

On the effects of total productivity growth of economic freedom and total resource rents: The case of both natural resource rich and OECD countries

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Abstract. *The focus of the paper is to analyse the relation between institutions on cross-country economic development in Natural Resource Rich countries and OECD countries. The paper emphasizes the effects of economic freedom that interacts with total resource rents on total factor productivity, covering 30 Natural Resource Rich, 34 OECD countries in dynamic panel data for the period of 2000-2013. Findings suggest that as economic freedom increases along with resource rents, total factor productivity increases for natural resource rich countries. The results are mixed for OECD countries.*

Keywords: natural resources, economic freedom, total productivity growth, generalized method of moments (GMM), instrumental variables (IV) estimation.

JEL Classification: P28, D02, D24, C23, C26.

1. Introduction

Economic growth is a popular concept in economic development literature. Economic growth theories are divided into two main groups, exogenous and endogenous. Exogenous model specifies a neo-classical production factor influencing the level of output such as physical capital, labor, and an exogenous technology. According to the endogenous growth theory; physical capital growth is not enough to find out per capita output growth and human capital by itself, therefore, international trade and technology are added to the model. Endogenous growth theory also suggest that, unlike the neoclassical growth theory, technological development has occurred in the economic system and also affected by economic decisions. Recent studies indicate that technological development has emerged as a reaction to economic signals such as price and profit in the economy.

In today's world of intense competition, efficiencies created by the impact of technological development constitute the basis for sustainable growth. As a key variable to measure production systems performance, productivity effects investigate the feasibility of producing more at lower cost. In other words, the productivity effect is expressing relationship between the inputs used in production and outputs.

Productivity is divided mainly into two parts; Partial Productivity and Total Factor Productivity (TFP). Partial productivity is calculated as a ratio of gross or net output to single factor input. Also, the total factor productivity is the ratio of total outputs to the inputs used in the production process. Higher total factor productivity means producing more and higher income with the same amount of capital.

Information technology, research and design (R&D) and investment in innovation, which particularly affect competitive advantages, are very important in terms of Total Factor Productivity. This condition is regarded as an increase in productivity to achieve more output with existing factors of production, and therefore seize the benefits of economies of scale. Productivity growth effect can not be explained by the amount of production inputs but can be explained as increase in the level of knowledge in technology and economies of scale.

Industrial Revolution has led to a great increase in production volume by means of mechanization. In this period, concept of competition and efficiency gained importance and businesses have turned to work more efficiently, which led to increased production. Developments in this area attract researchers to investigate the sources of productivity growth. Oyeranti (1994) and Bosworth and Collins (2003) observe that information and rapid developments in communications technology, research and design activities, development in human capital, foreign direct investment (FDI) and the free trade are the key factors in productivity increase. For example, in Romer (1986, 1990 and 1994) studies, he claimed that technological development in the research and design is the main force of growth. Technology can be transferred to the developing countries by the trade of goods. "Developed countries uses natural resources and human capital to invent new technology, while developing countries invest in human capital and their political and economic institutions to promote the diffusion and absorption of foreign technology" (Limam and Stephen, 2004).

Level of innovation together with acquiring and absorption of technology determine differences in growth rate of the countries. Romer also believes that liberalization of foreign trade and creating economic integration with rich countries in terms of human capital will affect economic growth positively.

Productivity is a simple ratio. However, productivity measurement is a great deal of conflict among the literature. Antle and Capalbo (1988) observe two main approaches to measure total factor productivity: The Growth Accounting Approach (index number) and The Econometric Approach.

Laspeyres exact index, geometric exact index, and Tornqvist-Theil index that approximates the Divisia Index (Oyeranti, 1994) are examples of above mentioned indexes. In this study Tornqvist-Theil index is going to be used.

Mentioned in the literature, there is also a problem in measuring institutions quality quantitatively. Table 1 shows five main sources measuring the effectiveness of the institution in economic era.

Table1. *Economic freedom data sources*

Data	Time Span Frequency	Aspects Covered	No. Of Economies Studied
Fraser Institute – Economic Freedom Index	Start from 1970- Annual since 2000	(1) Size of government; (2) Legal structure and security of property rights; (3) Access to sound money; (4) Freedom to trade internationally and (5) Regulation of credit, labour and business.	157
Heritage Foundation – Index of Economic Freedom	Start from 1994- Annual	(1) Trade policy (2) Fiscal burden of government (3) Government intervention in the economy (4) Monetary policy (5) Capital flows and foreign investment (6) Banking and financ (7) Wages and prices (8) Property rights (9) Regulation (10) Informal market activity	186
ICRG – International Country Risk	Monthly Since 1980	(1) Economic risk (2) Political risk (3) Financial Risk (1) Voice and accountability (2) Political stability and absence of violence	140
World Bank (WB) Governance Indicators	Start from 1996- Annual since 2002	(3) Government effectiveness (4) Regulatory quality (5) Rule of law (6) Control of corruption	215
WB Ease of Doing Business Report	Start from 2004- Annual	(1) Starting a business (2) Dealing with construction permits (3) Employing workers (4) Registering property (5) Getting credit (6) Protecting investors (7) Paying taxes (8) Trading across border (9) Enforcing contracts (10) Closing a business	189

Source: Lam, Kwok Ying., 2010. Institutions and Economic Development. *Phd Thesis*. pp.15 (Updated by authors)

We use Fraser Institute's economic freedom index (EFI) consisting of five subindices: government size, access to sound money, legal system and property rights, freedom to international trade and regulation of business, labor and credit markets (Appendix C).

