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KEY ROLE OF R&D INTENSITY ON POLITICAL AND FINANCIAL STABILITY: EVIDENCE FROM THE G-8 COUNTRIES

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Abstract

The concept of globalization has increased the importance of the expenditures on R&D, which are well known as the fundamental source for economic growth of both developing and developed countries. Even though, there have been a great number of studies subjected to the R&D-economic growth relationship, there have rarely been studied on the subject of the relationship among R&D, political stability and financial stability. In this regard, the main scope of this study is to investigate the causal relationships between R&D intensity and political stability and financial stability for G-8 countries during the period 1996-2013. Applying the Dumitrescu-Hurlin panel non-causality test, the empirical findings of this study shows that there exists a causal relationship running from R&D intensity to political stability and financial stability. Moreover, this study shows that R&D intensity has a positive and statistically significant effect on both political and financial stability of the G-8 countries.

Keywords: Research and Development Expenditures, Political Stability, Financial Stability, Panel Causality

JEL Codes: C23, G32, O32, P48

SİYASAL ve FİNANSAL İSTİKRARIN SAĞLANMASINDA AR-GE YOĞUNLUĞUNUN TEMEL ROLÜ

ÖZET

Küreselleşme kavramı, AR-GE harcamalarının önemini arttırmıştır. AR-GE hem gelişmiş hem de gelişmekte olan ülkelerin ekonomik büyümesinin temel kaynağı olarak bilinmektedir. AR-GE-ekonomik büyüme arasındaki ilişkinin araştırılması hususunda pek çok çalışma olmasına rağmen, AR-GE ile finansal istikrar ve siyasi istikrar arasındaki ilişki nadiren incelenmiştir. Bu bağlamda, bu çalışmanın temel amacı, 1996-2013 dönemleri arasında G-8 ülkelerinin AR-GE, finansal istikrar ve siyasi istikrar arasındaki nedensellik ilişkilerini Dumitrescu-Hurlin'in panel nedensellik testini kullanarak araştırmaktır. Test sonuçları tek yönlü bir nedensellik ilişkisi vermektedir ki bu da AR-GE yoğunluğundan finansal istikrar ve siyasi istikrar yönüne doğrudur. Ayrıca, Ar-Ge yoğunluğunun G-8 ülkelerinin hem siyasi hem de finansal istikrarı üzerinde pozitif ve istatistiksel olarak anlamlı bir etkiye sahip olduğu bulunmuştur.

Anahtar Kelimeler: Araştırma ve Geliştirme Harcamaları, Siyasi İstikrar , Finansal İstikrar, Panel Panel Nedensellik

Alan Tanımı: İktisat (Ekonomik Büyüme)

JEL Codes: C23, G32, O32, P48

1. Introduction

Sustained economic growth has been high in the list of priorities of both developed and developing nations because, economic growth is the most powerful instrument for increasing productivity arising from technological innovation, attributing to the accumulation of human and physical capital, reducing poverty and improving the quality of life. Hence, determinants affecting economic growth are important.

The three pioneers of the neoclassical growth model, Ramsey (1928), Solow (1956) and Swan (1956) suggest that the long-run rate of growth of aggregate capital depends on exogenous technological change and population growth rate. But, these growth models are heavily criticized because they assume the exogeneity of technological growth rate, along with the labor force growth rate (Güloğlu and Tekin, 2012).

On the other hand, the new growth theory, following the pioneering works of Romer (1986), Lucas (1988) and Grossman and Helpman (1991), emphasizes that economic growth results from the increasing returns associated with knowledge and therefore views technological progress as a product of economic activity (Cortright 2001).

Following the new growth theory which is focused on the role of technological change in the process of economic growth, along with the design and the efficiency of Research and Development (R&D) and innovation policies, there have been many theoretical and empirical works investigating the relation of technological development-economic growth. In general, the findings of these works shows that there is a significant and positive relationship between technological development and economic growth (Lichtenberg, 1992; Freire-Sereini, 1999; Bassanini and Scarpetta, 2001; Saraç, 2009; Korkmaz, 2010; Horvath, 2011; Güloğlu and Tekin, 2012; Özcan and Arı, 2014; Inekwe, 2014). However, relationship between technological advancement and both political and financial stability/risk has been rarely studied. This study attempts to fill this gap, and thus aims to analyze the causal relations among R&D intensity, political stability and financial stability in G8 countries empirically for the period 1996 and 2013. To test the causal relationships among the variables we apply the Granger non-causality test for heterogeneous panel data developed by Dumitrescu and Hurlin (2012) whose test statistic depends on the individual Wald statistics of Granger non-causality averaged across the cross-section units.

This paper is structured five sections. The second section provides a short survey of the related empirical literature. The third section presents the way the variables are defined and specifies the sources of data, before introducing the panel Granger causality testing methodology employed in the study. Next, in the fourth section, we present the findings of our Granger causality test results. The final section concludes the paper.

