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Economic Freedom and Endogenous Economic Growth

Ekonomik Özgürlük ve İçsel Ekonomik Büyüme

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Abstract

The relation between economic freedoms and economic performance is very crucial to determine economic growth and to the development policies of a country. Economic development and growth are the ultimate goal for all developed and emerging economies. Economic developed countries have been aiming to sustain their current situation, while developing countries apply policies that will provide economic growth and development. Convergence hypothesis which is the one of the main inference of Solow growth model states that, in a close economy, real income difference across countries tends to decrease because of the diminishing rate of return of capital. The concept of "economic freedoms" is one of the driving elements of economic growth and development. This study tests empirically economical freedom foster macroeconomic growth in an endogenous growth model. Panel data is used in covering 159 countries for the period of 1995-2014 via nonlinear least square methods. Findings suggest that there is significant relation between economical freedom and per capita growth.

Keywords: Institutions and the Macroeconomy, Institutions and Growth, Empirical Studies of Economic Growth, Economic Freedom, Convergence

JEL Classification: E2, O43, O47, D02, E10

Öz

Ekonomik özgürlükler ile ekonomik performans arasındaki ilişki, bir ülkenin ekonomik büyüme ve kalkınma politikalarının belirlenmesinde çok önemlidir. Ekonomik kalkınma ve büyüme, tüm gelişmiş ve

yükselen ekonomiler için nihai hedeftir. Ekonomik olarak gelişmiş ülkeler mevcut durumlarını sürdürmeyi hedeflerken, gelişmekte olan ülkeler ise ekonomik büyüme ve kalkınmayı sağlayacak politikalar uygulamaktadır. Solow büyüme modelinin temel çıkarımlarından biri olan yakınsama hipotezi, kapalı bir ekonomide ülkeler arasındaki reel gelir farkının, azalan sermaye getiri oranı nedeniyle azalma eğiliminde olduğunu belirtmektedir. "Ekonomik özgürlükler" kavramı, büyüme ve kalkınmanın itici unsurlarından biridir. Bu çalışma, içsel bir büyüme modelinde ampirik olarak ekonomik özgürlüğün makroekonomik büyümeyi desteklediğini test etmektedir. Panel veri doğrusal olmayan en küçük kareler yönteminde gauss newton algoritması (iteratif simülasyon) kullanılarak 1995-2014 dönemi için 159 ülke verisi analiz edilmiştir. Bulgular, ekonomik özgürlük ile kişi başına büyüme arasında anlamlı bir ilişki olduğunu göstermektedir.

Anahtar Kelimeler: Kurumlar ve Makroekonomi, Kurumlar ve Büyüme, Ekonomik Büyümenin Ampirik Çalışmaları, Ekonomik Özgürlük, Yakınsama

JEL Sınıflaması: E2, O43, O47, D02, E10

Introduction

Economic freedom and economic performance relation is very crucial to determine economic growth and to development policies. Economic development and growth are the ultimate goal for all developed and emerging economies. In general, economic developed countries have been aiming to sustain their current situation, while developing countries apply policies that will provide economic growth and development. Especially, after 1980's, liberalization/liberalization tendencies in the world economy continue to increase. The liberal economic policies have been re-established in the world's agenda and are in the center of law-economy relationship (Orend, 2006) also covers economic arrangements.

The concept of freedom covers not only regulations on social and political rights but also Freedom such as economic, politic, or civil liberty constitutes the institutions. "*Good Institutions are determinant or prerequisite for economic growth and development. Institutions have indirect effect on aggregate economic activity by means of investment or direct effect on total factor productivity*" (Dawson, 1998).

Lau and Lam (2002), and Beach and Miles (2006), describe economic freedom as a lack of government pressure on the production, consumption and distribution of goods and services, as well as this kind of activities of the citizens has been done freely under the protection of the government. According to Gwartney and Lawson (2002), "*The key components of economic freedom are; personal choice, voluntary exchange, freedom of competition and protection of persons and property*".

Economic freedom means that, individuals have right to acquire property without force, fraud, or theft and while using and transferring these right they have same rights as others (Gwartney et.al.,1996). Also, Friedman (2002) explains "*Economic Freedom is the protection of property rights, the special ownership of the production tools and the right to trade and compete with and the entrance or exit of a business activity*".

According to Patry (2009), economic freedom in general is a structure that drives free market mechanism, in which goverment less intervenes in system, maximizes individual prosperity, which warns the dynamics of economic growth and development, directs the economy to a natural balance and enables individuals make economic decisions in line with their wishes and has no external intervention to apply this decision.

Individuals eager to work in societies where their economic freedoms are secured, they direct some of their incomes to savings and these savings are transferred to the investments. Liberal economic system increases individual savings volume and accelerates the capital accumulation process in parallel with the development of financial markets. Hence the capital can be transferred to the markets where maximum profit on a global basis can be achieved. Increasing capital capacity towards countries where economic freedoms are provided, capital costs decreases and investment volume expands, consequently output amount increases. The liberal system provides to accelerate capital accumulation through the savings channel and through investments. Finally, Henry (2003) states, "*The increase in investment should generate a temporary increase in the growth rate of output per worker*".

Economic freedom is also important for maintaining macroeconomic stability. For example; realization of low and predictable inflation rates, establishment of interest levels that meet the needs of the country, ensuring the competitive level of exchange rates and ensuring the balance of payments. In parallel with this economic structuring, the volume of savings increases, long-term capital accumulation rises, the national welfare level is preserved, the investments to be made by making predictions for the future increases, capital accumulation arises and the effectiveness of the distribution of source is possible. As a result, these factors enable the growth process to accelerate and gain a sustainable momentum.