Acemoglu (2009) states that traditional growth regressions face the problem of endogeneity, measurement errors and omitted variables. Panel data solves omitted variables problem by considering country-specific and time-specific effects.

Generalized Method of Moments (GMM) estimation method helps overcome the problems of endogeneity problem. Serial correlations based on the GMM residuals are tested by Aurellona-Bond and over-identifying restrictions are tested by Sargan tests.

Main differences of this study, from other studies, are: first, most growth studies only deal with variables and effect of these variables on the total productivity growth. While this study focuses not only on variables, but their interaction effect on total productivity growth are also studied: second, using new econometric methods and different dimensions of economic freedom in not only Natural Resource Rich but also OECD countries are studied.

2. Review of literature

The investigation of relation between natural resource abundance and economic development is always key concept in economic literature. Among 1950-1980 many economist argue on the positive effect of resource abundance on economic growth in natural resource rich countries. But, world encountered big oil shock and this led to retardation on growth in oil exporting countries in the 70's.

In the 80's, The Dutch Disease concept was noticed. Labor and capital moved from non-resource sectors, especially manufacturing sector to the oil sector, and at the same time vast amount of foreign currency entrance in economy led to appreciation of the domestic currency in mainly Iran, Russia, Trinidad and Tobago and Venezuela. Totally, they cause the decline in growth in manufacturing sector. And late 80's, recourse curse theory is stated by Sach and Warners, and Richard Auty. Generally, theory says that natural resource abundance increase the probability of negative economic growth in natural resource rich countries.

In the 90's, the quality and efficiency of institutions in resource rich countries had changed government behaviour. Researches in this period show that weak institutions negatively affect growth and development and vice versa.

Resource revenue-growth theories can be divided mainly two parts. One part investigate resource curse hypothesis, the other part investigates Institutionalism (Kaznacheev, 2013).

2.1. Natural resource revenue and total productivity growth

Resource Curse Hypothesis states that Natural resources are a hindrance to an economic growth in Natural Resource Rich countries. Sachs and Warner's study (1995) is the first

significant and systematic one regarding economic problems concerning natural resources. They observe that economies with a high ratio of natural resource exports to GDP have slower growth from 1970 to 1990 than the world average. Sala-i- Martin (1997) confirmed the Sachs and Warner's results. Sala-i-Martin observe significant 22 variables on economic growth such as natural resources having negative effect. There is concurrence about the existence of a "resource curse" among studies in the 90's. Richard Auty (1993) studies natural assets, which lead the economy to a point where the benefits become curse. Auty (2000) also studied 70 developing countries and found that in resource rich countries corporate institutional weakness was spotted and due to limited diversification in manufactured goods led to constrained economic growth in these countries.

Researchers claimed "volatility curse" hypothesis in 2000's. The main topic in these studies was not only the resource dependence problem, but also the volatility of commodity prices in the global market. Atkinson and Hamilton (2003) observe significant and negative relationship between natural resources and economic growth for 91 countries in his model.

Arezki and Ploeg (2007) observe significant negative effects of natural resources on income per capita and indirect effect of natural resources on institutions. Also, they conclude that the natural resource curse severely influences economic performance of countries which have low degree of trade openness.

After 2007, some papers questioning the existence of resource curse. For example, Lederman and Maloney (2008) show that the negative impact of resources disappeared on growth putting fixed effects on their model. Brunnschweiler and Bulte (2008) declare a new concept as recourse dependence and observes that resource abundance has positive effects on growth and institutional quality unlike resource dependence. Butkiewicz and Yanikkaya (2010) argue that the panel data set comprised of developed and developing countries show that in emerging countries curse hypothesis is confirmed but similar results in developed countries can not be seen. Weishu Leonga and Kamiar Mohaddesaby (2011) find that volatility of resource rents negatively affect economic growth as resource rents increase real output per capita. They also show that higher institutional quality may eliminate some of the negative volatility effects of resource rents. Davis (2011) concludes that natural resources cause slower growth rates in mineral resources dependent countries and result in crowding-out effect. Cavalcanti, Mohaddes and Raissi (2015) show a direct positive relationship between resource abundance and growth. Also, they observe negative relationship between resource volatility and growth by using annual data for 1970-2007 and five-year non-overlapping observations.

2.2. Institutions and total productivity growth

A number of authors look for another channel about natural resource's impact on development, unlike macroeconomic explanation such as the "Dutch disease" and price volatility. They developed an alternative approach on institutional insufficiency, which is the key factor in growth decline in resource-abundant economies.

