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An investigation on the effects of financial and trade liberalizations and the number of scholars on patent, invention and accumulation of ideas in the developing countries

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Abstract: In recent years, great deals of studies have investigated the effects of financial liberalization and expenses of research and development on economic growth. The present paper deals with investigation of the effects of financial and trade liberalization and the number of the scholars on the patents, inventions and accumulation of ideas in the developing countries by use of GMM panel method. The results achieved from the dynamic panel reveal that the variables of research and development expenses, the number of the researchers and financial liberalization have positive and significant effect on the accumulation of ideas. On the other hand, trade liberalization has negative and significant effect on the accumulation of ideas. The received results of the estimation using data panel method with random effects show that the expenses of research and development and the number of researchers have positive and significant effects on the accumulation of ideas while financial and trade liberalization have insignificant effect on the accumulation of ideas and knowledge.

Key words: Financial liberation; Trade liberation; Accumulation of ideas

1. Introduction

One of the economic purposes of any country is achieving high economic growth. One of the frequently asked questions is that what factors affect the economic growth and how this effect is. In this regard, many studies have been conducted to provide a proper answer for this question.

The recent studies being conducted on the theory of endogenous growth indicate that research and development, financial factors, trade liberalization, ideas and technology are the most important factors of long-term growth (Blackburn and Hung, 1998; Aghion and Howitt, 2009). These studies predict that the deficiencies of financial markets hinder the fact that innovators obtain enough financial resources. They also indicate that financial liberation, remove of the credit restrictions and helping the facilitation of the modern technology bring about development of the industries' knowledge and technology.

On the other hand, production is the idea which manifests the process of changes of technology seriously and the new ideas create improvements in production of technology. In addition, if we follow the fluctuations of the innovative activities in productivity patterns, according to the rate of the changes in innovation, productivity might be accelerated or reduced (Bottazzi and Peri, 2007).

Bekaert (2005) and Edwardws (2001) studied the effects of financial liberalization on economic growth; however, these papers only have had direct effect of financial liberalization on economic growth. Since financial affairs have fundamental role in innovative activities, analyzing the effect of financial liberalization in innovation is the key of a channel which can affect economic growth.

The relation between financial affairs and economic growth is analyzed within the framework of the growth model based on innovation. These models predict that the deficiencies of the financial markets lead to increase of the surveillance costs and consequently, the hidden encourage from inventions will be successful so that the companies can prevent the repayment of loans. Removing the financial constraints lead to encouragement of more ideas for production and invention. In addition, the liberalization process has brought about the increase of financial system through removing the non-efficient inputs. Therefore, delving deeply into the innovation section predicts a positive correlation between financial affairs and innovative production.

In this paper, after representing the theoretical framework, in the third section of the paper, it has been dealt with the literature review of the effects of financial liberalization, trade liberalization and the number of the scholars on the patent, inventions and accumulation of ideas. Then, the variables have been introduced and the applied model is illustrated in the fourth section and finally, in the fifth section, the summary and conclusion are given. Also, according to the study's findings, political suggestions have been proposed.

2. Theoretical framework

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Financial liberalization and financial development are two variables from financial markets which can affect economics of a country from different aspects. The financial markets have key roles in creation of idea and knowledge and consequently, they improve the economic growth. The process of financial liberalization leads to the fact that financial system of a country to enjoy more efficiency through removing the non-efficient inputs, reduction of capital costs, reduction of monitoring costs and reforming the financial infrastructures. This process can decrease the problems related to asymmetry of information in financial markets. On the other hand, financial liberalization cannot be separated from trade liberalization. In this regard, some studies could be mentioned. Aizenman and Noy (2005) stated that financial liberalization is often happened after trade liberalization and it is due to the reason that trade convergence makes the constraints to be more serious in the financial affairs.

On the other hand, today research activities and development of the main bases are innovative and constantly provide the ground for new demands. These new demands which are stimulus for investment and finally insurance of economic growth and prosperity, have significant function in today's industrial world. In the present era which is the era of domination of science and technology to the universal economics, taking new steps to keep pace with the universal economics seems to be necessary (Hoseinzadeh, 2001).