2. The Relationship between R&D, Political Stability and Financial Stability: Short Survey of the Literature

There have been insufficient number of empirical studies that were conducted to examine the relation of technological development, political and financial stability. For example, Waguespack et al. (2005) examined the effect of national political institutions on patent application rates for 32 Latin American nations from 1973 to 1999. According to the results, political stability significantly influences patent application rates.

Varsakelis (2006) investigated the relationship between the quality of education and of political institutions and national innovation activity for a sample of 29 countries during the period 1995-2000. As a result of analysis with panel data, the quality of education and the efficiency of governmental institutions affect innovative productivity, which is proxied by the patent applications made by residents of a country. Furthermore, the empirical results suggested that the R&D expenditure intensity is statistically significantly associated with higher levels of the knowledge production function.

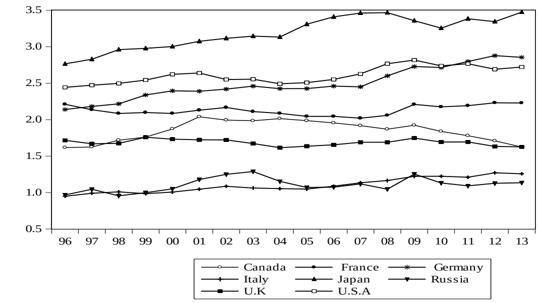
Similarly, Ductor and Grechyna (2013) concluded that technological development in both the financial and real sectors are proportionally necessary for stable and balanced economic growth.

Moreover, Masino (2015) analyzed the impact of macroeconomic instability on private innovative investment in the form of R&D in a mixed panel of 44 countries from 1994 to 2008. Using the fixed-effects estimator, the study concluded that there exists a negative relationship between private innovation incentives and real, political and monetary instability those are used as proxy variables for macroeconomic instability.

The current study is an attempt to enrich the literature by examining possible causal relations among political stability and financial stability in G8 countries during the period 1996-2013.

Figure 1 shows R&D intensity[1] of the nations included in this paper.

Figure 1. Research and Development Intensity: R&D/GDP (1996-2013)



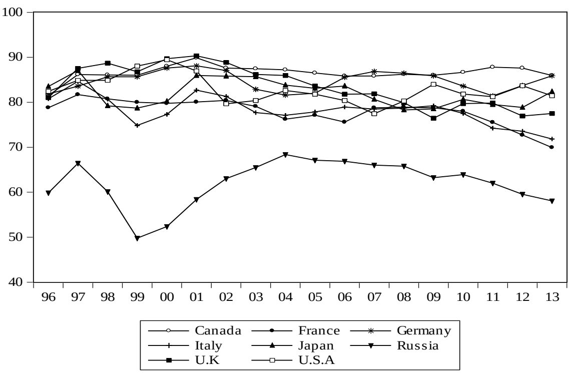
Source: World Bank, World Development Indicators, http://data.worldbank.org/indicator. [Retrieved May 21, 2015]

[1] R&D intensity is measured as the ratio of amount of R&D expenditures to GDP.

During this period, Japan has the highest R&D intensity rate (average 3%) among the G-8 countries. The USA, Germany and France follow Japan, respectively. On the other hand, both Italy and Russia have the lowest R&D intensity rate averaging around 1%.

Political stability index for each country taken from International Country Risk Guide (ICRG) is shown in figure 2. While, on average, Canada has the highest political stability score, the country has the lowest stability score is Russia. In addition, Russia's volatility of score of political stability is the highest compared to that of other countries.

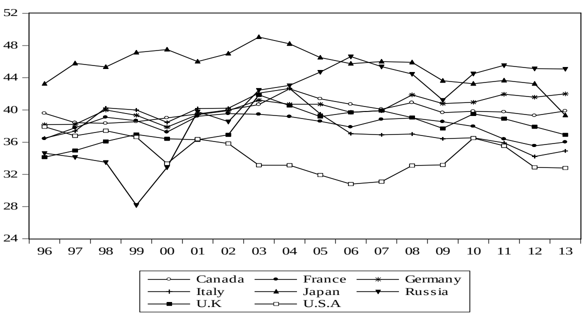
Figure 2. Political Stability Index (1996-2013)



Source: PRS Group, ICRG Methodology, The Political Risk Rating, http://www.icrgonline.com/page.aspx?page=icrgmethods, [Retrieved May 21, 2015].

Financial stability score of these countries are shown in Figure 3 below. While, Japan has the highest financial stability score, the USA has the lowest financial stability score in the average.

Figure 3. Financial Stability Index (1996-2013)



Source: PRS Group, ICRG Methodology, the Financial Risk Rating, from http://www.icrgonline.com/page.aspx?page=icrgmethods, [Retrieved May 21, 2015].

3. Methodology

Given the features of the data, which constitute a panel with N=8 countries[2] over T=18 years from 1996 to 2013, we apply panel techniques to test for causality between R&D intensity and political and financial stability. Before conducting the causality test between the variables of interest, it is necessary to perform cross-section dependency and unit root tests.