The institutionalist approach, dating back to Hayek (1945 and 1960), is based on the idea that resources and resource efficiency are determined by the institutional structure and policies implemented by these institutions. Even though there is debate over the actual character of the institutional structure, this structure can be stated in liberal perspective, as working of market economy, protection of property rights, removing obstacles to competition, minimal government intervention guaranteed economic freedoms. Therefore, this idea of seeing economic freedoms as the key to growth enters into the field of institutional approach.

Gwartney et al. (2004) states that the institutionalist approach emphasizes policy towards improving legal, economic and political institutions. Also, eligible institutional structure will encourage market actors investing in physical and human capital and will enable innovation to improve the production method. Chong and Calderon (2000) analyze causality between institutional measures and growth and show the existence of reverse causality. They observe that the poorer the country and the longer the wait, the higher the influence of institutional quality on economic growth. Also economic growth leads to institutional quality. Glaeser et al. (2004) claim that human capital is only the basic source of growth rather than institutional quality. Acemoglu, Johnson and Robinson (2005) state that good legal structure and secure property rights are important and necessary conditions for a successful economy. They lead to decrease irregularity in the allocation of resources, motivate savings, investment in human and physical capital and trade. Moreover, they provide motivation for individuals in entrepreneurial activities and foreign technologies. Halvor Mehlum, Karl Moene and Ragnar Torvik (2006) state that natural resource abundant countries form not only growth losers, but also growth winners and the quality of institutions create the difference.

2.3. Economic freedom and productivity growth

Economic freedoms in general terms can be described as a mechanism; which stimulates the dynamics of economic growth and development, leading the economy to come to the natural balance without any external intervention and letting the individuals in the society to take and implement economic decisions freely. An institutional structure guarantees economic freedoms; in other words, a liberal market economy creates an environment that is both augmenting growth and accelerating development.

Besides the idea of presenting economic freedoms to individuals as a right, some characteristics for a country to be economically free are the size of the public sector, the use of economic structures and markets, monetary policy and price stability, freedom to use alternative currencies, the existence of legal order and private property security, freedom in foreign trade, freedom of exchange in capital markets and freedom of enterprise.

Henry (2003), states that, the positive effects of economic freedoms on the physical capital occurs through capital accumulation by means of saving and investing this capital accumulation increases the amount of output per worker. As a result, economy reaches the final stage with sustainable rapid economic growth. Barro (2001), states that, at a given output level; a high human capital stock, equipped with factors such as education,

health, capital and knowledge, stimulates the rapid economic growth process with the help of two channels. In the first channel, higher human capital accumulation has an ability to absorb more qualified technological developments and this channel is related to the rate of schooling. The second channel is that an advanced human capital has the ability use the physical capital stock optimally in the country.

Economic freedoms, which are emphasized to be an important factor in ensuring macroeconomic stability also bring about a stable economy, such as the low and predictable inflation rates, the creation of interest rates to meet the needs of the country, the realization of exchange rates at competitive levels and the balance of payments. In parallel with this economic structuring, saving volume increases, long-term capital accumulation increases, and national prosperity is preserved, future investments increase, capital accumulation increases and efficiency in resource allocation is ensured. Depending on the combination of the stated factors, the growth process is accelerating and gaining a sustainable momentum.

“Economic Freedom” is not quantitative. It is a qualitative subjectivity and imprecision in measuring the notion. Among many indices, the most widely used one is the Economic Freedom of the World (EFW Index) published by the Fraser Institute Canada. Main sub-indices of Economic Freedom are:

- Rule of law and property rights (LEG).
- Size of government and taxation (GVZ).
- Soundness of money (SMN).
- Trade regulation and tariffs (FRT).
- Regulation of business, labour and capital markets (REG).

The assurance of the legally acquired property of individuals is one of the essential elements of both civil society and economic freedoms. Countries with secured property rights are subject to high valuation the measure of economic freedom.

There are many empirical studies finding positive and important relationships between economic freedom and the protection of property rights and the legal structure, such as Heckelman (2000), Halvor Mehlum, Karl Moene and Ragnar Torvik (2006), Barro (1991), Torstensson (1994), Knack and Keefer (1995).

Heckelman (2000) observes positive relationship between economic freedom and property rights. Halvor Mehlum, Karl Moene and Ragnar Torvik (2006) analyze relationship and find that entrepreneurs look for unproductive rent-seeking and grabber-friendly activities due to weak protection of property rights in resource rich economies.

The size of government is main the concept of classical liberal scholars. The government intervenes in the economy through government consumption, public investments and marginal taxation. That is a good measure of economic freedom (Bjørnskov and Foss, 2006, p. 12).

The fact that an economy is economically free does not mean that there is no government intervention in that economy. In a liberal society, there is absolutely a minimal state

intervention that protects individual freedoms. In terms of economic freedoms the size of the government is important.

Strong money access function means that all people reach the strong (stable) currency. Unexpected price changes and monetary instability can lead to welfare decline and deterioration. Economic freedom is necessary in a stable monetary order. There is positive relationship (Ayal and Karras, 1998) and negative relationship (Gwartney et al., 1998) between economic growth and first three criteria (rule of law and property rights, size of government and taxation, soundness of money) in the EFW index targeting to measure price stability. However, no strong correlation was observed by Levine and Renelt (1992) and Sala-i-Martin (1997).

