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# A Study on Interaction between Economic Openness and R&D Policies

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## 1. Background

This study discussed two issues. First, considering the interaction between economic openness and R&D investment, we investigated their effects on economic growth. Second, we analyzed R&D policy directions under the new international trade environments such as deepening trade liberalization, Korea's fast economic growth, and potential dispute under the WTO.

There have been many studies that focus on the industrial policy and open economy policy as a major cause of rapid economic growth in the past Korean economy. However, the consideration of the interaction of both policies is not enough.

In this study, we tried to present the direction of R&D policy corresponding to the new international trade environments based on understanding the interaction between the economic liberalization policy and R&D.

The research on the interaction between economic liberalization policy and R&D is necessary not only to develop the direction of future R&D policies but also to derive policy recommendations to maximize the effects of R&D investment prior to further liberalization.

Open economy policy has facilitated the quantitative growth by the expansion of export markets and led to its development by increased productivity through learning-by-doing technology adoptions, economies of scale, and technology spillover from advanced countries. In addition, R&D policies improve productivity with the development of new technologies as well as the improvement of the absorption capacity of the technology developed in other countries. Therefore, unless a comprehensive analysis takes into account the interaction of open economy policy and R&D policy, the effect of economic openness is likely to be overestimated as a factor of economic growth. Opening up the market does not promote the growth automatically.

In addition, in order for the Korean government to properly respond to the rapidly changing international trade environment such as further trade liberalization with FTAs, Korea's tumbling economic growth, dispute possibilities through the WTO, the new R&D policy direction should be sought.

FTAs have rapidly spread throughout the world, and the DDA negotiations and plurilateral agreements are expected to further promote trade liberalization. As for Korea, FTAs with U.S. and EU have already entered into force and FTA negotiations with major trading partners such as China and other emerging economies are underway. Trade liberalization of Korea will inevitably be even larger and deeper in coming years.

Moreover, Korea, the seventh largest exporting country, competes intensively with major economies in the world market. This implies that Korea's R&D policy affects not only Korea's competitiveness but also other countries'. Therefore, from a global perspective, Korea should pursue a strategic R&D policy to conform to international norms by considering the trade friction with other WTO members.

## 2. Economic Openness and R&D Investments

For the past 20 years, trade liberalization has been pushed forward all over the world. Since the 8th multilateral trade negotiations, the Uruguay Round was concluded in 1993 and the WTO was launched in 1995, the scale of international trade has shown a very rapid increase.

According to UNCTAD, the size of the trade in goods increased by 9.1% annual average of USD 36.6 trillion in 2011 from USD 7.6 trillion in 1993 and the proportion of merchandise trade to the world GDP increased sharply to 30.0% in 2008 from 53.3% in 1993. FDI has increased by 11.4% year on average USD1.5 trillion in 2011 from $54.1 billion in 1980 (flow), and FDI increased to USD20.4 trillion over the same period from USD 0.7 trillion by an annual average of 11.5%.

Similarly, R&D investment by major countries has also continuously increased. Fourty-one countries for which the OECD provides R&D investment database show increase in R&D investments monotonically except in 2008 and reached USD1 trillion and USD 29.2 billion as of 2009. In particular, non-OECD members have invested more compared to OECD countries and the proportion of non-OECD R&D investment to the world total investment increased steadily from 8.9% in 2009 to 18.5% in 2001.

As a result of examining the relationship among R&D investment, trade and FDI, we found a meaningful interaction between R&D investment and economic openness. Since 1997, the trade in high tech or mid tech items has increased more than the trade in low tech items among OECD countries. These statistics show that economic liberalization makes competition in export markets around the world more intense, and OECD countries improve the competitiveness in quality and technology. Because foreign firms perform R&D activities with funding from the headquarters, FDI influences product competitiveness and R&D investment of the destination countries. In most countries, the shares of R&D investment by foreign companies tend to increase. In other words, attracting FDI by the development of an open economy encourages foreign companies to carry out more R&D activities in a country.