3.1. Panel Unit Root Test

Pesaran (2006) showed that ignoring cross-section dependency causes substantial bias and size distortions in estimation of the relationship between two variables. This study investigates the presence of cross-sectional dependence across G-8 countries via Breusch and Pagan (1980)'s CD_{BP} test. CD_{BP} test is useful when N is fixed and T goes to infinity. Hence according to the results of CD_{BP} test statistic, it will be decided whether there exists cross-sectional dependence across G-8 countries.

Aftermath of the determining the presence of cross-sectional dependency, it is necessary to control whether there exists unit root in the panel series in order to obtain unbiased inferences. Therefore, this study performs the panel stationarity tests Z_A^{SPC} and Z_A^{LA} proposed by Hadri and Kurozumi (2012) that take into account both the serial correlation and cross-sectional dependence and that can also be used in which both T<N and T>N.

Hadri and Kurozumi (2012) consider the following model:

$$y_{it} = z'_t \delta_i + f_t . \gamma_i + \varepsilon_{it}, \text{ for } i = 1,2,\dots,N, \text{ and } t = 1,2,\dots,T \quad (1)$$

where z'_t is deterministic, $z'_t\delta_i$ is the individual effect while f_t is a one-dimensional unobserved common factor, γ_i is the loading factor, and ε_{it} is the individual-specific error with an AR(p) process.

For the correction of cross-sectional dependence, for each *i*, Hadri and Kurozumi (2012) regress y_{it} on $w_t = \left[z'_t, \bar{y}_t, \bar{y}_{t-1}, \dots, \bar{y}_{t-p} \right]$ and construct the following test statistic:

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[2] Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, the United States.

$Z_A = \frac{\sqrt{N}(\overline{ST} - \xi)}{\zeta}$, here $\overline{ST} = 1/N.\sum_{i=1}^{N} ST_i$ with $ST_i = \frac{1}{\hat{\sigma}_i^2.T^2}\sum_{t=1}^{T} S^w{}_{it}$, here $S_{it}{}^w = \sum_{s=1}^{t}\hat{\varepsilon}_{is}$, $\hat{\sigma}_i^2$ is the estimator of the long-run variance. $\overline{ST}$ is the average of the Kwiatkowski et al. (KPSS) hence forth (1992) test statistic across *i*. Hence, the Hadri-Kurozumi test can be considered as the panel version of the KPSS test.

Hadri and Kurozumi (2012) estimate the AR(p) model augmented by the lags of $\bar{y}_t$ for each *i* by the least-squares method,

$$y_{it} = z'_t\hat{\delta}_i + \hat{\varphi}_{i1}.y_{it-1} + ... + \hat{\varphi}_{ip}.y_{it-p} + \hat{\Psi}_{i0}\bar{y}_t + ... + \hat{\Psi}_{ip}\bar{y}_{t-p} + \hat{v}_{it}\,. \tag{2}$$

Hadri and Kurozumi (2012) construct the estimator of the long-run variance by $\hat{\sigma}^2_{iSPC} = \frac{\hat{\sigma}^2_{vi}}{(1-\hat{\varphi}_i)^2}$ where $\hat{\sigma}^2_{vi} = 1/T.\sum_{t=1}^{T}\hat{v}^2_{it}$ and $\hat{\varphi}_i = \min\left\{1 - \frac{1}{\sqrt{T}}, \sum_{j=1}^{p}\hat{\varphi}_{ij}\right\}$. The test statistic of $Z_A{}^{SPC}$ is created using the formula below by Hadri and Kurozumi (2012):

$$Z_A{}^{SPC} = \frac{1}{\hat{\sigma}^2_{iSPC}.T^2}\sum_{t=1}^{T}(S_{it}{}^w)^2 \to N(0,1) \tag{3}$$

In order to obtain the other test statistic, $Z_A{}^{LA}$, Hadri and Kurozumi (2012) considered the lag-augmented method proposed by Choi (1993) and Toda and Yamamoto (1995) and they estimated the following an AR(p+1) model:

$$y_{it} = z'_t\tilde{\delta}_i + \tilde{\varphi}_{i1}.y_{it-1} + ... + \tilde{\varphi}_{ip}.y_{it-p} + \tilde{\varphi}_{ip+1}.y_{it-p-1} + \tilde{\Psi}_{i0}\bar{y}_t + ... + \tilde{\Psi}_{ip}\bar{y}_{t-p} + \tilde{v}_{it} \tag{4}$$

Aftermath of this estimation, the test statistic $Z_A{}^{LA}$ is created using the formula below by Hadri and Kurozumi (2012):

$$Z_A{}^{LA} = \frac{1}{\hat{\sigma}^2_{iLA}.T^2}\sum_{t=1}^{T}(S_{it}{}^w)^2 \to N(0,1)\,, \tag{5}$$

here $\hat{\sigma}^2_{iLA} = \frac{\hat{\sigma}^2_{vi}}{(1-\tilde{\varphi}_{i1} - ... - \tilde{\varphi}_{ip})^2}$. This test states that series do not contain unit root under a null hypothesis, while series contain unit root under an alternative hypothesis.