Gwartney and Lawson (2004) state that by unsound monetary policies create uncertain markets distorting relative prices in which it is difficult to plan wisely and be eager to innovate for entrepreneurs. That leads to lower productivity and lower economic growth.

For a country's economy to be economically free, it is expected that it will not only be free in national trade but also free in international trade. Reducing trade barriers and liberalizing trade, leads countries to mutually earn and effectively distribute their own resources more efficiently. Moreover, as free trade will interact with foreign investors, it will increase the international competitiveness of firms by creating widespread foreign technologies and increasing the productivity of local companies.

Cagetti and DeNardi (2006) state that the fewer restrictions on capital movements across borders lead the easier the access to international capital markets that increases the supply of venture capital, which may lead huge increase in innovation.

It is possible to say that, the less the regulations on the credit market, the labor market and the enterprises, the higher the economic freedom in country. The competitive nature of the credit market will result in effective borrowing by reducing the cost of information and money transfer between borrowers and lenders.

Iimi (2006) observe that rent-seeking behavior and corruption can be reduced by efficient business, labor and credit regulations mitigating the effects of the resource curse.

“Secure property rights, a high quality of regulations and the judicial system, sound money, openness to international trade and investment have positive effect on TFP. Also a high level of regulation and high taxes may or may not be noxious to TFP” (Bjørnskov and Foss, 2010).

3. Empirical framework

The dynamic panel regression model:

$$Tfp_{i,t} = \beta_0 + \beta_1(Efi_{i,t-1}) + \beta_2Totr_{i,t-1} + \beta_3Efi_{i,t-1} * Totr_{i,t-1} + \beta_4Tfp_{i,t-1} + \pi_i + \rho_i + \varepsilon_{i,t} \quad (1)$$

In Equation (1) The subscript ‘*i*’ shows a country, subscript ‘*t*’ shows time, *Efi_{i,t}* shows economic freedom (EFI), *Tfp_{i,t}* indicates total factor productivity (TFP) growth

(Appendix B), $Totr_{i,t}$ indicates ratio of the natural resource rents to GDP, π_i is country-specific fixed effects, ρ_i is a time dummy and $\varepsilon_{i,t}$ is the random error term.

In equation we use the one year lagged value of TFP, EFI and TOTR to estimate current TFP growth, because the effects of resource rents and economic freedom on productivity growth doesn't occur at the same period or vice versa.

The regression model in Eqn. (1) is estimated using data over the period 2000-2013 for a panel of 30 sample natural resource rich countries based on the country classification by United Nations and using data over the period 2000–2013 for a panel of 34 sample OECD countries based on the country classification by OECD Websites. The countries used in the analyses are listed in Appendix A.

4. Methodology and data

4.1. Methodology

The data will be analyzed by using dynamic panel regression model putting on Stata.

$$Y_{i,t} = \alpha Y_{i,t-1} + \beta X_{i,t} + \pi_i + \varepsilon_{i,t} \quad (2)$$

In this model, $X_{i,t}$ are correlated with the unobserved individual fixed country effect (π_i) but uncorrelated with the past, present and future of error terms ($\varepsilon_{i,t}$) i.e. exogenous, $Y_{i,t-1}$ are correlated both country effect and past values of error terms i.e. endogenous (Arellano, 2003, p. 129).

To get an econometric model first cross-sectional dependence is analysed in panel data. Mainly used methods are; Pesaran (2004) CD_{LM} (if $T < N$), Breusch-Pagan (1980) CD_{LM1} test (If $T > N$), Pesaran (2004), CD_{LM2} (If $T = N$ almost) and Pesaran, Ullah ve Yamagata (2008) CD_{LMADJ} . Cross-Sectional dependency is tested by using Pesaran (2004) CD_{LM} method.

It tests whether a shock (increase in labor, growth, investment, research and development) subjected to a country in panel data influences other countries' or not. We find cross-sectional dependence in both the series and in the equation. In this case, the shock subject to one of the countries also affects the other countries. With this in mind, it can be said that countries must be aware of interacted countries by determining their policies. As the cross-sectional dependency was determined between countries, we use methods considering cross-sectional dependency while testing unit root.

If there is cross-sectional dependence than second generation unit root test must be applied. Mainly used second generation unit root tests in literature are; the multivariate augmented Dickey-Fuller (MADF), SURADF (Seemingly Unrelated Regression Augmented Dickey-Fuller), Bai ve Ng (2004), Cross-Sectionally Augmented Dickey-Fuller-CADF (Pesaran, 2006) and PANKPSS (Carrion-i-Silvestre, 2005).

Since cross-section dependency was identified among the countries in this study, the stationary of the series was tested with CADF second-generation unit root tests.

Stationary of the series are achieved by taking difference of the some explanatory variables.

To get rid of endogeneity in dynamic panel model, Anderson and Hsiao (1981, p. 604) proposed to use variables with different lag levels as an instrument variables. In his model, he chooses new instrument variables (Z), which are uncorrelated with the error terms ($Cov(Z, \varepsilon) = 0$) (i.e. exogenous) but correlated with the regressors.