In the industrially developed countries, the expenses on research and development are more than %97 of the total expenses of research and development in the rest of the world. In this group of countries, exploiting the human resources and creativity, science and technology form the cultural, social, and economical structures and they create a special quality of life for people.

The most important role of the innovative activities in the long-term growth models have gained momentum in theoretical frameworks of input growths. In studying these models, a simple function of production is used in which Y_t is the total production during time t:

$$Y_t = A_t^{\alpha} K_t^{\alpha} L_t^{1-\alpha} \sigma > 0, \quad 0 < \alpha < 1 \qquad (1)$$

In the above model, A_t shows the storage of the total available knowledge or idea in economics, K_t is the physical capital and L_t stands for the existed workforce. We assume that there is a constant rate of return in K_t and L_t which keeps A_t unchanged.

If equation 1 could be rewritten in the form of per capita, we will have:

(2) $y_t = A_t^{\alpha} k_t^{\alpha} \sigma > 0, \quad 0 < \alpha < 1$

With logarithm and integral of both sides of growth rate from per capita production in period t we can write:

(3) $\frac{\dot{y}_t}{y_t} = \sigma \frac{\dot{A}_t}{A_t} + \alpha \frac{\dot{k}_t}{k_t}$

In the direction of balanced growth, growth rate of per capita production is as follow:

(4) $g_y = \frac{\sigma}{1-\alpha} g_A$

Equation 4 shows that accumulation of the ideas is an important factor in long-term growth.

According to the function of the production of ideas, the rate in which new ideas are discovered depends on the allocated resources to discovering ideas which are storage of the present ideas. According to this framework, the growth based on innovation, and research and development activities are the main factors in producing new ideas. Romer (1990) believes that the researchers are interested in the benefit of their inventions and for this purpose they continue to discover new ideas.

In the models of hidden inventions, the right of ownership is not taken into account and to some extent; this assumption is not valid, since considering these factors in the models is very important. The ability to conceal the successful inventions or to enjoy the monopoly power from the new invention can significantly be effective in discovering the new ideas. The recent developments in theories of endogenous growths reveal that the undesirable concealing the production of inventions could be decreased by deepening the financial system. For instance, using different models of production, Blackburn and Hung (1998) believe that the companies have encouraging factors which make the successful projects in research and development to be concealed so that they can avoid the repayment of their loans. Here, there is an ethical problem which increases the expenses of supervision and the compatible loans with interest motivation. Also, in their model, the financial system allows that financial intermediaries participate in many projects so that they can reduce the costs significantly. And the reduction of surveillance costs leads to production of ideas and development of technology.

Financial liberalization and financial development are two different variables of financial affairs which can be effective in production of ideas from different aspects. Among the recent studies, we can point to Ang (2010) indicating that while financial development helps the inequalities of income, financial liberalization has opposite effects. Also, Ang asserts that financial development in Malaysia has led to the encouragement of private savings in this country while financial liberalization has opposite effects. Although financial development has been effective in creating knowledge, the above-mentioned results reveal that it is better to consider the common effects of these two financial variables together.

3. Review of the literature

Romer (1990) states that there are new theories in growth models which have accepted new factors such as research and development, and discovery of ideas and inventions are motivating forces for economic growth of a country. Industrial innovation with motivation of achieving benefits which is the result of research and development activities would

lead to accumulation of knowledge and technology and because, to some extent, they are exclusive, they are considered as a source of growth for a country.

Stadler (1992) shows that production of desirable innovative activities has inverse correlation with interest rate. According to the point that reduction in the limitations of interest rate is often related to financial liberalization, this event is possible. In general, the costs higher than capital impede production of innovative activities in technology section. Schwartz (1992) also believes that if more budgets are allocated to technology section, we can expect a widespread economics in the field of innovative activities.

For 21 countries which were members of OECD group, Co and Helpman (1997) came to this conclusion that in relation with the countries with a high share in research and development, the countries which adopted open-trade policy have achieved more foreign interests from research and development activates than the countries which did not. These researchers have used the research and development expenses of the country and also the average weight of the research and development expenses of their trade partner countries as substitution of capital reserve regarding research and development of the country and the world that is a kind of innovation.