3.2. Panel Non-Causality Test

Finally, in this study, the panel non-causality test developed by Dumitrescu and Hurlin (2012) was also performed. This test is a simple version of the Granger

(1969) non-causality test for heterogeneous panel data models with fixed coefficients. For each individual $i = 1, 2, \dots, N$ at time $t = 1,2, \dots, T$, Dumitrescu and Hurlin (2012) consider the following linear model:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \qquad (6)$$

Where $x_i = (x_{i1,\dots,} x_{iT})'$ and $y_i = (y_{i1,\dots,} y_{iT})'$ are stationary variables in T periods and $\beta_i = (\beta^{(1)}{}_i, \dots, \beta^{(k)}{}_i)'$. It is assumed that lag orders K are identical for all cross-section units of the panel and the panel is balanced. Besides, it is allowed that autoregressive parameters $\gamma_i^{(k)}$ and the regression coefficients slopes $\beta_i^{(k)}$ are constant in time and they vary across groups. The hypotheses of the Dumitrescu and Hurlin (2012) test are formulated as follow:

$$H_0 : \beta_i = 0 \;\; \forall_i = 1, \dots, N$$

$$H_1 : \beta_i = 0 \;\; \forall_i = 1, \dots, N_1 \text{ and } \beta_i \neq 0 \;\; \forall_i = N_1 + 1, \dots, N \qquad (7)$$

Under the null hypothesis, it is assumed that there is no individual causality relationship from x to y exists. This hypothesis is denoted the Homogeneous Non Causality (HNC) hypothesis.

The alternative hypothesis is denoted the Heterogeneous Non Causality (HENC) hypothesis. Under the alternative hypothesis, it is assumed that there is a causal relationship from x to y for a subgroup of individuals and β_i may differ across groups.

In the model of Dumitrescu and Hurlin (2012), the average statistic $W_{N,T}^{HnC}$ associated with the null Homogeneous Causality (HNC) hypothesis is defined as follows:

$$W_{N,T}^{HnC} = 1/N. \sum_{i=1}^{N} W_{i,T}, \qquad (8)$$

here $W_{i,T}$ denotes the individual Wald statistics for the i^{th} cross-section unit corresponding to the individual test $H_0 : \beta_i = 0$

Authors also define $Z_i = [e : Y_i : X_i]$ as the $(T, 2K + 1)$ matrix where e represents a $(T, 1)$ unit vector. In addition, they introduce $\theta_i = (\alpha_i \gamma'_i \, \beta'_i)'$ as the vector of parameters of the model. The test for the HNC hypothesis can be expressed as $R.\theta_i = 0$ where R is a $(K, 2K+1)$ matrix with $R = [O : I_k]$ (Dumitrescu and Hurlin, 2012). For each $i = 1, \ldots, N$ the Wald statistic $W_{i,T}$ corresponding to the individual test $H_0 : \beta_i = 0$ is defined as,

$$W_{i,T} = \hat{\theta}_i' R' [\hat{\sigma}_i^2 R (Z_i' Z_i)^{-1} R']^{-1} R \hat{\theta}_i = \frac{\hat{\theta}_i' R' \left[R (Z_i' Z_i)^{-1} R'\right]^{-1} R \hat{\theta}_i}{\hat{\varepsilon}_i' \varepsilon_i / (T-2K-1)} \tag{9}$$

here, $\hat{\theta}_i$ is the parameter estimates of θ_i which is measured under the alternative hypothesis, and the residuals' estimated variance denoted as $\hat{\sigma}_i^2$. Under the null hypothesis of non-causality, each individual Wald statistic that converges to a chi-squared distribution with K degrees of freedom showed as following expression

$$W_{i,T} \underset{T \to \infty}{\overset{d}{\to}} \chi^2(K) \text{ , } \forall_i = 1, \ldots, N \tag{10}$$

$Z_{N,T}^{Hnc}$, the standardized average statistic, which has asymptotic distribution, for $T, N \to \infty$ denotes the fact that $T \to \infty$ first and then $N \to \infty$ is as follows: $Z_{N,T}^{Hnc} = \sqrt{N / 2K}.(W_{N,T}^{HnC} - K) \to N(0,1)$ (11)

$\tilde{Z}_N^{HnC}$, the standardized average statistic, which has semi-asymptotic distribution, for a fixed T dimension with $T \succ 5 + 2K$ converges in distribution:

$$\tilde{Z}_N^{HnC} = \sqrt{\frac{N}{2K}}.\sqrt{\frac{T-2K-5}{T-K-3}}.\left[\left(\frac{T-2K-3}{T-2K-1}\right).W_{N,T}^{HnC} - K\right] \underset{N \to \infty}{\overset{d}{\to}} N(0,1) \text{ with } W_{N,T}^{HnC} = 1/N.\sum_{i=1}^{N} W_{i,T}, \tag{12}$$

Thus, the asymptotic distribution for $T > N$ and the semi-asymptotic distribution for $N > T$ was used in HNC hypothesis.