Arellano and Bond include all possible instrument variables in the Generalized Moments Method (GMM). The deficiency of this difference equation is, it does not include country specific effects. Arellano and Bover (1995) first developed system GMM estimation method, which considers the difference and level equations together and considered to be more effective (Roodman, 2006, p. 1).

The Sargan/Hansen tests the validity of the instrument variables. Null hypothesis is that all instruments are exogenous. Elitza Mileva (2007) states that the higher the p-value, the better Sargan statistic.

Arellano and Bond (1991) developed an autocorrelation tests. The null hypothesis is that there isn't second order autocorrelation for the residuals of the first difference model. In the first difference model, autocorrelation at first degree – AR(1) – is not important, and even expected because regression uses the lag value of the dependent variable. However, in order to achieve effective results, autocorrelation should not occur at the second level – AR(2).

4.2. Data

Total Productivity Growth (TFP) data are taken from TED Total Economy Database. It is the extensive database with annual data covering GDP, population, employment, hours, labor quality, capital services, labor productivity, and total factor productivity for approximately 123 countries in the world. The data covers the period from 2000-2013 and 128 countries in the world, including 5 top developed economies. We have 476 observations from OECD, 420 observations for Natural Resource Rich countries.

The ratio of oil rents to GDP (OILR), The ratio of Natural Gas rents to GDP (NATGR) and Total Resource rents (TOTR) (oil, natural gas and mineral rents) to GDP ratios are taken from the 2013 World Development Indicators online database.

The Fraser Institute Freedom Index (EFI) are taken from the Fraser Institute Database. Index values ranges between 0-10. "0" value shows "less economic freedom" and the value of "10" shows "more economic freedom" for a specific country.

Natural Rich Countries list are taken from "Conflict Prevention in Resource-Rich Economies" report of United Nations and OECD Countries List are taken from OECD website.

The pairwise correlation matrix for our data is stated in Table 2.

Table 2. Correlation matrix for natural resource rich countries and OECD countries

	TFP	EFI	GVZ	LEG	SMN	FRT	REG	OILR	NATGR	TOTR
TFP	1,00									
	(1,00)									
EFI	-0,09	1,00								
	(0,05)	(1,00)								
GVZ	-0,02	0,25	1,00							
	(0,05)	(0,06)	(1,00)							
LEG	-0,05	0,77	-0,22	1,00						
	(0,06)	(0,76)	(-0,32)	(1,00)						
SMN	-0,11	0,81	0,14	0,53	1,00					
	(-0,09)	(0,68)	(-0,32)	(0,40)	(1,00)					
FRT	-0,06	0,79	0,10	0,53	0,57	1,00				
	(0,07)	(0,52)	(-0,33)	(0,43)	(0,42)	(1,00)				
REG	-0,09	0,80	0,06	0,63	0,48	0,58	1,00			
	(0,06)	(0,78)	(-0,08)	(0,57)	(0,50)	(0,21)	(1,00)			
OILR	0,18	-0,13	-0,23	0,07	-0,22	-0,19	0,08	1,00		
	(-0,13)	(-0,04)	(0,00)	(0,07)	(-0,10)	(-0,22)	(0,04)	(1,00)		
NATGR	0,17	0,00	-0,02	-0,05	0,00	0,07	0,06	0,27	1,00	
	(-0,11)	(0,12)	(-0,04)	(0,24)	(-0,03)	(-0,05)	(0,15)	(0,83)	(1,00)	
TOTR	0,22	-0,09	-0,15	0,03	-0,18	-0,13	0,09	0,91	0,59	1,00
	(-0,12)	(0,13)	(0,21)	(0,08)	(-0,05)	(-0,09)	(0,12)	(0,70)	(0,66)	(1,00)

Note: The numbers in parentheses are values for OECD countries.

Source: Author's computation using Stata.

In natural resource rich countries, Total productivity growth is positively correlated with the total resource rents and other resources, OILR and NATGR. Economic Freedom and its five sub-indices are negatively correlated with productivity growth. This pairwise correlation matrix indicates that country's level of development is not only related to the measures of natural resources, but also related to the freedom of an economy.

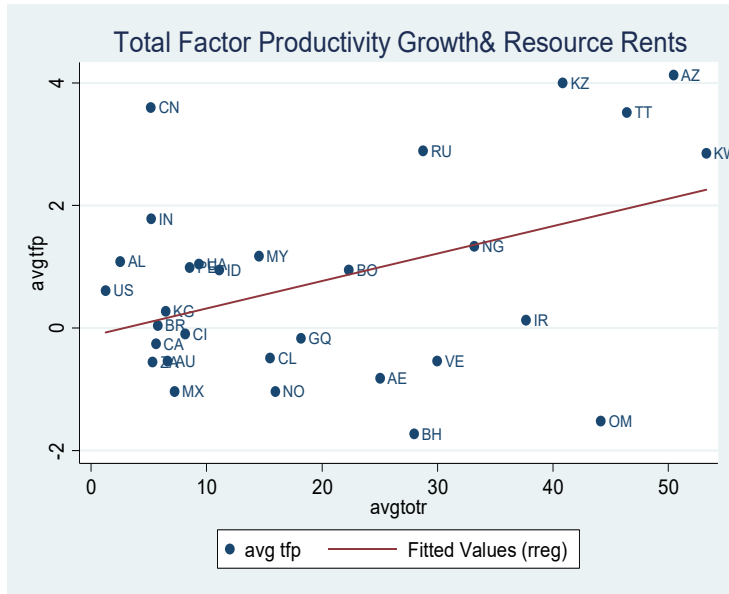
On the other hand, TOTR is negatively correlated with the EFI and its major five subindices (except LEG and REG). But the level of correlation is not too high and this is a good evidence of the less multicollinearity problem in this study.