Ang (2008) investigated the effects of financial development and financial liberalization on knowledge accumulation and the results he achieved show that while financial development facilitates collection of new ideas, it has negative correlation with execution of financial reform policies. In addition, he indicated that increase of research and development of activities and spiritual ownership have useful effects on knowledge accumulation.

Do and Levchenko (2004) have studied the effects of trade liberalization and increase of trade level on financial development. Based on the results they achieved, the effect of trade has been different in different countries. Trade has had positive effect on promotion of financial system in the wealthy countries and negative effect on promotion of financial system in the poor countries.

Based on the above-mentioned facts, the amount of production of new ideas $A_t$can be as a product of production process of ideas which has been created by usage of research and development input(R_t). Also, the already discovered idea is A_t and F_t shows new ideas managed by financial system. F_t is the pattern of the protective framework. The production process of idea can be stated by the following equation:

(5) $A_t = \lambda R_t^{\delta} A_t^{\varphi} F_t F_t^{\pi} 0 < \delta \leq 1 \quad \varphi < 1 \quad \theta > 0 \quad \pi > 0$

Under static conditions, the growth rate of accumulation of ideas $\frac{A_t}{A_t}$, is fixed. To confirm this, we can point to the experimental findings of Howitt (2007), Ha (2007) and Peri (2007) which indicate that storage of ideas is always convergent to the direction of balanced random growth.

By solving the above equation we will have:

(6) $\ln A_t = \beta_0 + \beta_R \ln R_t + \beta_F \ln F_t + \beta_p \ln F_t$

The above equation shows that $\ln F_t$, $\ln F_t$, and $\ln R_t$ are the effective factors in production of ideas in long terms. In fact, this equation shows the financial importance in determining the development of new technology. Most likely, the financial development can be effective in production of new ideas through reduction of surveillance costs and ethical hazard problems.

Ang and Madsen (2008), show that the function of knowledge production can be used for testing the effect of financial liberalization to produce ideas. They proposed the following equation as the function of idea production:

(7) $\ln A_t = \alpha + \beta \ln A_t + \chi \ln (\frac{X}{Q})_t + \delta \ln FI_t + \varepsilon_t$

In which A_t is the production of idea, A_t is the amount of knowledge or idea storage and $(\frac{X}{Q})_t$ shows the research sensitivity, and ε_t is indicative of measurement error. It is expected that based on the prediction of Schumpeter Ian's endogenous growth theory, the amount of parameter β be a unit amount. When the research and development activities encourage innovative activities, the parameter χ has a positive sign. They also suggest that the financial liberalization FI_t has positive effects on knowledge production. Therefore, they expect that parameter δ has positive sign, too. They have used the above equation during 1967 to 2005 for Korea.

Regarding the domestic studies, it should be mentioned that no research has been conducted about the effects of financial liberalization on accumulation of ideas. However, in the conducted studies, it has only been dealt with the effects of financial and trade liberalization and their correlation with economic growth such as Komeijani and Nadali (2007) who studied the correlation between financial deepening and economic growth in Iran and their results showed that there is a positive correlation between economic growth and financial deepening.

Yousefi and Mobarak (2008) studied the effects of financial and trade liberalization on condition of two real and financial sections of Iran's economics. The results of this study revealed that increase of trade level in Iran's economics leads to increase of financial development level and economic growth. For financial development liberalization to be effective in economic growth, it is necessary to prepare its preconditions and background.

4. Stipulation of the model

To analyze the effects of financial liberalization, research and development expenses and the number of the researchers on the variable of accumulation of idea and knowledge we used Ang (2010)'s model which was used for Korea. The model is as follow:

(8)

$\ln STOCK =$

c_1 + c_2 ln$R\&D$ + c_3 ln$RESERACHER$ + c_1 ln$FINANCE$ + c_5 ln$OPEN$ + ε_i

In this model, ln$STOCK$ is logarithm of accumulation of idea and knowledge, ln$R\&D$ is logarithm of research and development expenses, $lnRESERACHER$ is the logarithm of the numbers of the researchers, $lnFINANCE$ is financial liberalization, and ln$OPEN$ is trade liberalization.

