MOTIVATION AND IMPACT OF INTERNATIONAL INTEGRATION ON SCIENCE AND TECHNOLOGY: FROM THEORETICAL VIEW

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Abstract:

Science and technology (S&T) international integration has become a natural trend and causes impacts to almost all the S&T sectors of all countries. All the countries have gained experience in adjustment and re-organization of their own activities to pay more attentions to implementation capacities and quality of research products in compliance with international standards. Namely, they focus priorities on links between enterprises and S&T organizations, domestic activities and international cooperation, training and recruitment of high quality human resources (including foreign ones), in order to benefit in maximum development opportunities and to become part of global S&T development. In this process, there are some nations which managed to make in-time adjustment and to capture opportunities offered from S&T international integration and, by this way, to enhance S&T forces to achieve the objectives of national development. But there also exist nations which could not capture momentum for adjustment of their systems and then could not face challenges of being left behind. These countries cannot promote values of S&T for national economy and contributions to the world's S&T knowledge.

In this paper, on basis of precious theoretical studies of many researchers, the author gives a system of visions to main driving forces which push up the S&T international integration process and cause impacts to the national S&T system. Some points are also suggested to present views to Vietnam international integration process.

Keywords: *International integration; Science-technology; Science-technology management; Research-development; Innovations.*

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S&T has three net core features of internationalization. Namely: i) service for economic development; ii) creation of new knowledge for service of human kind; and iii) involvement in solution of global challenges. It is these features to make nations increasingly closer and linked, as we have them today, and to create strong and irreversible trends of globalization in the world. These trends are accelerated by many factors, including economic growth, nature of internationalization of knowledge, S&T global

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challenges and common "rules of game", all together being put towards international S&T communities and, at the same time, causing back impacts to the S&T system of each country.

Main driving forces

Competition in economic development is a key driving force to push up the communities to create new technologies, the new technologies then make find new markets, and the new markets, in turn, put down needs to develop new S&T products and a flow to move knowledge and technologies in the world scale. Enterprises play the dominating roles in promotion of globalization and S&T integration because they want to bring their creative products into world markets. One of the important ways for that is to go through foreign direct investment channels *(Archibugi D. and Iammarino S., 1997)*, establishment of R&D centers in other countries *(Gerybadze A. and Reger G., 1999)* with main objectives to get access to sources of local talents *(Nobel and Birkinshaw, 1998, Cees van Beers et al., 2007)*. From another point of view, the wealth of a nation depends on its participation in global economy, namely the participation in global chains of values *(OECD, 2014)*. The stronger is the international economic integration, the higher the level of specialization of economic activities is. A nation would be the user of imported input values and, at the same time, the supplier of intermediate goods and services for exportation to other countries *(Koopman et al., 2011, in OECD, 2014)*. When the inter-dependency of nations increases, it leads to the growth of "foreign contents" rate in export commodities between countries *(OECD, 2014)*. Therefore, the economies need to find out solutions in order to increase their own values when getting involved in global chains of values. Only S&T and innovations can help to find out components of those high added values through creation of new ideas, new products and new business models. This has become driving forces to promote international cooperation in R&D activities and technology transfer activities in the world scale. In reality, through recent decades, numerous nations, not only OECD members but also other emerging economies, pay greater attentions to attract foreign direct investments in S&T and innovation sectors, especially the sector of high techs. This movement leads to new trends of importation policies. Investment flows are oriented to key sectors such as electronic and communication equipment, pharmaceutics, aerospace, and car business, services and production. In addition to the approaches based on separate sectors of industries, the nations begin to take to account the approaches on basis of global chains of values of corporations. Therefore, new approaches appear to give priorities to components of innovations through the attraction of R&D laboratories and foreign investments for domestic S&T activities

(typical cases are Costa Rica and Japan), and the attraction of R&D activities already available in the country (typical cases are Germany and Finland). Some other countries, such as Chile and Sweden, establish research centers of excellence to attract high quality R&D sources. Another case is South Africa which pays attention to push up the promotion of MoUs with multi-national corporations to attract investments for R&D infrastructure in the country *(OECD, 2014)*.

Nature of internationalization of knowledge and the mobility of scientists. From one side, technologies are under strong pressure of markets and enterprises in international integration process and, from another side, the knowledge and the science get influenced by strong impacts from academic environment and science research promoting policies of every nation. The knowledge and the science themselves contain already self-rooted contents for escalation and propagation in international scale. In academic communities, by traditional ways, knowledge transferring activities between scholars are a kind of natural process which does not require any payment *(Archibugi D. and Iammarino S., 1997)*. They have internal needs to share and to propagate knowledge in the world scale, to compare and to establish links among themselves to produce new knowledge. Links and movements beyond national borders are some things natural which originate from the internal nature of knowledge and science as well as the wills of those who produce them. This feature gets more clearly observed in context of intensive trends of globalization. Here, the means of mass media, communication and transport become more comfortable for sharing and propagating knowledge over the whole world. In addition to that, governments have trends to support this process through intensive measures to promote S&T cooperation through many past decades. Policy makers consider that: (i) S&T cooperation activities would push up S&T information exchange, formation of new ideas and, then, enhancement of endogenous capacities for the national S&T system itself; (ii) S&T cooperation activities would facilitate activities to attract talents for service of interests of their research system and the country and, at the same time, to offer local scientists chances to learn experience and to exchange their skills abroad; (iii) S&T cooperation may produce values for the economic system as well as the higher education system through education fees from students which are to share investment costs for domestic research infrastructure *(OECD, 2014)*.