Another mechanism that economic freedom activates economic growth process is the financing. The main focus is that both domestic and foreign investors are able to operate freely and consequently they accelerate economic growth by facilitating the savings and simplifying investments in the advanced financial markets. Liberal financial system accelerates the increase in the volume of savings and promotes more effective use of physical capital by increasing both its volume and efficiency and thereby contributing to economic growth (Luintel and Khan, 1999).

It is possible to say that economic freedoms have created similar effects on the accumulation of human capital as on physical capital stock. High human capital accumulation has a capacity to absorb more qualified technological developments and this channel has close relationship with a high school rate. And also advanced human capital includes an ability to use existing physical capital stock optimum (Barro, 2001).

Another factor related to the economic growth is technological innovation. Schumpeter (1911), is the first one describing this relation. Technological innovations increase the amount of output per work and this stimulate rapid economic growth. Although Neo-Classical growth theories accept the level of technological development as exogenous, they agree that new machinery-equipment and new production techniques will increase marginal return of capital. Especially Jones (1998), assumes that technological development and innovation lead to growth at a macro level, increase in profits of companies and market share at micro level. In other words, the externalities and overflows resulting from the investments made by each firm (technological and human capital) for technological innovations lead to the emergence of an increased return by removing the economy from the decreasing return and thereby cause long-term growth (Jones, 1998). With the help of a mechanism based on economic freedom, the theories of endogenous growth, which bring classical and neo-classical growth models one step further, accepts the technical development as endogenous and introduces growth models based on technological investments.

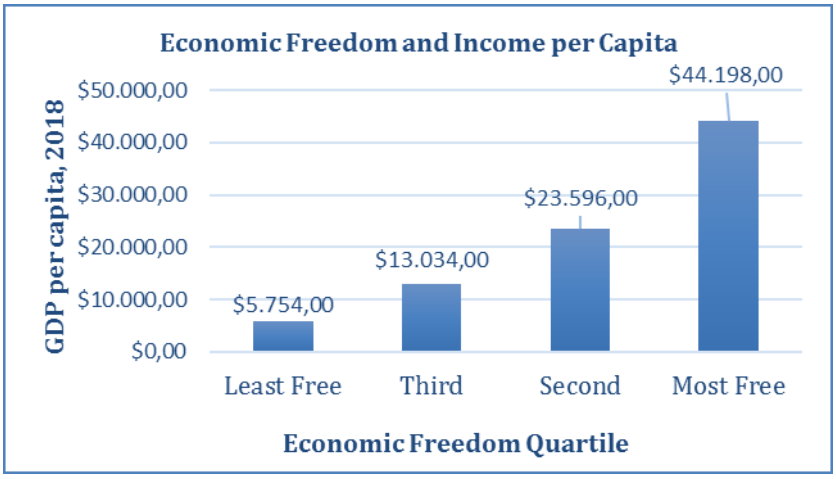
On economic growth, the free foreign trade impact by economic freedom channel is discussed under two views. The first one assumes that new technologies by the entrance to the country along with the liberalization in foreign trade accelerate economic growth by leading to increased returns in the production process. The second is based on the convergence hypothesis. This hypothesis proposes that due to the free foreign trade all countries will have the same technology, preferences and growth rate in labour and capital, thus they will approach each other in the same stable state balance and this results in economic growth in these countries (Srinivasan, 1999).

Economic freedom should be measurable both for determining the role of liberties in the development of countries and for comparative analysis of the freedom levels of countries. After 1990, calculations by international institutions - Heritage Foundation and the Fraser Institute- play an important role in making economic freedom quantitative to be measurable. After this, it can be predicted, whether the changes in the level of economic freedom affect economic performance. According to these estimations made at the same time, countries that are more liberal in economy than other countries seem to achieve faster growth, higher per capita income levels, lower unemployment rates, broader political and civil liberties and lower levels of corruption (Acar, 2010).

According to the Economic Freedom of the World: 2020 Annual Report, published by Fraser Institute, "*There is a direct relation between income per capita and economic freedom. Increases in the country's economic freedoms lead to increases in per capita income*".

Graph 1

Per Capita Income and Economic Freedom Level



Source: Fraser Institute, Economic Freedom of the World: 2020 Annual Report

Graph 1 shows that, per capita income of countries which have low economic freedom is low. The value is $ 5.754. The per capita income increases as economic freedom increases and highest value is 44.198 $.

This study tests empirically whether economic freedom fosters macroeconomic growth in an endogenous growth model or not. Panel data covering 159 countries is used for the period of 1995-2014 by nonlinear least square methods. In order to stimulate theoretical framework for the empirical section of study, derivation of endogenous macroeconomic model dynamics, convergence coefficients and transitional stability conditions are also mentioned. Findings suggest that, economic freedom and per capita income growth are in relation.

This study consists of 6 sections. In the second section, international studies about economic freedom on output per worker are examined in detail. In the third section derivation of endogenous macroeconomic model dynamics, convergence coefficients and transitional stability

conditions are shown. Followed by; methodology, data and empirical results.

Review of Literature

Literature Review on Economic Freedom

In literature, there are many empirical studies about economic freedom and its effect on economic growth done recently. In general, studies made by time series and panel data analyses revealed that (including some exceptions) economic freedoms have an impact on economic growth.

Table 1

Economic Freedom and Economic Growth Literature

Authors	Country	Period	Results
Barro (1994)	100	1960-1990	The favorable effects on growth include maintenance of the rule of law, free markets, small government consumption, and high human capital.
Nelson and Singh (1998)	67	1970-1989	The results of the study showed that democracy and political freedoms are in the positive direction with growth.
Ayal and Karras (1998)	58	1975-1990	It was concluded that economic freedoms increased growth by increasing total factor productivity and capital accumulation.
Barro (1999)	100	1960-1990	The superiority of the law, the human capital, the improvement in trade and investments have positive effects on growth.
Berggren (1999)	17	1975-1985	In the countries that succeeded in increasing the level of economic freedom, justice in income distribution and hence economic growth would be achieved faster.