As Kortum (1993) asserted, the patent and invention activities can be proposed as proxy for innovative activities. Therefore, the patents by domestic scholars are used as a criterion for output of the patent A_t. The internal storage of knowledge or accumulation of idea $STOCK_t$ is calculated based on A_t and by usage of perpetual inventory method with %10 amortization rate. The primary storage of knowledge equals to the number of patents in the first period divided by amortization rate plus the average growth in the patent right in the whole of the studied period. It is shown as the following equation.

(9) $STOCK_0 = \frac{A_0}{\delta+g}$

4.1. The studied countries in the research

The countries studied in the research include 23 selected developing countries. These countries are: Argentina, Brazil, Chile, China, Colombia, Ecuador, Estonia, Hungary, India, Iran, Lithuania, Malaysia, Malta, Mexico, Moldova, Paraguay, Singapore, Slovakia, Slovenia, Thailand, Tones, Turkey, and Uruguay. These countries were chosen based on availability of data and less loss of data.

4.2. Data

The variables used in this study include the number of patents, financial liberalization, the number of researchers and the proportion of imports to gross domestic product as proxy for trade liberalization that these data were collected from World Intellectual Property Indicators and the website www.heritage.org and the two recent cases from the World Development Indicators. The studied period of this research was from 1996 to 2009. The descriptive analysis of the variables is given in the following Table.

Table 1: The statistical analysis of the variables

	Mean	Maximum	Minimum	Standard deviation
STOCK	5525	95259	3	12896
R&D	0/68	2/66	0/05	0/46
RESEARCHER	1179	5954	40	1177
FINANCE	52	90	10	18
OPEN	102	445	14	77

5. Testing the Unit Root

In the first stage and before estimation of the model, the variables are analyzed by usage of models of GMM panel and data panel. The results of testing the unit root indicate that all of the variables are in level and the zero hypothesis of having unit root in the variables is rejected. Therefore, in the next stages, estimation of artificial regression is ignored and the coefficients can be interpreted by more reliability.

Table 2: The results of testing the unit root of Shin and sons at level

	Testing statistics	Probability
LSTOCK	-2/59*	0/00
LR&D	-1/29**	0/09
LRESEARCHER	-10/52*	0/00
LFINANCE	-1/89*	0/02
LOPEN	-1/86*	0/03

*and ** are indicative of significance at the error level of %5 and %10 respectively

6. The method of GMM panel

Usage of compound method instead of sectional method provides this opportunity to analyze the dynamicity of the changes. Usage of compound data has other advantages, too, such as considering individual inequalities and more information, omitting the biases along with sectional regressions which lead to more precise estimations and less co-linearity in order to estimate the pattern of dynamic panel that we will use GMM method.

The general form of the model in this method is as follow:

(10) $y_{it} = \alpha y_{it-1} + \beta X_{it} + \mu_t + \varepsilon_{it}$

And equally:

(11) $\Delta y_{it} = \alpha \Delta y_{it-1} + \beta \Delta X_{it} + \Delta \varepsilon_{it}$

In which y is dependent variable, and X is the explanatory variable vector. Indices of i and t are country and time respectively. ε and μ are error and special unobserved effects of each country.

However the fundamental problem in estimation of this pattern is that the pause of dependent variable in the right side has correlation with

particular sectional effects of every country. This problem leads to the fact that estimation of the pattern by usage of the method of fixed or random effects will be biased and incompatible. Therefore, to remove this problem, we use GMM method which has been developed by Arellano & Bond for panel patterns. To remove the correlation of the dependent variable with pause and error, the pause of variables as instrument in two-stage GMM estimator is applied.

The achieved results from estimation of the model and the coefficients related to the variables are shown in Table 3:

Table 3: The results achieved from estimation of GMM panel

	Coefficient	Statistic t	Probability
LSTOCK(−1)	0/66	70/08	0/00
LR&D	0/26	4/13	0/00
LRESEARCHER	0/44	4/50	0/00
LFINANCE	0/60	11/31	0/00
LOPEN	-0/55	-3/33	0/00
test Wald	having chi-square distribution with 0/00 probability		
Sargan statistic	having amount of 16/99		

*indicates significance at the error level of %5

The results achieved from the estimation of dynamic panel shows that the variable of research and development expenses has had positive and significant effect on accumulation of idea and knowledge so that by one unit increase in research and development expenses, accumulation of ideas is increased by %26.