S&T international integration also gets influenced by S&T global challenges which require the involvement of large communities for solution of problems in regional and international scales. There are so many problems which: (i) go beyond all kind of national border barriers; (ii)

cause impacts to almost all nations; and (iii) cannot find out solutions by a single country or a small cluster of countries, e.g. in sector of health care (epidemics of H_5N_1, HIV, Ebola virus), energy, foods, greenhouse gas emission, treatment of water source pollution and etc. The complexity of these problems leads to the high necessity of technologists for settlement of problems in the world scale *(Roger E., 1979)*. From this point of view, S&T sectors have duties: (i) to provide a unified understanding of scientific aspects of problems; (ii) to describe and to invent S&T solutions for settlement of those problems; and (iii) to forecast impacts from issued solutions. In addition, the aesthetic aspects in research activities and scientific behaviors as well as monitoring of their respects in the world scale (such as problems related to GMOs, human gene decoding, cloning, stem cell-based organ transplant and etc.) also require S&T activities to be coordinated or governed at the world level. The world needs to have international S&T programs and these programs can get successful when they are conducted with sharing of responsibilities and actions among members *(Nichols, R.W., 2003)*. Therefore, S&T activities are required to be conducted under forms of international institutions, mobilization of participation of experts from numerous different fields of sciences, and political independency without being restricted within the scope of national institutional regulations *(Roger E., 1979)*. The role of NGOs is observed increasing. United Nations, themselves, have established S&T specific organizations which have missions to give contributions to settlement of global problems through S&T solutions *(King A., 1979)*.

S&T international integration is pushed up by standards, norms and regulations which are accepted and applied largely in global scale. These "rules of game" cause strong impacts to S&T individuals, organizations and the whole nation up to extent that these objects should be put into position to accept the participation in the game or to be rejected from the game. One of the typical "rules of game" which are applied largely is the application of the common gauge to measure scientific values of research works published in internationally prestigious scientific magazines, especially in the magazines acknowledged by Institute for Scientific Information (ISI), or the Impact Factor (IF). IF remains controversial and actually the ISI statistic figures are the most respected measure which is used by the UN agencies, Governments and international organizations for management and planning of science policies. In terms of technologies, nations as well as regional and international organizations issue certain standards for every type of technologies. In lines with economic integration process (such as establishment of bilateral and multilateral Free Trade Agreements (FTA), WTO, TBT and others) these technical standards get closer each to other and

have the global nature (signatory members to Mutual Recognition Agreements (MRA) are to harmonize technical standards). A new technology which is lower than the international standards has low chances for long existence since it is difficult for it to be accepted by markets. S&T organizations get evaluated for their capacities on basis of a system of indexes largely applied in the world which includes the number of professors and doctors, number of international and domestic scientific papers, number of granted patents within the year, financial revenues collected from contracts signed with enterprises and etc. The scientific capacities of individual researchers are assessed by the "rules of game" of evaluation in the world scale. Their individual contributions and achievements are listed in the top of requirements. The most typical index is the so called H-index proposed by American physicist Jorge E. Hirsch in 2005 to measure the intensity and impacts of references of research products of a scientist or a scholar[2]. Some famous science magazines such as Nature, Science, Cell and PNAS, and science management organizations in Europe, America and Australia use the H-index as backgrounds for appointment, grant of supports and evaluation of success of an individual scientist or a research group *(Nguyen Van Tuan, 2008)*. In national scale, the indexes such as the total social investment for R&D activities (GERD), investments by enterprises for R&D activities (BERD), Global Innovation Index (GII) by WIPO, Knowledge Economy Index (KEI) by WB and many other indexes are established and applied to measure the effectiveness of S&T activities and S&T capacities of a nation *(Godin, 2004; OECD, 2013; WB, 2012)*.