Carlsson and Lundström (2001)	74	1975-1995	Some of the sub-indices of economic freedom (monetary policy and price stability) are insignificant in terms of economic growth, some are fragile variables in terms of growth (economical structure and operations in markets and free exchange in capital markets) others (freedom of public exchange and foreign exchange) have negative relationship. Only freedom in foreign exchange using, protection of private property and the legal structure have a positive relationship with economic growth.
Scully (2002)	26	1975-1990	Economic freedoms have been found to increase the economic growth rate and improve income distribution.
Gounder (2002)	1	1968-1996	In Fiji Democratic restructuring and economic freedoms are two vital factors for economic growth and that rapid economic growth is achieved due to the effectiveness of these factors.
Bengoa and Sanchez-Robles (2003)	18	1970-1999	Economic freedoms result in foreign capital inflows and this support the process of economic development
Doucoliagos and Ulubaşoğlu (2004)	82	1970-1999	There is a positive relation between economic freedoms and economic growth, but it is stated that the dimensions of this effect may vary according to the measurement methods and variables.
Gwartney et al. (2004)	90	1980-2000	Countries reach higher growth and income rates through institutions and policies that support economic freedom.

Dawson (2006)	64	1980-2000	As a result of the study, it has been found that regulation is positively related to private investments and negative relations with public investments, and that more regulation has a negative correlation with long-term economic performance.
Sameti and Shahchera (2006)	14	1980-2002	They have found that on economic growth, economic freedoms have an increasing effect.
Weede (2006)	102	1980-2000	Economic freedom has a more dominant effect than the coastal population and human capital accumulation.
Ashby and Sobel (2008)	1	1980-2003	Economic freedoms support income growth and income growth rate.
Justesen (2008)	72	1970-1999	Public volume and regulations strongly influence economic growth and investments.
Heckelman and Knack (2009)	68	1990-2000	As a result of the study, no evidence was found that economic freedoms affected the foreign aid rates received
Azman-Saini et al. (2010)	85	1975-2004	Economic freedom is a driving force for long-term growth and foreign direct investment has a positive effect on growth depending on economic freedoms.
Mahmood and Azid (2011)	96	2000-2006	As a result of the studies, regarding the effect of economic freedom on economic growth; They found a unilateral and strong relation in the countries including the upper-middle and lower income groups, while detecting double-sided relation in high and low-middle income countries.
Panahi et al. (2014)	13	2000-2009	Economic institutions specifically economic freedoms, have played an important role in the development of countries and positive correlation with the economic growth.

Source: Author

Convergence Hypothesis

Whether or not convergence among countries per capita income levels has been subject of studies intensively since 1980's. The convergence hypothesis is the most important inference of the Neo-Classical Growth Model developed by Solow (1956). According to this hypothesis, the lower the per capita income level of a countries or region from others than the higher the growth potential is. So it can converge with rich countries or regions. The main reason for this result is that, under closed economic conditions, the low capital stock in the poor countries has a marginal rate of return which is diminishing slowly than the rich countries. It is expected that underdeveloped countries will show high growth rate and developed countries will show low growth rate (Barro and Sala-i-Martin, 1995). This process results to a higher growth rate in underdeveloped countries with poor capital and the capture of capital wealth (per capita income level) of the developed countries. Indeed, despite the decline in the growth rates of developed countries in recent years, the high growth rates observed in developing countries. Capturing means that one country reaches another country (Abromovitz, 1986), and convergence (Baumol, 1986; Barro and Salai-Martin, 1992), means that the per capita income gap between countries will gradually decline, has become one of the popular topics of growth literature in recent years. Islam (2003), states that these discussions have created a broad application area for the validity of neo-classical growth models (Solow, 1956) and new endogenous growth models (Romer, 1986; Lucas, 1988).

The first empirical test of Convergence Hypothesis has been made by Baumol (1986), by covering 16 developed countries data between the period of 1870-1979. By using crossectional regression analysis, in these countries, he observed convergence in terms of real income percapita. Also the convergence process applies only to developed countries and to those countries that are in the preparation or departure phase of take-off but such a relationship is not the case for underdeveloped countries. Because of the publication of long-run macroeconomic data in the 1980's, as well as the understanding of the importance of the economic growth process in terms of economic development and increasing interest in sustainable economic growth has led to the emergence of the New Growth Theory (Sala-i Martin, 2002).

In Neo-Classical Model developed by Solow (1956), economies converges to steady state equilibrium level determined by parameters

such as discount rate, factor substitution elasticity between periods, share of capital and depreciation rate (Mankiv et.al. 1992). This is also called conditional convergence hypothesis. After a steady state of equiliburim, the economy grows at a constant rate of zero. Galor (1996), states that: "*Countries that are similar in all respects (in preferences, technologies, rates of population growth, government policy, etc.) except for their initial level of output per capita are expected to converge to the same steady-state equilibrium and hence to one another*".

An economy grows faster than other economies if the initial labor-capital ratio is lower than the stationary state equilibrium labor-capital ratio (consequently, the marginal productivity of capital is high). The low initial level of labor capital ratio results in rapid growth and rapid accumulation of the capital stock. Thus, if two economies are identical to one another, if one is reached to the other's steady state equilibruim level, the per capita real return level will be the same. In this case, the growth rate is in negative relation with the distances of the countries to the steady state equilibruim level. According to Sala-i Martin (2002), technology is exegoneus in this model and assumptions are as follows:

- There is no new sources to produce technology
- Everybody shares same level of techology
- No one pays extra money from benefiting this technology.

Assumptions of the model are: households are owners of inputs and financial assets; production is made as a single sector; production technology has fixed return in terms of scale and technology is exegoneous; firms rent capital and labor from households for production purposes; and sells output to the firms and households. The price of goods and production factors are derived by the competition in the markets freely. If the economy is a closed economy where the state is not involved savings are equal to the investments. Technological development rate of is neutral. Also with the population growth rate, it is assumed constant and determined exegoneously.

