Choice. *Public Choice*. 25: 45-61.

Westerlund J, Mahdavi S, Firoozi F (2011). The Tax-Spending Nexus: Evidence from a Panel of US State-Local Governments. *Economic Modelling*. 28(3): 885-890.

Wildavsky A (1988). *The new politics of the budgetary process*. Glenview, IL Scott Foresman and Company.

Young AT (2009). Tax-spend or fiscal illusion. *Cato Journal*. 29(3): 469-485.

Appendix A

TABLE A.1 - REV, EXP, DEBT AVERAGES OF ALL SELECTED OECD COUNTRIES, 1976 TO 2017

Countries/Variables	REV	EXP	DEBT
Australia	33.32	35.80	2.11
Canada	40.64	43.77	1.79
France	47.98	51.11	4.61
Germany	44.74	46.87	2.46
Greece	35.91	42.81	5.43
Ireland	37.63	42.63	2.24
Israel	44.04	52.17	-0.11
Italy	42.28	48.71	2.10
Japan	30.07	34.40	6.29
Korea, Republic of	19.39	17.97	2.58
Mexico	17.74	21.51	3.38
Netherlands	48.06	50.83	1.13
Portugal	36.09	41.48	4.92
Spain	30.76	34.39	6.25
Sweden	46.47	49.75	2.39
Turkey	22.17	27.34	2.03
United Kingdom	39.85	44.07	1.76
United States	32.41	36.40	2.27
Average	36.09	40.11	2.98

Sources: IMF's Fiscal Monitor, Global Debt Database and World Economic Outlook (October 2018); OECD and Turkish Treasury and Finance Database.

TABLE A.2 - EMPIRICAL LITERATURE ANALYZING THE INTERACTION BETWEEN PUBLIC REVENUE AND EXPENDITURE WITH MULTI-COUNTRY BENCHMARKS

Studies	Period	Country	Methods	Results
Owoye (1995)	1961-1990	G7 Countries	ECM	EXP↔REV: US, Germany, UK, France, Canada REV→EXP: Japan, Italy
Payne (1998)	1942-1992	US States	Engle-Granger ECM	REV→EXP: 24 states EXP→REV: 8 states REV↔EXP: 11 states
Cheng (1999)	1949-1995	8 Latin American Countries	Granger Causality	REV→EXP: Colombia, Dominican Republic, Honduras, Paraguay REV↔EXP: Chile, Panama, Brazil, Peru
Chang, Liu and Caudill (2002)	1951-1996	10 Industrialized Countries	Granger Causality	REV→EXP: Japan, Korean Rep., Taiwan, UK, US EXP→REV: Australia, S. Africa REV↔EXP: Canada REV⇎EXP: New Zealand, Thailand
Narayan and Narayan (2006)	1950-2000	12 Developing Countries	Granger Causality	REV→EXP: Mauritius, El Salvador, Haiti, Chile, Venezuela

				EXP→REV: Haiti REV↔EXP: Peru, S. Africa, Guatemala, Uruguay, Equator
Konukçu-Önal and Tosun (2008)	1999:01-2007:04	4 Transition Economies	Granger Causality	REV→EXP: Belarus, Russia REV↔EXP: Kazakhstan, Kyrgyzstan
Afonso and Rault (2009a)	1960-2006	25 EU Countries	Panel Causality	EXP→REV: Italy, France, Spain, Greece, Portugal REV→EXP: Germany, Belgium, Austria, Finland, UK
Chang and Chang (2009)	1992-2006	15 OECD Countries	Cointegration and Causality	REV↔EXP
Westerlund, Mahdavi, and Firoozi (2011)	1963-1997	50 US State-Local Governments	Cointegration	REV→EXP
Mehrara, Pahlavani and Elyasi (2011)	1995-2008	40 Asian Countries	Cointegration	REV↔EXP
Paleologou (2013)	1965-2009	3 EU Countries	TAR, MTAR	REV→EXP: Greece REV↔EXP: Sweden, Germany
Bolat (2014)	1980-2013	10 EU Countries	Bootstrap Panel Granger Causality	REV→EXP: Germany, Italy, Netherlands EXP→REV: France, Portugal REV↮EXP: Austria, Belgium, Denmark, Finland, UK
Mutascu (2015)	1988-2014	5 EU Countries	Bootstrap Panel Granger Causality	REV→EXP: Greece, Italy EXP→REV: Portugal REV↮EXP: Ireland, Spain
Mutascu (2016)	1995-2012	10 East European Countries	Bootstrap Panel Granger Causality	REV→EXP: Czech Republic, Hungary, Slovenia EXP→REV: Bulgaria REV↔EXP: Slovak Republic REV↮EXP: Estonia, Latvia, Lithuania, Poland, Romania
Shastri, Giri and Mohapatra (2017)	1985-2014	5 South Asian Economies	Cointegration and Causality	REV→EXP: Nepal EXP→REV: Bangladesh, India, Pakistan, Sri Lanka
Akram and Rath (2019)	1980-2015	26 Indian States	Panel Causality	REV↔EXP
Gurdal, Aydin and Inal (2020)	1980-2016	G7 Countries	Panel Causality	REV→EXP: US / France, US EXP→REV: Japan / Germany REV↔EXP: Canada / Italy REV↮EXP: UK
Tashevska, Trenovski and Trpkova-Nestorovska (2020)	1999-2015	6 East European Countries	Bootstrap Panel Granger Causality	REV→EXP: Albania, Bulgaria, Croatia, Serbia, Slovenia REV↔EXP: Macedonia

Note: REV shows related government's revenue, EXP denotes government's expenditure, → signifies one-way causality, ↔ signs two-way causality and ↮ indicates no causality between REV and EXP.

Appendix B

FIGURE B.1 - LONG-TERM INTERACTION BETWEEN REV, EXP AND DEBT FOR EACH INDIVIDUAL COUNTRY