In OECD Countries, where five of them (Australia, Chile, Mexico, Norway, United States) are common in Natural Resource Rich Countries, productivity growth is negatively correlated with the OILR and NATGR which are alternative measures of resource rents. In pairwise correlation matrix, Resource rents – GDP ratio (TOTR) positively correlated with the EFI as well as its major five subindices (except SMN and FRT).

5. Empirical results

Figure 1 shows the average value of total factor productivity growth and the average value of the Resource Rents in natural resource rich countries. The plot shows that Total Resource Rents are positively related to TFP growth.

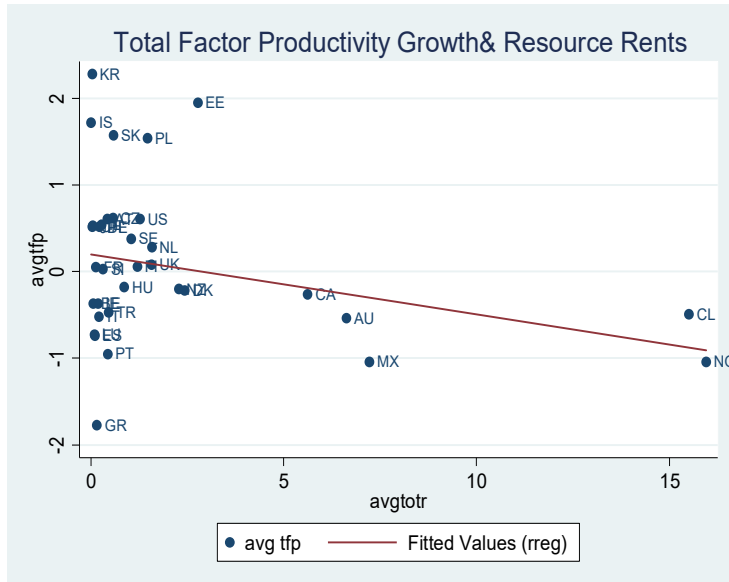
Figure 1. Average resource rents versus average total factor productivity growth (2000-2013) in natural resource rich countries



Source: Data processed by the authors

Figure 2 shows the average total factor productivity growth and the Resource Rents in OECD countries. The plot shows that Total Resource Rents are negatively related to TFP growth. Most of the countries have negligible amount of resource rents, so their effect can not be seen on TFP growth.

Figure 2. Average resource rents versus average TFP growth (2000-2013) in OECD countries



Source: Data processed by the authors

According to general literature review in Equation 1; we expect β_2 value as negative which shows resource curse, β_1 value as positive which shows good institutions have positive effects on economic growth, and β_3 interaction value as positive which shows the negative effect of the resource rents on TFP growth decreases when the quality of economic institutions increase. We expect also absolute value of β_3 larger than β_2 .

Table 3 presents the Economic Freedom, Total Resource Rents and TFP Growth and interaction effect of economic freedom and Total Resource Rents on TFP Growth in Natural Resource Rich Countries.

Table 3. Economic freedom, total resource rents and TFP growth: 2000-2013 in natural resource rich countries⁽¹⁾

Index Sample	EFI N.R. (1)	GVZ N.R.(2)	LEG N.R.(3)	SMN N.R.(4)	FRT N.R.(5)	REG N.R.(6)
$Totr_{i,t-1}$	-0.05 (-18.50)	-0.48 (-12.59)	-0.05 (-22.47)	-0.05 (-13.59)	-0.04 (-8.45)	-0.04 (-11.41)
$Tfp_{i,t-1}$	0.15 (16.71)	0.21 (54.99)	0.16 (18.28)	0.21 (20.49)	0.23 (39.80)	0.25 (19.96)
$d(Efi_{i,t-1})$	1.74 (5.95)	0.35 (3.81)	0.31 (4.22)	0.04 (0.23)	1.90 (14.35)	-0.26 (-2.53)
$dEfi_{i,t-1} * Totr_{i,t-1}$	0.12 (12.07)	0.02 (22.89)	0.00 (0.42)	0.03 (14.82)	0.07 (23.25)	0.01 (2.23)

Note: t-stats are given in parentheses.

Source: Author's computation using Stata.

Table 4 presents the Economic Freedom, Total Resource Rents and TFP Growth and interaction effect of economic freedom and Total Resource Rents on TFP Growth in OECD Countries.