Şanlı (1996), states "*In general, the findings of Neo-Classical Theories can be summarized as follows: the economy converges to the stationary state equilibruim independent of the initial conditions in the long run, the stationary state level depends on the saving rate and population growth rate, the growth rate of per-capita income in stationary state depends only on the speed of technological development, in the stationary state, the capital*

stock grows at a rate equivalent to the rate of income growth and therefore the ratio k/y is constant, the marginal productivity of the capital is stable in the steady state, whereas the productivity of the workforce grows as technological development rate, if the initial conditions are assumed to be the same for all economies considered, the convergence process becomes "absolute convergence". Otherwise convergence is „conditional convergence" and the determination of the convergence rate depends on the initial conditions of each country and on external random shocks".

For this reason, the model doesnt explain income per capita growth. In Neo-Classical Model, growth rate is determined by external factors in long-term. The dynamics of the balanced growth path, which expresses long-term growth, shows how the per capita income level converges to its own stationary state level and how it would approximate the per capita income levels of other countries. According to Neo-Classical growth theory, each economy converges to its stationary state equilibruim, and its convergence is inversely proportional to its distance from the stationary state level. The findings of Barro's study on 108 countries supports conditional convergence hypothesis. Involving only 20 OECD countries, absolute convergence have been achieved (Barro, 1991; Barro and Sala-i-Martin, 1995).

Romer (1986), puts technology into the production function as an important factor for growth. In his model technology is assumed as endogenous. According to Romer, knowledge accumulation in the economy must be increased to development of technology. With the accumulation of knowledge, new products and technologies will emerge, other firms are benefited from these by spill-over effect and as a result whole economy will be positively affected. Therefore, the increase of knowledge accumulation will also increase the efficiency of the physical capital stock. Romer (1986) and Lucas (1988), states that development in technology is a side effect of the investment decisions of the private sector and takes place endogenously. According to Romer, Reserach and Development (R&D) activities in private sector are spreading the whole society over time, creating effects on the technological knowledge stock that the whole society has.

Lucas (1988) and Rebelo (1991), include the HC in the production function. The human capital is the person's skill found in born or growed later, skill, ability, knowledge and experience to be acquired, together with the state of health, the place of social relations and the level of education. Lucas (1988), considers human capital as a factor

of production, such as physical capital. According to Lucas (1988), the marginal productivity of the physical capital stock tends to be constant. However, human capital is not subject to decreasing productivity. This is because, human capital increases by knowledge accumulation. Thus, the growth rate of human capital increases constantly, this will also increase economic growth rate. Moreover, in countries where human capital is high, the labor force is more productive and, therefore, has higher wages. Therefore, migration towards the wealthy countries is starting from the poor countries. This prevents the development of poor countries and impedes the development of developed countries. In this context, even if the long-term growth rates of all countries are initially the same, poor countries will continue to be poorer in the future than rich countries. Mankiw et al. (1992) have restructured the production function by incorporating human capital into the neoclassical growth model and empirically tested it.

New growth models states that; the growth process can not be explained by simple neoclassical production function and its assumptions but human capital, education, internal population dynamics, disruptive market phenomena, state interventions, and increased returns must also be included in the model.

Theoritical Framework

This study follows papers mainly Ulusoy (2001), Ulusoy and Yalçın (2011), Karpavicius et.al. (2014), and PHD Thesis Borucu, 2017. In first two papers, Ulusoy focuses on accumulation of Human Capital (HC) and international trade by emphasizing spillover effects of them on growth and convergence. Third paper improves first two papers by entering learning by doing model in the former model. In this paper, author analyzes empirically balanced growth path, per capita income level distribution and convergence speed along the path and equilibrium.

Borucu (2017), empirically test whether financial innovation, human capital and foreign direct investment stimulates macroeconomic growth within endogenous growth model and in thesis he derived explicitely endgonenous macroeconomic model dynamics, balanced grotwhpath equilibrium, stability conditions and also convergence coefficients.

Measurement of Convergence Coefficients

Analyzes of the convergence hypothesis have been formed around three studies. These are expressed as "Beta Convergence", "Sigma Convergence" and "Log-Per-Person Convergence". Beta (β) is a coefficient included in the concept of unconditional convergence which assumes that all economies have the same structural features. Poor economies grow faster than a rich economies and catch up rich economies in terms of level of income percapita.

The per capita income average growth rate and the per capita income level in the initial year relation can be expressed with the help of equation (1):

$$y_{ti}-y_{0,i}/y_{0,i} = \alpha+\beta y_{0;i}+\varepsilon_{(t,i)} \qquad (1)$$

In equation (1); y_{ti} ,is the per capita income level in country i;$y_{0,i}$, is the inital level of per capita income, the left side of the equation reflecting the dependent variable is the income growth level; α is fixed coefficient, β is the convergence coefficient and $\varepsilon_{(t,i)}$ is the error term.

If beta coefficient is statistically significant and has negative value, then there is convergence period and in the case of a positive value of beta, the divergence period occurs in these countries. Two different coefficients can be calculated with the help of the regression model

(1), the first one is the convergence rate and the second coefficient called the half life in the literature which are necessary for reaching the steady state equilibrium.

Convergence rate can be calculated with the formula of : (2)

$s= -Ln(1+T\beta)/T$ (2) where T is the time period between t and (t– 1)

Half Life can be calculated as : (3)

$\tau= -Ln(T)/Ln(1+\beta)$ (3)

"Sigma convergence reveals how the income per capita is distributed over a certain period of time and assumes that the differences of the per capita income distribution of comparative economies will decrease within time (Sala-i-Martin, 1996). The criterion used to measure the sigma convergence is the standard deviation. If the standard deviation shows a tendency to decrease at a certain time, it is mentioned converging or otherwise diverging" (Valdes, 1999).

$$\sigma_t = \sqrt{I^{-1} \sum_{i=1}^{I} S_{it} - S^*_t)^2} \quad (4)$$

In equation (4) I, the country considered in the analyzes; S_{it} reflects the income level of country *i* in period t and *S** shows the average income level of all other countries in period t.