4. The Data Set and Empirical Results

4.1. The Data Set

The aim of this paper to investigate whether there is possible causal relationship among R&D intensity, political stability and financial stability. The variables, their explanations and sources are illustrated in Table 1 given below.

Table 1: Data Set, Explanations and Sources

Symbols	Explanations	Sources
RD	Expenditures for research and development are current and capital expenditures (both public and private) on creative work undertaken systematically to increase knowledge, including knowledge of humanity, culture, and society, and the use of knowledge for new applications. R&D covers basic research, applied research, and experimental development.	World Development Indicators, World Bank
PR	PRS Group (2005) has provided information on 12 risk indicators that address not only political risk, but also various components of political institutions. The overall political stability index includes scores on countries' government stability (measuring the government's ability to carry out its policies and to stay in office); socio-economic conditions (measuring socio-economic pressures at work in society); the investment profile (measuring the risk of investment that are not covered by financial and economic risk components); international conflict (measuring political violence in the country); external conflict (measuring the risk to the incumbent government from foreign actions); military in politics (measuring the influence of the military in politics); religious tensions (measuring religious tensions of a single religious group); ethnic tensions (measuring the degree of tension among ethnic groups attributable to racial, nationality, or language divisions); corruption (measuring the level of corruption); democratic accountability (measuring the responsiveness of government to its people); bureaucracy quality (measuring the institutional strength and impartiality of the legal system). If the points are in the 50-60% range it is high risk, in the 60-70% range moderate risk, in the 70-80% range low risk and in the 80-100% range very low risk.	PRS Group, The International Country Risk Guide (ICRG)
FR	PRS Group (2005) has provided information on 5 financial risk indicators. the ICRG financial risk index, which is our main indicator of financial risk, captures countries' overall financial risk. The index includes scores on foreign debt as a percentage of GDP; foreign debt service as a percentage of exports of goods and services; current account as a percentage of exports of goods and services, net international liquidity and exchange rate stability. If the financial risk points are in the 0.0%-24.5% range it is very high risk; in the 25.0%-29.9% range high risk; in the 30.0%-34.9% range moderate risk; in the 35.0%-39.9% range low Risk; and in the 40.0% or more range very low risk.	

Table 2 shows some descriptive statistics for the data set

Table 2: Descriptive Statistics

	RD	PR	FR
Mean	2.019685	79.69560	39.31597
Median	2.029240	81.25000	39.31250
Maximum	3.474090	90.29167	49.04167
Minimum	0.948080	49.75000	28.16667
Std. Dev.	0.703775	7.995694	3.910964
Observation	144	144	144

Source: Authors' estimation

First of all, on average, R&D intensity among the countries we consider is around 2%, while Japan has the highest R&D intensity rate (average 3%), both Italy and Russia have the lowest R&D intensity rate averaging around 1%. Second, the mean for the political risk index is 79.70. That means the countries in this study can be listed in the range of low political risk in average, while Canada has the lowest political risk, Russia has the highest one. Finally, in case of financial risk, countries fall into low risk interval with having 39.32 financial risk point on average.

Correlation matrix of these three variables is shown in Table 3.

Table 3 Correlation Matrix

	RD	PR	FR
RD	**1.000000**	0.482299	0.223594
PR	0.482299	**1.000000**	0.032097
FR	0.223594	0.032097	**1.000000**

Source: Authors' estimation

Even though the calculated correlation coefficients do not show a strong relationships among these variables, they all have the positive sign that means there are a positive relationships between both R&D-political stability and R&D-financial stability.

Descriptive statistics are presented in Table 2 and the correlation matrix between all variables is shown in Table 3. Data are gathered on yearly basis from 1996 to 2013 of the G-8 countries. In order to carry out the paper E views 8.0 and Gauss 6.0 software programs were used.

We estimate following equations (with subscript *i* denoting a country and *t* denoting year) using annual data between 1996 and 2013 for the G-8 Countries:

$$PR_{it} = \alpha_i + \beta RD_{it} + \varepsilon_{it} \quad (13)$$

$$FR_{it} = \gamma_i + \chi RD_{it} + \nu_{it} \quad (14)$$

Here, α, β, γ and χ are the parameters are going to be estimated. Finally, both ε and ν are a normally distributed, mean zero, random error terms.

4.2. Empirical Results

4.2.1. Results of the Cross-Sectional Dependence Test

An important issue is to control whether there is a possible cross-sectional dependence across the G-8 countries. The panel data literature draws the conclusion that panel data sets are likely to exhibit substantial cross-sectional dependence, which may occur due to the presence of common shocks and unobserved components.

The empirical results of CD_{BP} test are illustrated in Table 4.

Table 4 Results for Cross-Sectional Dependence Test

Variable	$CD_{BP\ (constant)}$	$CD_{BP\ (constant\ and\ trend)}$
RD	41,144 (0.052)*	39,691 (0,070)*
PR	40,525 (0.059)*	62,154 (0,000)***
FR	41,757 (0.046)**	43,531 (0,031)**

***, **,* indicate rejection of the null hypothesis at the 1%, 5%, 10% significance level respectively.

Source: Authors' estimations.