Table 4. Economic freedom, total resource rents and TFP growth: 2000-2013 in OECD countries

Index Sample	EFI OECD (1)	GVZ OECD(2)	LEG OECD(3)	SMN OECD(4)	FRT OECD(5)	REG OECD(6)
$dTotr_i$	0.30 (6.00)	0.22 (7.42)	0.36 (8.18)	0.37 (6.80)	0.40 (7.66)	0.36 (9.79)
$d(Tfp_{i,t-1})$	0.39 (47.62)	0.35 (33.34)	0.43 (64.20)	0.40 (44.12)	0.40 (39.85)	0.42 (74.66)
$d(Efi_i)$	4.24 (16.77)	2.60 (22.00)	0.27 (3.57)	-0.57 (-2.53)	-0.82 (-6.50)	1.16 (25.59)
$dEfi_{i,t} * Totr_{i,t}$	-0.20 (-8.16)	-0.10 (-4.94)	-0.03 (-4.98)	0.19 (0.47)	0.04 (2.09)	0.85 (2.73)

Note: t-statistics are in parentheses.

Source: Author's computation using Stata.

The coefficients of total resource rents appear to be significantly positive in the OECD countries but negative in Natural Resource Rich (NRR) Countries. The negative effects of TOTR on TFP growth are consistent with the resource curse hypothesis.

Economies with abundant natural resources have tendency to grow slower than resource-poor counterparts (Auty, 2001; Frankel, 2010; Sachs and Warner, 2001). We expect the sign of the coefficients of economic freedom to be positive and our results show there is positive relation between economic freedom and total factor productivity growth in NRR and OECD countries. The coefficients are statistically significant also. We find also that coefficients of the interaction variables are positive and statistically significant. It means

that for NRR countries the more economic freedom the higher productivity growth. But the results for OECD countries showed different pattern as opposed to NRR samples.

In NRR countries, columns (2-6) of Table 3 reports the growth effects of the resource rents – GDP ratio, five major components of the EFI, and the interaction between these two groups on TFP growth. The results shows that except sound of money and regulations all subindices of Economic Freedom show positive and significant effect on total productivity growth. The interaction effect of sub-indices with total resource revenue have positive effects on TFP as well. Our results also similar to (Farhadi et al., 2015) where the size of government and access to sound money don't show significant interaction effects with the TOTR.

Columns (2-6) of Table 4 reports growth effects of the resource rents – GDP ratio, five major components of the EFI, and the interaction between these two groups on TFP growth of OECD economies. All subindices are statistically significant except interaction effects of Sound of Money with Resource Rents. The results shows that higher natural resource rents increase productivity growth in countries with greater freedom in legal system/property rights and government size. However, the access to sound money and international trade shows negative effect on productivity growth although there is positive interaction effect of these subindices on TFP growth.

6. Conclusion

In this study, the link between total factor productivity growth and natural resource rents and economic freedom in 30 Natural Resource Rich and 34 OECD member countries are analyzed by using Two System GMM method. Cross-Sectional dependency is tested by using Pesaran (2004) CD_{LM} method and found to have cross-sectional dependence in both series and in the equation. Panel unit root test; Pesaran (2015) was conducted with CADF tests and the series were found to be non-stationary. This indicates that the effect of shocks, subjected to the economies of the respective countries, is a long run phenomena. Due to dynamic characteristic of model, autocorrelation and endogeneity problem arised. Exogenous instrument variables are used to get rid of this problem. The main findings of this study are similar with the resource curse literature and quality of institutions determines the curse or blessing in Natural Resource Rich countries. Although OECD countries are more market oriented than Natural Resource Rich countries, positive impact of natural resource rents on economic growth decreases as economic freedom increases. In Natural Resource Rich countries, subindices of the Economic Freedom are positive impacts on the growth except regulations but the interaction of regulations with resource rents turns this negative effect to positive. In OECD countries, subindices of the Economic Freedom are positive impacts on the growth except sound of money and international trade, but the interaction of them with resource rents turns this negative effect to positive.

Note

- ⁽¹⁾ The dependent variable is total factor productivity Tfp_i growth in every one year interval from 2000 to 2013. $Totr_{i,t-1}$ indicates 1-year lagged value of ratio of total resource rents (oil, gas and mineral rents) to GDP. $Efi_{i,t-1}$ indicates Lagged economic freedom index. Two-step system GMM estimation results are used for estimating coefficients. All regressions satisfy AR(1) test for first-order serial correlation and no second-order serial correlation AR(2). The numbers in second row of each explanatory variables are z-statistics. Number in bold shows that results are not statistically significant at %1, %5 and %10 confidence level.