## 3. Interactions between Economic Openness and R&D Investment

In order to investigate the impact of liberalization on the R&D investment, determinants of R&D in the private and the government sectors were analyzed. For the empirical tests on the effects of economic openness to R&D, we divided R&D into Business R&D and Government R&D, classified countries into two main groups: all 34 OECD members (OECD34) and 21 high-income OECD members (OECD21), and compared periods between 1990s and 2000s.

According to the results, business R&D is increased by trade liberalization ($Trade$) while it has no effect from investment liberalization ($FDI$). On the other hand, government R&D has the opposite effects depending on the channels of economic openness ($Trade$ or $FDI$). That is, government R&D has a negative impact from an increase in trade and a positive impact from an increase of FDI. The noticeable finding is that an increase in trade diminishes government R&D as the import which embodies foreign R&D increases. It can also be understood as an economy gets more involved in international trade, government R&D subsidies that are in conformity with the provisions of the WTO enforcement decrease.

The effect of GDP per capita (In$PGDP$) on business R&D has decreased since 2000 while the effect on government R&D varies depending on the countries included. For example, the positive impact of GDP per capita on Government R&D has decreased in OECD 34 while it increased in OECD 21 in the 2000s.

Also the results show that the effect of direct or indirect R&D subsidies by Government (direct government funding for business R&D subsidies (In$BGRD$) and protection levels of IPR($IPR$) has significantly increased in OECD 21. In other words, government policy supporting R&D promoted business R&D. However, the effect of the government's intent to R&D measured by the level of IPR ($IPR$) and government expenditures (*Size*) as a percentage of GDP has significantly decreased in 2000s.

In order to verify the effect of R&D investment on economic openness (export performance), we have analyzed Korean firm-level data for the years 1980–2011, which was provided by the Korea Information Service.

We investigated the effects of the firms' R&D investment on export such as the proportion of exports to total sales, whether to export, and whether to start exporting. We consider two types of R&D: process R&D and product R&D.

**Table 1. Analysis Results of Economic Openness on R&D**

| I | Business R&D | | | | Government R&D | | | |
|---|---|---|---|---|---|---|---|---|
| | OECD 34 | | OECD 21 | | OECD 34 | | OECD 21 | |
| | 1990s | 2000s | 1990s | 2000s | 1990s | 2000s | 1990s | 2000s |
| $Trade$ | -0.002<br>(0.003) | 0.003*<br>(0.002) | -0.002<br>(0.005) | 0.002<br>(0.001) | 0.003**<br>(0.001) | -0.010***<br>(0.002) | 0.003<br>(0.002) | -0.010***<br>(0.002) |
| $FDI$ | -0.007<br>(0.007) | -0.001<br>(0.001) | -0.006<br>(0.009) | -0.001<br>(0.001) | -0.004<br>(0.004) | 0.004***<br>(0.002) | -0.003<br>(0.004) | 0.003**<br>(0.001) |
| $\ln PGDP$ | 0.968**<br>(0.392) | 0.188<br>(0.259) | 1.183***<br>(0.432) | 0.694*<br>(0.372) | 1.420***<br>(0.199) | 1.302***<br>(0.264) | 1.773***<br>(0.208) | 2.194***<br>(0.471) |
| $IPR$ | 0.216***<br>(0.056) | 0.040<br>(0.060) | 0.157**<br>(0.072) | 0.412*<br>(0.249) | 0.169***<br>(0.025) | 0.162**<br>(0.065) | 0.058*<br>(0.034) | 0.280<br>(0.334) |
| $\ln BGRD$ | 0.070**<br>(0.029) | 0.199***<br>(0.022) | 0.072<br>(0.051) | 0.121***<br>(0.030) | | | | |
| *Size* | | | | | 0.066***<br>(0.009) | 0.047***<br>(0.013) | 0.058***<br>(0.011) | 0.043***<br>(0.016) |

Note 1) ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
2) Numbers in brackets are standard errors.
3) Time dummies were included, but the results are not reported.