According to Table 4, the null of no cross-sectional dependence across the G8 countries is rejected for all variables. Thus, the second generation tests should be applied that consider cross-sectional dependence in search of whether variables have a unit root or not.

4.2.2. Results of the Panel Unit Root Test

In order to get unbiased estimations, we investigated the existence of unit root in the series via the Hadri and Kurozumi (2012) panel stationarity test. Results are shown in Table 5.

Table 5 Results for the Hadri-Kurozumi (2012) Stationary Test

Variable	*Statistic*	*p-value*
RD		
Z_A^{SPC}	-1,8037	0,9644
Z_A^{LA}	-2,5130	0,9940
PR		
Z_A^{SPC}	-1,8766	0,9697
Z_A^{LA}	-1,8908	0,9707
FR		
Z_A^{SPC}	-0,3733	0,6455
Z_A^{LA}	-1,0664	0,8569

Source: Authors' estimations.

According to Table 5, the null hypothesis of stationarity cannot be rejected for all variables. Therefore, we can conclude that the variables of RD, PR and FR are stationary variables at their levels when taking into consideration of the cross sectional dependency.

4.2.3. Results of the Panel Non-Causality Test

In this study, to investigate the presence of possible causal relationships between RD, PR and FR, the Granger non-causality test developed by Dumitrescu and Hurlin (2012) is applied. The Dumitrescu and Hurlin (2012) panel non-causality test results are illustrated in Table 6 and Table 7.

Table 6 The Results for Dumitrescu and Hurlin (DH) Panel Granger Non-Causality Test (PR-RD)

Null Hypothesis	Test Statistic	p-value
PR does not Granger Cause RD		
Whnc	0,753327	0.300385
Zhnc(Asymptotic)	-0.493347	0.353231
Ztild(Semi-Asymptotic)	-0.621468	0.328884
RD does not Granger Cause PR		
Whnc	2.332107**	0.026297
Zhnc(Asymptotic)	2.664214**	0.011471
Ztild(Semi-Asymptotic)	1.752272*	0.085935

**,* indicate rejection of the null hypothesis at the 5% and 10% significance level respectively

Source: Authors' estimations.

According to the results from Table 6, one can conclude that R&D intensity does Granger-Cause political stability at 5% significance level, but not vice versa. Thus, we can say that a unidirectional causal relationship exists between RD and PR for the G-8 countries.

Furthermore, Table 7 below gives the results for possible causal relationship between FR and RD.

Table 7 The Results for Dumitrescu and Hurlin (DH) Panel Granger Non-Causality Test (FR-RD)

Null Hypothesis	Test Statistic	-value
FR does not Granger Cause RD		
Whnc	1.179775	0.198916
Zhnc(Asymptotic)	0.359551	0.373971
Ztild(Semi-Asymptotic)	0.019709	0.398865
RD does not Granger Cause FR		
Whnc	3.379044***	0.001323
Zhnc(Asymptotic)	4.758088***	4.84E-06
Ztild(Semi-Asymptotic)	3.326371***	0.001578

*** indicates rejection of the null hypothesis at the 10% level of significance.

Source: Authors' estimations.

It is seen from the table that findings are similar to the PR-RD relationship. While FR does not Granger-Cause RD, RD does Granger-Cause FR. In another worlds, the empirical findings suggest that a unidirectional causality relationship running from RD to FR for the G-8 countries at 1% significance level, but not vice versa.

Based on these causal relationships, we also estimate the relationship between RD, PR and FR using panel least squares estimator. Before estimating the regression coefficients in (13) and (14), it is aimed to diminish the degree of cross-sectional dependence of PR, RD and FR. To perform this objective, we used the time-demeaned PR, FR and RD series, which have the following transformations.

To understand these transformations, following model is taken into consideration with a single explanatory variable: for each i,

$$y_{it} = \beta_1 x_{it} + u_{it}, \text{ for } t = 1, 2, \dots, T \tag{15}$$

Now, for each i, averaging this equation over time. We get the following equation:

$$\bar{y}_{it} = \beta_1 \bar{x}_{it} + \bar{u}_{it}, \text{ for } t = 1, 2, \dots, T \tag{16}$$

where $\bar{y}_{it} = T^{-1}\sum_{t=1}^{T} y_{it}$, $\bar{x}_{it} = T^{-1}\sum_{t=1}^{T} x_{it}$, and, and $\bar{u}_{it} = T^{-1}\sum_{t=1}^{T} u_{it}$.

We substract (16) from (15) for each t, and then we wind up with the following equation:

$$\ddot{y}_{it} = \beta_1 \ddot{x}_{it} + \ddot{u}_{it}, \text{ for } t = 1, 2, \dots, T \qquad (17)$$

Here $\ddot{y}_{it} = y_{it} - \bar{y}_{it}$ is the time-demeaned data on y, and similarly for $\ddot{x}_{it}$ and $\ddot{u}_{it}$.