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Appendix A

NATURAL RESOURCE RICH COUNTRIES (NRR)		
Albania (AL)	Ecuador (GO)	Norway (NO)
Australia (AU)	India (IN)	Oman (OM)
Azerbaijan (AZ)	Indonesia (ID)	Peru (PE)
Bahrain (BH)	Iran, Islamic Rep. (IR)	Russian Federation (RU)
Bolivia (BO)	Kazakhstan (KZ)	South Africa (ZA)
Brazil (BR)	Kuwait (KW)	Trinidad and Tobago (TT)
Canada (CA)	Kyrgyz Republic (KG)	Ukraine (UA)
Chile (CL)	Malaysia (MY)	United Arab Emirates (AE)
China (CN)	Mexico (MX)	United States (US)
Côte d'Ivoire (CI)	Nigeria (NG)	Venezuela, RB (VE)

OECD COUNTRIES			
Australia (AU)	Germany (DE)	Mexico (MX)	Switzerland (CH)
Austria (AT)	Greece (GR)	Netherlands (NL)	Turkey (TR)
Belgium (BE)	Hungary (HU)	New Zealand (NZ)	United Kingdom (UK)
Canada (CA)	Iceland (IS)	Norway (NO)	United States (US)
Chile (CL)	Ireland (IE)	Poland (PL)	
Czech Republic (CZ)	Israel (IL)	Portugal (PT)	
Denmark (DK)	Italy (IT)	Slovak Republic (SK)	
Estonia (EE)	Japan (JP)	Slovenia (SI)	
Finland (FI)	Korea, Rep. (KR)	Spain (ES)	
France (FR)	Luxembourg (LU)	Sweden (SE)	

Appendix B

Total factor productivity

Robert Solow (1956) is the first in literature explaining total productivity by the Cobb-Douglas (1928)'s production function in which there is single good with two factors.

$$Y = A(t) F[K(t), L(t)] \quad (2)$$

Y = Total production,

L = Labor input,

K = Capital input,

A = Total factor productivity

First, we take differences of the equation (2). So production function turns to growth base.

$$\frac{\dot{Y}_t}{Y} = \frac{\dot{A}_t}{A} + \frac{F_K}{F[K(t), L(t)]} \dot{K}_t + \frac{F_L}{F[K(t), L(t)]} \dot{L}_t \quad (3)$$

In this equation, F_K is marginal product of capital, F_L is the marginal product of labor.

We know from Eq. (2) that

$$\frac{Y}{A} = F[K(t), L(t)]$$

And putting this in equation (3)

$$\frac{\dot{Y}_t}{Y} = \frac{\dot{A}_t}{A} + \frac{A_t F_K K_t}{Y_t K} \frac{\dot{K}_t}{K} + \frac{A_t F_L L_t}{Y_t L} \frac{\dot{L}_t}{L} \quad (4)$$

In a competitive market, we pay marginal product to factor of product

$$\frac{dY}{dK} = A \frac{dF}{dK} = A F_K \text{ and } \frac{dY}{dL} = A \frac{dF}{dL} = A F_L$$

As a result

$$\frac{\dot{Y}_t}{Y} = \frac{\dot{A}_t}{A} + r \frac{K_t}{Y_t} \frac{\dot{K}_t}{K} + w \frac{L_t}{Y_t} \frac{\dot{L}_t}{L} \quad (5)$$

Where r is a price of capital and w is a price of labor

$$s_k = r \frac{K_t}{Y_t} \text{ where } s_k \text{ is the weight of physical capital in production}$$

$$s_l = w \frac{L_t}{Y_t} \text{ where } s_l \text{ is the weight of labor in production}$$

$$s_k + s_l = 1$$

$$\frac{\dot{Y}_t}{Y} = \frac{\dot{A}_t}{A} + s_k \frac{\dot{K}_t}{K} + s_l \frac{\dot{L}_t}{L} \quad (6)$$

Equation (6) shows that, the source of change in economic growth mainly depends on changes in technological development, capital accumulation and changes in labor of inputs. According to this production function, production is an increasing function of these inputs, and output increases through technological development (change in A) at a given capital and labor level.

Appendix C

Government size index (GVZ) ranges from 0–10. Countries with a larger proportion of government expenditures, with larger transfer sectors, when government investment exceed 50% of total investment, with the higher marginal tax rates gets 0 rates.

Legal System and Property Rights index (LEG) ranges from 0–10. Countries with no judicial independence, inefficient legal framework for private businesses, no protection of property rights, high military involvement in politics and no integrity of legal system gets 0 rates.

Access to sound money index (SMN) ranges from 0–10. Countries, where the money supply growth rate greatly exceeds real output growth rate, where the annual standard deviation of the inflation rate is approximately 25%, where annual inflation rate is over 50% and where foreign currency bank accounts were restricted both domestically and abroad gets 0 rates.

Freedom to trade internationally index (FRT) ranges from 0–10. Countries with more than 15% taxes on international trade, mean tariff rates is nearly 50%, the standard deviation of tariff rates increases toward 25%, longer import or export procedures, the percentage difference between official exchange rates and black-market rates is over 50%, highly restrictive regulations for international capital flow, highly capital control gets 0 rates.

Regulation index (REG) ranges from 0–10. It includes credit market, Labor market and Business regulations. Countries where 10% or less of private deposits held in privately owned banks, where greater government borrowing occurs, where lending and deposit rates are fixed by the government, where fixed-term working contracts are used for any kinds of task, where hiring and firing of workers is hindered by regulation, where wages are set by a centralized bargaining process, where conscription period is over 18 months, to start a new business takes longer times or more costly, long time and high monetary cost to obtain licence to construct warehouse gets 0 rates.