"Log-Per-Person Convergence questioned whether the different countries share a common deterministic or stochastic trend". This type of convergence has been emphasized in studies by Bernard and Durlauf (1995), Evans and Karras (1996). Formula is stated in (5):

$$\log(y_{it}) = a + (1-\beta) \log(y_{i,t-1}) + \mu_{i,t} \quad (5)$$

In formula (5) y_{it} represents income per capita growth rate in country *i*, β ,convergence coefficient, $y_{i,t-1}$, initial income per capita in country *i*, $\mu_{i,t}$ shows error term.

Endogenous Growth Model

According to Solow, technological development is needed for long-term positive growth rates per worker.

In Neo-Classical Cobb-Douglas Production function ;

$$Y_{it} = A_{it} K_{it}^{a} L_{it}^{1-a} \quad (6)$$

Subscript i, represents country, subscript t, represents time period, Y_{it} represents total production, K_{it} represents capital, L_{it} represents labour, A_{it} denotes technology level and $0< \alpha <1$. The model's critic assumption is that, it has constant return to scales in terms of K and L

"*Doubling K and L while A is constant, doubles the amount produced. The Solow model assumes that, economy is big enough and if K and L are doubled, the new inputs are used in essentially same way as the existing input so as a result output doubled*" (Romer, 1996).

In model, the variable A_{it} meaures external effects such as national-based externatilies or industry based. Market determines technological progress.

Technological progress can be written as;

$$\dot{A}_{it} = Y_{it}^{\beta} A_{it}^{\theta} - \gamma A_{it} \quad (7)$$

Ulusoy and Yalçın (2011), states "$\dot{A}_{it}$ *denotes derivatives of* A_{it} *with respect to time,* γ *is the depreciation rate of technology,* $\theta<1$ and $0<\beta\leq1$"

In equation 7, technology doesn't have constant returns to scale as opposed to Equation 6. Since β value, doubling gross production level, technological advances level increase less than double.

When $\theta>0$, it means the previous inventions increase the efficiency of subsequent inventions. When $\theta<0$, it means that the discovery of new products is becoming increasingly difficult.

Fredoom index is added to the model 7.

$$\dot{A}_{it} = Y_{it}^{\beta 1} FI_{wit}^{\phi} A_{it}^{\theta} - \gamma A_{it} \quad (8)$$

Growth rate of technology dynamic model can be re-written as;

$$\dot{A}_{it}/A_{it} = Y_{it}^{\beta 1} FI_{wit}^{\phi} A_{it}^{\theta-1} - \gamma \quad (9)$$

Where FI_{wit} is Freedom Index for country *i* at time period *t*. In model 9, $\emptyset\leq1$ is assumed.

In theory, change in capital stock equals new investment minus capital stock (K) multiplied by depreciation rate of the capital (δ) i.e.

$$\frac{dK_t}{dt} = \dot{K} = sY - \delta K \quad (10)$$

In a closed economy output divided two parts. Investment and consumption. The ratio of income reinvested again to capital stock-saving rate (s)-assumed constant and exogenous (Solow and Swan, 1956).

In theory, labour force increase at a rate of *n* and assumed as constant (Romer D.,1996)

$$\frac{dL_t}{dt} = \dot{L} = nL_{it} \tag{11}$$

Formula implies that labour force grow exponentially. $L_t = e^{nt}$

As economy grows over time, instead of using capital stock (K), it is convenient to use capital stock per unit of effective labor, *k* .

Since $k = K/L$

By using chain rule derivative of k with respect to *t* is taken as;

$$\dot{k} = \frac{\dot{K}L - L\dot{K}}{L^2} \tag{12}$$

$$\dot{k} = \frac{\dot{K}}{L} - \frac{K}{(L)}(\frac{\dot{L}}{L}) \tag{13}$$

From equation 10 we know that $\dot{K} = sY - \delta K$

From equation 11 we know that $\dot{L}$=nL_{it}

Since k=K/L

$$\dot{k} = \frac{sY - \delta K}{L} - \mathrm{k}n \tag{14}$$

$$\dot{k} = \frac{\mathrm{sY}}{\mathrm{L}} - \frac{\delta K}{L} - \mathrm{k}n \tag{15}$$

$$\dot{k} = \frac{sY}{\mathrm{L}} - \delta\mathrm{k} - \mathrm{k}n \tag{16}$$

$\frac{Y}{L} = \mathrm{y}$ (perworker output) and from the equation 6

$$y = A(\frac{K}{L})^a(\frac{L}{L})^{1-a} = Ak^a \tag{17}$$

$$\frac{\dot{k}}{k} = sAk^{a-1} - (n + \delta) \tag{18}$$

This is per worker capital growth equation.

Balanced Growth Path

Kaldor (1961), states "*Each of the growth rates of labour, capital, and output are roughly constant in the most of the major industrialised countries over the*

past century. So it can be said that along the balanced growth path, growth rates of per capita capital stock and technology are constant".

Romer D. (1996), states "*Solow Model implies that, regardless of initial values of inputs, the economy converges to a balanced growth path which means that each variable in the model is growing at constant rate. On the balanced growth path, growth rate of output per worker is determined solely by the rate of technological progress*".

Jones (1995,1998), states "*Technological progression is result from innovations and human capital-augmented labour".*

Empirically saying, in Equation 18 and Equation 9 right hand sides are constant. By differentiating each equations with respect to time is equal zero.