According to the result of the analysis, firms' total R&D investment have no impact on total exports, but the share of R&D investment in total sales affects positively whether to export, export ratio, and whether to start exporting. To sum up, as the share of R&D investment in a firm increases, the firm is likely to increase export share (intensive margin) and the probability to enter new export market (extensive margin).

**Table 2. The effects of R&D on export performance**

| Dependent variable | Whether to export | Export shares | Starting export |
|---|---|---|---|
| ln(total sales) | 0.055*** | 0.077*** | 0.006** |
| | (0.004) | (0.004) | (0.002) |
| R&D share | 0.003*** | 0.003*** | 0.001** |
| | (0.001) | (0.001) | (0.001) |

Note 1) ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
2) Numbers in brackets are standard errors.

We also analyzed the long-term interactions among R&D intensity, the inflows of foreign R&D through trade, and value-added growth of manufacturing industries in Korea by using a panel VAR approach.

Table 3. The effects of product and process innovation on export

| Dependent variable | Whether to export | Export shares | Starting export |
|---|---|---|---|
| share of product innovation R&D | 0.004*** | 0.003*** | 0.002*** |
| | (0.001) | (0.001) | (0.001) |
| share of process innovation R&D | | | |
| ln(total sales) | 0.073*** | 0.076*** | 0.013*** |
| | (0.006) | (0.006) | (0.004) |

Note 1) ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.
2) Numbers in brackets are standard errors.

The impulse-response analysis and variance decomposition of forecast errors provided the three main findings in the long-run influence of one variable to the other two variables. First, the impulse-response analysis shows that the inflows of foreign R&D through trade have induced the increase in domestic R&D intensity in Korea, which have subsequently led to the positive value-added growth. The inflows of foreign R&D through trade have not directly influenced on the value-added growth of Korea in short-run; however, they have gradually increased the value-added growth in the long-term. Second, the increase of domestic R&D intensity has led the inflows of foreign R&D to decrease. These results can be interpreted that technological progress through domestic R&D activities substitutes imported products or technologies in the long-run. Third, the variance decompositions show that domestic R&D intensity and inflows of foreign R&D through trade have influenced on each other's changes. Regarding economic growth, however, domestic R&D intensity and foreign R&D inflows show different impacts. The former shows higher explanatory power than the latter in variance decomposition of forecast errors.

Overall results are consistent with the theoretical expectations on the interactions between domestic R&D activities and the trade openness. The foreign R&D inflows through trade had acted as an important factor to increase domestic R&D expenditure. Strenuous domestic R&D activities ultimately have the economy move forward with higher value-added growth.

These results have some enlightening policy implications. Since economic growth in Korea has been made stable through domestic R&D activities, it is desirable to continuously support R&D activities of companies or industries. At the same time, trade openness is important because domestic R&D intensity increases as the foreign R&D inflows increase. More importantly, it is noticeable from the analytical results that supporting R&D activities and trade openness should be pursued together. Without the increase of domestic R&D intensity, foreign R&D inflows play a very limited role in economic growth. In turn, foreign R&D inflows boost domestic R&D activities.

## 4. Strategic R&D Policy and CGE Analysis.

We conducted an experiment of policy using a computable general equilibrium (CGE) model based on the theoretical foundation of strategic trade policy to derive a proposal for effective R&D policies. We adopted a CGE model and a strategic trade policy considering

the development of international production networks and interdependency of industrial policies among countries competing in the world market. We analyzed of the case that the two countries compete in investment of R&D for intermediate goods and final goods. Also, we divided R&D activities into process innovation, product innovation, and absorptive capacity building. The results proposed differentiated supporting policies by industry based on its comparative advantages and international cooperative programs in order to avoid unnecessary overinvestment. KIEP