Finally, the equation (17) was estimated by the OLS estimator. The results of panel estimation are summarized in Table 8 and Table 9.

According to Table 8 given below, research and development expenditures as % of GDP have statistically significant and positive effect on political stability at the 1% significance level for the G-8 countries. As the differences in R&D intensity increases 1%, differences in political risk index increases nearly 7%. That means political risk is reduced by higher R&D investment.

Table 8 Results for Panel Least Squares Method (PR-RD)

Dependent Variable: D(PR)				
Method: Panel EGLS (Cross-section weights)				
White cross-section standard errors & covariance (d.f. corrected)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(RD)	7.131316***	2.913709	2.447505	0.0016
C	-0.356844	0.330276	-1.080440	0.2823

D is first difference operator. *** indicates significance at the 1% level.

Source: Authors' estimation

Similarly, results shown in Table 9 also indicates that R&D is important determinant of financial risk of the countries we considered in this study.

Table 9 Results for Panel Least Squares Method (FR-RD)

Dependent Variable: D(FR)				
Method: Panel EGLS (Cross-section weights)				
White cross-section standard errors & covariance (d.f. corrected)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(RD)	5.584277**	2.262565	2.468118	0.0149
C	-0.063501	0.149925	-0.423553	0.6726

D is first difference operator. ** indicates significance at the 5% level.

Source: Authors' estimation

Estimated parameter is statistically significant at the 5% significance level and indicates that differences in financial stability index goes up by 5.5%, as a result of increased differences in R&D intensity by 1%. So again, we can say that greater research and development expenditures statistically significantly improve financial stability.

5. Conclusion

Research and Development (R&D) is the term widely used to characterize the activities undertaken by firms and other entities such as individual entrepreneurs in order to create new or improved products and processes (Hall 2008). The empirical literature has repeatedly confirmed that R&D investment has a positive and significant impact on total factor productivity. Especially, economic growth models emphasize that the technological development that is proxied by R&D investments is the main driver of economic growth in the long run. Within this economic growth models, many empirical works demonstrated that R&D activities have played a key role in economic growth and development.

As well as the relation of R&D-economic performance, the relationships among political instability, financial instability and economic performance have been subjected to many empirical studies. Both political instability and financial instability are regarded by economists as serious malaises harmful to economic performance due to that they lead to a more frequent switch of policies, creating volatility. Particularly, political instability disrupts market activities and labor relations, which has a direct adverse effect on productivity. In addition, the uncertainty associated with an unstable political environment may reduce investment and the speed of economic development.

Similarly, the other macroeconomic instability, financial instability has caused a loss of economic value or confidence in, and attendant increases in uncertainly about, a substantial portion of the financial system. Specially, volatility that is intrinsic to financial instability can be disruptive and costly. A sudden decline in asset evaluations can diminish the value of collateral on which access to external finance depends. In the event that credit and leverage are widely utilized, the result may be a domino effect of bank failures and can a create threat among nonbank financial intermediaries as well. So, an occurred financial instability will cause to cancel investment projects, leading to a sharp drop in output (Eichengreen 2004).

From the point of the importance of political risk and financial risk in countries' economic performance, this paper examined possible causal relationships among political stability, financial stability and R&D intensity using the most recent panel data of the G-8 countries. According to empirical results of this study, R&D intensity does Granger-cause both of political stability and financial stability. But, the results showed that a reverse causality relation does not exist between R&D intensity, political stability and financial stability, that is, political and financial stability do not Granger-cause R&D intensity.

Furthermore, this study investigated the effect of R&D intensity on both political stability and financial stability by using Panel Least Squares Method. According to the estimated coefficients estimates R&D intensity is positively associated with both political and financial stability, indicated by estimated coefficients that are statistically significant. This study examining the developed countries' performance has concluded that leader countries in R&D activities have higher political and financial stability than other countries selected.

Therefore, it should be stressed that developing countries, in order to achieve political stability and financial stability, should increase their R&D activities that are associated with the technological development.

References

Akcali, Burcay Y. & Elcin Sismanoğlu. *"Innovation and the Effect of Research and Development (R&D) Expenditure on Growth in Some Developing and Developed Countries"*, Procedia-Social and Behavioral Sciences. 195, 2015, 768-775.

Bassanini, Andrea & Scarpetta, Stefano. *"The Driving Forces of Economic Growth: Panel Data Evidence for The OECD Countries"*, OECD Economic Studies. 2001, No. 33.

Breusch, Trevor S. & Pagan, Andrea R. *The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics*, Review of Economic Studies. 47:1, 1980, 239-253.

Cortright, Joseph. New Growth Theory, Technology and Learning: A Practitioner's Guide (No. 4). Washington, DC: US Economic Development Administration, 2001.

Ductor, Lorenzo & Grechyna, Daryna (2013). *Financial Development, Technological Progress and Economic Growth*, SSRN:http://ssrn.com/abstract=1997526 or http://dx.doi.org/10.2139/ssrn.1997526 [İndirme Tarihi: 7.01.2016]

Dumitrescu, Elena-Ivona & Christophe Hurlin. *"Testing for Granger non-causality in heterogeneous panels"*. Economic Modelling, 29:4, July 2012 1450-1460.