By differentiating equation 18 with respect to time;

$$\frac{\dot{A}_{it}}{A_{it}} + (a-1)\frac{\dot{k}_{it}}{k_{it}} = 0 \qquad (19)$$

By differentiating equation 9 with respect to time,

$$\beta 1 \frac{\dot{Y}_{it}}{Y_{it}} + (\theta - 1)\frac{\dot{A}_{it}}{A_{it}} = 0 \qquad (20)$$

Let us assume that

$\frac{\dot{k}_{it}}{k_{it}} = \Omega_k$ and $\frac{\dot{A}_{it}}{A_{it}} = \Omega_A$ then;

$$\Omega_k = \frac{\beta 1 n}{(1-\alpha)(1-\theta) - \beta 1} \qquad (21)$$

$$\Omega_A = \frac{(1-\alpha)\beta 1 n}{(1-\alpha)(1-\theta) - \beta 1} \qquad (22)$$

Ω_A and Ω_k shows per worker capital and technology growth rate and are constant on balanced growth path (Ulusoy and Yalçın (2011)).

The values of per worker pyhsical capital stock (k_t^g) and technology (A_t^g) on balanced growth path are determined by substituting the constant values in equation 21 into the equation 18 and 9 and solving for the levels of *A(t)* and *k(t)*.

$$F_k = \frac{(1-\alpha)(1-\theta)}{(1-\alpha)(1-\theta)-\beta 1} \tag{23}$$

$$F_A = \frac{(1-\alpha)\beta 1}{(1-\alpha)(1-\theta)-\beta 1} \tag{24}$$

$$D = (1-\alpha)(1-\theta)-\beta 1 \tag{25}$$

$$A_t{}^g = \frac{s^{\frac{\alpha\beta 1}{D}} FI^{\frac{\emptyset(1-\alpha)}{D}} L^{\frac{\beta 1(1-\alpha)}{D}}}{(\delta + F_k n)^{\frac{\alpha\beta 1}{D}} (\gamma + F_A n)^{\frac{(1-\alpha)}{D}}} \tag{26}$$ [1]

$$k_t{}^g = \frac{s^{\frac{1-(\theta+\beta 1)}{D}} FI^{\frac{\emptyset}{D}} L^{\frac{\beta 1}{D}}}{(\delta + F_k n)^{\frac{1-(\theta+\beta)}{D}} (\gamma + F_A n)^{\frac{1}{D}}} \tag{27}$$ [2]

From these equations, on balanced growth path, physical capital stock per worker and technology level depends on freedom index of an country, labour force level and growth rate of its, saving rate (fraction of investment in income) with the other constant values from production function.

Speed Of Convergence

By deriving speed of convergence, transtional dynamics of the system is quantified by log linearisition of equations 18 and 9.

$$\frac{\dot{k}}{k} = sA_{it}k^{\alpha-1} - (n+\delta) \equiv g_k(LnA, LnK) \tag{28}$$

$$\dot{A}_{it}/A_{it} = Y_{it}^{\beta 1} FI_{wit}^{\emptyset} A_{it}^{\theta-1} - \gamma \equiv g_A(LnA, LnK) \tag{29}$$

[1] Ulusoy and Yalçın, 2011
[2] Ulusoy and Yalçın, 2011

In these equations g values denotes growth rate functions of capital per worker and technology level. Ulusoy and Yalçın (2011), state *"Apply first order Taylor Series approximation on production function i.e.* $y(t) = A_t k_t^a$ *.As a result of Taylor expansion around balanced growth path values results in* A_t^g, k_t^g *following functional expression for Ln[k(t)] where k(t) denotes the value along the linearised transational path".*

$$Ln[k(t)] = \left(1 - e^{-\beta t}\right) Ln[k^g(t)] + e^{-\beta t} Ln[k(0)] \qquad (30)$$

Ulusoy and Yalçın (2011), state also "*For* $t \geq 0$ *, capital per worker value is the weighted avarage of initial and balanced growth path values with weight on the initial value of capital stock declining exponentially at the rate of* $\beta > 0$*. This rate states that physical productivity converges to its balanced growth path at a speed of convercence rate i.e.* β".

Formula (29) can be also written as (30).

$$Ln[A(t)] = \left(1 - e^{-\beta t}\right) Ln[A^g(t)] + e^{-\beta t} Ln[A(0)] \qquad (31)$$

And time path for production function is

$$Ln[y(t)] = \left(1 - e^{-\beta t}\right) Ln[y^g(t)] + e^{-\beta t} Ln[y(0)] \qquad (32)$$

Now β values can be found by log linearisation of equation along the balanced growth path (28) and (29)

$$\frac{\dot{k}}{k} = sAk^{\alpha-1} - (n + \delta) = \Omega_k$$

$$\dot{A}_{it}/A_{it} = Y_{it}^{\beta 1} FI_{wit}^{\emptyset} A_{it}^{\theta-1} - \gamma = \Omega_A$$

gives us speed of convergence also i.e.

In paper of Ulusoy and Yalcin (2011),

$$2\beta = [\alpha\beta_1(\Omega_A + \gamma) + (\Omega_k + (n + \delta))] - [(\alpha\beta_1(\Omega_A + \gamma) + (\Omega_k + (n + \delta)))^2 + 4(\Omega_k + (n + \delta))(\Omega_A + \gamma)((1 - \theta)(1 - \alpha) - \beta_1)]^2 \qquad (33)$$

Speed of convergence, β per unit of t, determines how fast ouput per worker production value converges its balanced growth path. If $\beta \uparrow$,the difference between $Ln[y(0)]$ and $Ln[y^g(t)]$ tend to 0 and rapid convergence occur to the balanced growth path, thus $Ln[y(t)]$ will be equal to $Ln[y^g(t)]$.