The number of the researchers has had a positive and significant effect on accumulation of ideas so that one unit increase of the number of the researchers led to 44 units increase in accumulation of idea and knowledge in the developing countries and statistically, this coefficient is significant.

Financial liberalization also has positive and significant effect on accumulation of ideas in that an increase of one unit in financial liberalization led to 60 units of increase in accumulation of idea and knowledge. On the other hand, trade liberalization has had a negative and significant effect on accumulation of ideas.

Based on the results of Wald test which enjoys Chi-square distribution with equal freedom degrees, and the number of explanatory variables minus the fixed component, the zero hypothesis saying that all of the coefficients at the level of %5 are zero, is rejected; therefore, the estimating coefficients have the required validity.

Sargan test statistic which enjoys Chi-square distribution with equal freedom degrees with the number of excessive clear limitations, rejects the zero hypothesis about correlation of the wastes with instrumental variables. Therefore, the validity of the results for interpretation is confirmed.

The positive and significant effects on the function of production of the accumulation of ideas show that the carried out activities on research and development in the developing countries have an important role in development of technology. On the other hand, financial liberalization of the surveillance costs and ethical problems will be reduced; consequently, they can be efficient in production of ideas. The number of researchers and maintaining their patents increase the motivation for innovation. Therefore, executing rigorous activities to support ownership of the researchers can be considered a fruitful strategy in production of knowledge and technology. Park and Ginarte (1997) argument that the increase rate of innovation by supporting the researchers is occurred in long terms.

7. The achieved results from data panel

In this stage, to prove that the results of the previous testing have the required validity, the coefficients were estimated again by data panel test. The results of this estimation are given in Table --. At first, Hausman test was carried out and the achieved results of this test showed that the estimation is acceptable with random effects.

The results achieved from the estimation using data panel method with random effects indicate that research and development expenses and the number of the researchers have positive and significant effects on accumulation of ideas so that %1 increase in research and development expenses leads to %67 increase of accumulation of ideas. Also, %1 increase in the number of the researchers makes %82 increase in accumulation of ideas and knowledge.

On the other hand, financial and trade liberalization have insignificant effects on accumulation of ideas and knowledge.

8. Summary and conclusion

During recent years, a vast area of studies has been conducted about the effects of financial liberalization, trade liberalization and research and development expenses on economic growth. Ang (2010) stated that these variables can have a significant role in ideas and inventions and consequently be effective in economic growth.

Analysis of the results obtained from the effects of financial and trade liberalization, research and development expenses, and the number of the researchers on the function of accumulation of ideas in developing countries with usage of dynamic panel indicated that research and development expenses, the number of the researchers, and financial liberalization have positive and significant effects on

accumulation of ideas while trade liberalization have negative and significant effects on accumulation of ideas. On the other hand, the results achieved from data panel with random effects indicated that the number of the researchers and research and development expenses also have positive and significant effects on accumulation of ideas while trade liberalization has negative and insignificant effects on the accumulation of ideas.

Table 4: The results achieved from panel test with random effects

	Coefficient	Statistic t	Probability
c	14/35	6/90	0/00*
LR&D	0/67	2/29	0/02*
LRESEARCHER	0/82	3/14	0/00*
LFINANCE	0/23	1/14	0/25
LOPEN	-0/25	-0/65	0/51
Hausman test	Having chi-square distribution with statistic of 7/77 and probability of 0/10		
test wald	Having chi-square distribution with probability of 0/00		

*indicates significance at the level of %5 error

The results of the study revealed that increase of expenses in research and development leads to efficiency of the elites and increase in technology which bring about increase in accumulation of ideas and patents. On the other hand, financial liberalization decreases the costs of surveillance and ethical problems which can have an effective role in production of ideas.

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