Eichengreen, Barry. *"Financial Instability"*, in: Byorn Lomborg, (Ed), Global Crises, Global Solutions. New York: Cambridge University Press, 2004, pp. 251-280.

Freire-Serén M. J. (1999). *"Aggregate R&D expenditure and endogenous economic growth"*, *UFAE and IAE Working Papers*. No. WP 43699. Barcelona, Spain: Unitat de Fonaments de l'Anàlisi Econòmica (UAB) and Institut d'Anàlisi Econòmica (CSIC), 1999.

Grosman, Gene M. & Elhanan Helpman. Innovation and Growth in the Global Economy. Cambridge: MIT Press, 1991.

Guloğlu, Bulent. & R. Barıs Tekin. *"A Panel Causality Analysis of the Relationship Among Research And Development, Innovation, and Economic*

Growth in High-Income OECD Countries", Eurasian Economic Review, 2:1, June 2012, 32-47.

Hadri, Kaddour & Eiji Kurozumi. *"A Simple Panel Stationarity Test in the Presence of Serial Correlation and a Common Factor"*, Economics Letters. 115:1, April 2012, 31–34.

Hall, Bronwyn H. *"Research and Development"*, in: William A. Darity, (Ed), International Encyclopedia of the Social Sciences, 2nd edition. Detroit: Macmillan Reference USA, 2008, pp. 199-201.

Horvath, Roman. *"Research & Development and Growth: A Bayesian Model Averaging Analysis"*, Economic Modelling. 28:6, November 2011, 2669–2673.

Inekwe, John N. *"The Contribution of R&D Expenditure to Economic Growth in Developing Economies"*, Social Indicators Research: An International and Interdisciplinary Journal for Quality-of-Life Measurement. 124:3, December 2015, 747-764.

Korkmaz, Suna. *"Türkiye'de Ar-Ge Yatırımları ve Ekonomik Büyüme Arasındaki İlişkinin VAR Modeli İle Analizi"*, Journal of Yaşar University. 20:5, 3320-3330.

Kwiatkowski, Denis & Peter C.B. Phillips & Peter Schmidt & Yongcheoi Shin. *"Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root: How Sure Are We that Economic Time Series Have a Unit Root?"*, Journal of Econometrics. 54:1-3, October-December 1992, 159-178.

Lichtenberg, Frank R. *"R&D investment and international productivity differences"*, NBER Working Paper Series. No: 4161, September 1992.

Lucas, Robert E. Jr. *"On the mechanics of development planning"*, Journal of Monetary Economics. 22:1, July 1988, 3-42

Masino, Serena. "Macroeconomic Volatility, Institutional Instability and the Incentive to Innovate", Review of Development Economics. 19:1, February 2015, 116-131.

Özcan, Burcu & Ayşe Arı. *"The Relationship Between R&D Expenditures and Economic Growth: Panel Data Analysis"*, Maliye Dergisi. 166, Ocak-Haziran 2014, 39-55.

Pesaran, M. Hashem. *"Estimation and Inference in Large Heterogeneous Panels with Multifactor Error Structure"*, Econometrica. 74:4, July 2006, 967-1012.

PRS Group (2015). *ICRG Methodology, The Financial Risk Rating*, http://www.icrgonline.com/page.aspx?page=icrgmethods, [İndirme Tarihi: 21.05.2015]

PRS Group (2015). *ICRG Methodology, The Political Risk Rating*, http://www.icrgonline.com/page.aspx?page=icrgmethods, [İndirme Tarihi: 21.05.2015]

Ramsey, Frank. *"A Mathematical Theory of Saving"*, Economic Journal. 38, December 1928, 543-559.

Romer, Paul M. *"Increasing Returns and Long-Run Growth"*, Journal of Political Economy. 94:5, October 1986, 1002-1037.

Saraç, B. T. *"Araştırma-Geliştirme Harcamalarının Ekonomik Büyüme Üzerindeki Etkisi: Panel Veri Analizi"*. EconAnadolu 2009: Anadolu International Conference in Economics, June 17-19, 2009, Eskişehir, Turkey.

Solow, Robert M. *"A Contribution to Theory of Economic Growth"*, American Economic Review. 57:2, May 1956, 65-94.

Swan, Trevor W. *"Economic Growth and Capital Accumulation"*, Economic Record. 32, November 1956, 334-361.

Varsakelis, Nikos C. *"Education, Political Institutions and Innovative Activity: A Cross-Country Empirical Investigation"*, Research Policy. 35:7, September 2006, 1083–1090.

Waguespack, David Matthew & Jóhanna Kristín Birnir & Jeff Schroeder. *"Technological Development and Political stability: Patenting in Latin America and the Caribbean"*, Research Policy. 34:10, December 2005, 1570–1590.

World Bank (2015). *World Development Indicators*, http://data.worldbank.org/indicator, [İndirme Tarihi: 21.05.2015]