Balanced Growth Path Prediction

To test the model, $y^g(t)$ must be derived around balanced growth path. Substituting equations 26 and 27 into the model 34,

$$y^g(t) = A^g(t)[k^g(t)]^\alpha \tag{34}$$

$$y^g(t) = [\ (\frac{s}{(\delta + F_k n)})^{\alpha(1-\theta)} \frac{FI^{\emptyset}\ L^{\beta 1}}{(\gamma + F_A n)}\ ]^{\frac{1}{D}} \tag{35}$$

This is opposite to the neoclassical approach, i.e. per worker ouput is now proportional to the Freedom Index and the Level of Labor force and saving rate. The higher the efficiency of labour in economicaly free countries will increase the positive effect of saving per worker income around balanced growth path values.

Taking the natural logarithm of 35 and inserting equation 32 will gives us

$$\begin{aligned} Lny_{it} = {} & \left(1 - e^{-\beta t}\right)\alpha(1-\theta)Lns_{it} + \left(1 - e^{-\beta t}\right)\beta 1\, LnL_{it} + \left(1 - e^{-\beta t}\right)\emptyset\, LnFI_{it} + \\ & \left(1 - e^{-\beta t}\right)Ln[\gamma + (1-\alpha)\beta 1 n_{it}] + \\ & \left(1 - e^{-\beta t}\right)\alpha(1-\theta)Ln[\delta + (1-\alpha)\left((1-\theta)n_{it}\right] + e^{-\beta t}Lny_{t-1} + \mu_{it} \end{aligned} \tag{36}$$

Ulusoy and Yalçın (2011), states "*If the speed of convergence parameter is positive, one can predict the sign of the coefficients in formula, The first coefficient* $(1–e^{-\beta t})\alpha(1–\theta)>0$ *indicates that the more a country saves, the more rapidly it grows, The second* $(1–e^{-\beta t})\beta 1>0$ *, indicates that the scale of the labour force is a contributing factor to the per worker output, The third coefficient* $(1–e^{-\beta t})\emptyset$ *shows the effect of economic freedom on the production of a country and it is expected to be positive, Finally, the last term* $e^{-\beta t}$ *indicates that countries grow faster if they are initially below their balanced growth path*".

Methodology and Data

Methodology

Recent studies in applied and theoretical econometrics focus on nonlinear time series and panel data models. Particularly in the area of macroeconometry and macro finance, practical studies have begun on OECD, EU, G7 group countries. The most important reason for this is the expansion of trade in the world in the last 30 years and the integration of financial markets and the globalization of the aftermathing economies and their increasing dependence on each other. Globalization has helped economies to work with similar mechanisms. Hence, it has

become feasible for these similar economies to be analyzed together in the panel data set. One of the general characteristics of these studies was that they presupposed that the relationship between variables was linear. On the other hand, it can be said that the relations between economic variables are more complex and linear mathematical expressions are insufficient to explain this complexity. It is accepted that linear mathematical modeling is the reduced form of nonlinear models also. In other words, non-linear models are more inclusive and reliable in explaining economic relations as they include linear ones. On the other hand, panel data analyses have several advantages over cross-sectional or time series analysis.

If derivative of the model with respect to parameters depends on one or more than one parameter then we can say model is nonlinear in parameters.

Bates and Watts (1988), describes a nonlinear regression model as;

$$y_i=f(x_i,\theta_*)+\varepsilon_i \text{ where } i=1,2,\ldots.n \qquad (37)$$

In this model is ε_i error term, it is assumed that $\varepsilon_i \sim (0,\sigma^2)$, f is expectation function, x_i shows vector of independent variable and θ represents p amount of unknown in nonlinear in parameters. Bates and Watts (1988), states *"For nonlinear models, at least one of the derivatives of the expectation function with respect to the parameters depends on at least one of the parameters"*.

In non-linear regression models, the Least Squares (OLS) or Maximum Likelihood Estimators (MLE) are used to estimate parameters. However, nonlinear regression it will be difficult to find analytical solutions in model, contrary to linear regression, so using iterative methods will be the right way to estimate. Bates and Watts (1988), states also "*An approach suggested by Gauss is to use a linear approximation to the expectation function to iteratively improve an initial guess* θ^0 *for* θ *and keep improving the estimates until there is no change*".

The Gauss-Newton method uses Taylor series expansion and increases the convergence speed of the operations and reduces the number of consecutive operations. The method starts with an initial value. This initial value should be well-defined. If the starting point is chosen far from the most appropriate point, the number of consecutive operations will increase. In study, iterative optimization technique-Panel Nonlinear Least Square Method With Gauss Newton Algorithm

has been used by Stata econometric software.

Data

Empirical estimation results for panel data comprising of 159 world countries through the years 1995-2014 via nonlinear least square methods.

In model 36, Gdp per worker (y), Labor Force (L), Saving Rate (s) data are taken from PenWorld Table version 9. Freedom Index data are taken from Heritage website, Growth of Labor Force (n) has been calculated manually from Labor Force data and negative values are transformed to positive values by adding smallest negative value in series to the entire series. So whole series become positive and data will not lose its original properties. In model depreciation rate of capital (delta) and depreciation rate of technological advances (Gamma) has been taken constant values of, 0.06 and 0.12.

Data definition and source of them are detailed in Appendix.

Table 2

Descriptive Statistic of Variables

	Mean	Std. Dev.	Min	Max
y	36666.26	36834.35	501.4178	257008.8
L	1.80E+07	7.06E+07	45444	7.87E+08
FI	59.70121	10.67603	21.4	90.5
s	0.21598	0.090923	0.019824	0.889013
n	0.114525	0.033738	0	0.331819

Source: Author's computation using Stata

Table 3

Pairwise Correlation Matrices of Variables

	s	FI	L	n
s	1.000			
FI	0.3045	1.000		
L	0.1234	-0.0643	1.000	
n	0.1059	0.0111	-0.0406	1.000

Source: Author's computation using Stata

Empirical Results

Nonlinear model has been simulated for verious starting values of coefficient vector which are implied by theory. Sum of Squared Residual values of the converged parameter were compered after each iteration. Convergence cooefficient simulation range of values reflect the view that developed countries are assumed to be close to steady state growth pahase.

θ (Theta) $0< \theta <1$

α (Alpha) $0< \alpha <1$

After many iterations we found convergence by the initial values

β =0.09 α= 0.3 θ= 0.08 $\beta 1$= 0.1 Ø= -0.1

Table 4

Results of nonlinear least square estimations

Parameters	Estimates	t-Statistic
β	0.006517	6.03
α	1.084271	67.91
θ	-1.142696	-2.82
$\beta 1$	0.370339	3.68
Ø	2.516176	8.35

Source: Author's computation using Stata

Results of non-linear estimation of dynamic econometric model in equation 36 are as follows:

- Income share of physical capital α estimate is unity where a one percent increase in capital per worker would increase perworker output by %1.08.
- Coefficient of saving rate $\alpha(1-\theta)$ is positive as theory implies and statistically significant.It means %1 percent increase in saving rates would increase GDP by %2.32
- θ shows that existing technology stock have negative effect on the productivity of new technology stock. It means that %1 increase in current technology level would decrease GDP by %1.14.

- Coefficient of Total Labor Force (β1) is positive indicating that %1 increase in employment rate would increase GDP per capita by %0.37.
- Coefficient of Freedom Index Ø on the production of country is positive indicating that % 1 increase in freedom index would increase GDP percapita by % 2.51

In our result convergence coefficient β is statistically significant and quite low (0.0065179 a year) which may imply that GDP Growth of these 159 countries are slow and will be effective in the long run. Half life on a logarithmic scale of output per worker is aprroximately;

$Ln(2)/0.0065179 = 107$ years

In other words, 107 years are necessary to close half of the gap between the income per capita of any country in 1995 and the long-term per capita income of 159 countries (stationary state income).

Conclusion

This study aims to test empirically whether economic freedom stimulates macroeconomic growth, within endogenous growth model. Study follows mainly papers of Ulusoy (2001), Ulusoy and Yalçın (2011), Karpavicius et.al. (2014). Derivation of endogenous macroeconomic model dynamics, convergence coefficients and transitional stability conditions are also mentioned. Panel data covering 159 countries is used for the period of 1995-2014 by nonlinear least square methods. The implications of empirical results on economic policies are as expected; the investments share in GDP and growth of population have positive and significant effect along the balanced growth path. On this path the increase in production through economic freedom is effective for all countries also. % 1 increase in capital per worker, saving rates, employment rate and freedom index would increase GDP per capita by %1.08, %2.32, %0.37 and %2.51 percent respectively. By maintaining macroeconomic stability in parallel with economic fredoom, the volume of savings, long-term capital accumulation, the national welfare level, the investments arise and the effectiveness of the distribution of source is possible. Economic freedoms are important especially for developing countries to achieve a sustainable economic growth rate and to reduce unemployment. In countries with high levels of economic freedom, investor and consumer confidence is high. This high confidence increases domestic savings and foreign capital inflows. In this way, new investments gain momentum, trade volume and production increase and therefore economic growth increases. For this, first of all, developing countries should pave the way for economic freedoms. Empirical results are consistent with the economic freedom and economic growth literature and Fraser Institute's Annual 2020 reports.

Past empirical studies generally use linear and log-linear models. This study contributes to the literature by preferring non-linear specification and deriving concept of convergence coefficient within the model. Other studies on economic freedom also used non-linear estimation such as Generalized Method Of Moments (GMM) but iterative non-linear estimation techniques have been used in this study.

This study may enforce further research on non-linear estimation (GMM), interaction variable with Freedom Index and other variables and variables using different iterative algorithms other than Gauss Newton Algorithm (GNA).

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Appendix

y=Real GDP at constant 2011 national prices (in mil. 2011US$) /Number of persons engaged (in millions) (GDP per Worker)- GDP values are taken from PenWorld Table https://www.rug.nl/ggdc/productivity/pwt/

L= Total Labor Force (Total Labor Forces comprises people ages 15 and older) datas are taken from World Data Bank

http://databank.worldbank.org/data/reports.aspx?source=2&series=SL.TLF.TOTL.IN&country=

n=Growth of Labor Force

Sv= Saving Rate (Share of gross capital formation at current PPP-Investment/GDP) datas are taken PenWorld Table https://www.rug.nl/ggdc/productivity/pwt/

FI=Heritage Freedom Index are taken from https://www.heritage.org/index/

Depreciation Rate (Delta- δ)= Avarage depreciation rate of the capital stock

Depreciation Rate (Gamma-Y)= Depreciation rate of technological advances

Theta (θ)=Returns to technology from existing tehnology stock

Alpha (α)= Capital Share in income (The value of α tells us how rapidly the economic usefulness of additional investment in buildings and machines declines as the economy accumulates more and more of them)

Beta (β) =Speed of Convergence (how fast the output per worker reaches its balanced growth path)

Balanced Growth Path= Situation in which output per worker, capital per worker and consumption per worker grow at constant (but potentially different) rates

β1 and "Ø" Coefficients of Total Labor Force and Freedom Index

Ek Beyan / Declaration

— Makalenin tüm süreçlerinde TESAM'ın araştırma ve yayın etiği ilkelerine uygun olarak hareket edilmiştir.

— Bu çalışmada herhangi bir potansiyel çıkar çatışması bulunmamaktadır.

— Yazarlar bu çalışma için finansal destek almadığını beyan etmiştir.

— 1. yazar %60 oranında, 2. yazar %40 oranında katkı sağlamıştır.

— In all processes of the article, TESAM's research and publication ethics principles were followed.

— There is no potential conflict of interest in this study.

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— 1. author 60%, 2. the author contributed 40%.