Main impacts

S&T international integration causes increasing impacts to the national socio-economic and S&T development. These impacts have a dual nature which combines together opportunities and challenges. In the oldest concept of the process of globalization and international integration, markets and trading activities are the factors causing the highest impacts to the development of all nations. However, since the years 1980s and early they ears 1990s, the impacts from markets and trading activities get subject much to S&T. The national S&T capacities have been proved to be non-price factors which cause impacts to competitiveness of an economy *(Petrella R., 1992)*. Therefore, for any economy, the openness, economic integration and S&T integration cause greater impacts because the openness in trading sector and the economic integration would accelerate the exchange of knowledge and science, technology transfer and external

[2] This index was established on basis of the formula to make a balance between the quantitative and qualitative aspects of research works of scientists. The H-index is calculated on basis of the number of published papers and the number of cited references (*Hirsch, J.E, 2005*).

propagation of technologies. Smaller sized nations, as rules, have strong trends to absorb S&T knowledge which is transferred into their countries. Big sized nations have trends to be more self-providing in terms of technologies and, by this way, they get less impacted by the international movement trends of S&T *(Carlsson B., 2005)*. More than that, inversely, the big sized nations are pro-active to govern these trends. Majority of research works show that developed nations get more benefits from exchanges of S&T knowledge and technology transfer than developing nations can do because they hold more chances thanks to a highly advanced level of their national technological capacities. The chances of developing nations locate in their capacities to identify niche and specification technologies. These nations would create certain sectors with specifically fast growth rate (mainly in sectors of high techs) and, by this way, they have opportunities to do not only a fast development, profit in maximum opportunities of application and use of new technologies developed by S&T revolutions but also enhance their potentials and positions in the process of international labor sharing, thanks to advanced particularities accumulated in process of technological development *(Lucas, 1988, in Archibugi and Iammario, 2006; Child and Rodrigues, 2005 in Hsu et al, 2014)*. But, by side, without being equipped with protecting tools, developing nations would experience a very high pressure from multi-national companies and corporations. It is also not excluded that they could become the countries to receive out-dated technologies, to fabricate technologies and to conduct tests of new technologies from other countries *(Archibugi and Iammarino, 1997, Peng, Wang, & Jiang, 2008 in Hsu et al., 2014)*. They have to permanently face with chronic challenges of low investment sources, vicious cycle of poorness and under-development, limited capacities of advanced technology absorption, regular process of brain drain and others *(Nguyen Chi Hai, 1998)*. In many cases, multi-national corporations have their own interests in actions of acquisition of competitors, corporate mergence, share reductions or, even, liquidation of R&D laboratories of partner countries. These actions would make poorer the national technological infrastructure, exclude domestic enterprises from participation and limit the scope of contribution of local S&T organizations *(Archibugi and Iammarino, 1997)*.

S&T organizations, in irreversible trends of S&T international integration, have to make shifts and to adjust their own activities (Sharif and Baark, 2009). One of the main particularities to shape the globalization and S&T international integration deals with the re-arrangement of S&T organizations to turn focus on R&D activities *(Godin, 2004)*. During the years 1990s, multi-national corporations started the establishment of R&D facilities abroad or the purchase of a big number of laboratories in other

countries. The main objectives were: (i) search for new and dynamic markets; (ii) check and test of new ideas and products; (iii) immediate involvement in the countries having the regulatory niche to get benefits from their pioneer positions (for products of high techs); (iv) great advantages in terms of time, quality, flexibility and costs, and (v) access to resources, top ranked research results and high qualified human resources in research centers of excellence abroad *(Gerybadze and Reger, 1999)*. The fact that multi-national corporations make external R&D investments in other countries causes great impacts to the organization of R&D activities in general and S&T activities in particular in target countries. R&D activities cannot be viewed in traditional ways, i.e. targeting the domestic implementation and serving own needs of a sole country. The most important change in the new way of consideration is that, from one side, part of R&D activities is conducted within national borders to serve needs of external markets and, from another side, part of R&D activities, inversely, is conducted abroad to serve needs of domestic markets *(OECD, 2004 in Godin, 2004)*. This fact causes impacts to re-arrangement of S&T organizations. Some S&T organizations were privatized, some other S&T organizations started the application of the system of indexes of evaluation of capacities in their management process. Some S&T organizations exhibited their concerns and hesitations under pressure of integration and commercialization of research results. In this case, scientists have lower passions for scientific research in traditional ways where the center attentions are paid to new knowledge and creativity in terms of driving forces instead of integration and markets *(Buenstorf, 2009 in Sharif and Baark, 2009)*. Research results, however, have also shown that majority of S&T organizations chose the ways to establish links with enterprises as well as other partners in the National Innovation System (NIS) in order to change and/or to improve the quality of their activities. These links are not confined within domestic topics but also extended to international partners *(Chesbrough, 2003 in Sharif and Baark, 2009)*.

For S&T organizations in developing countries, the pressure from globalization and international integration is higher, especially in the way of organization and management of implementation of activities of fundamental research, R&D, innovations and commercialization of technologies. The main causes of that, in these countries, are the low effective mechanism of S&T management, low rate of R&D investments from GDP, low quality of R&D activities, high focus for adaptation and transfer of technologies from foreign countries, primitive local S&T market, low attentions by local enterprises for S&T development and application instead of their high accents for exploitation of natural resources, real estate potentials, oil and gas. The lack of S&T resources

(finances, infrastructure and human resources), in addition to low needs of local markets for complex and expensive technologies, discourages private enterprises in their efforts of investment for R&D activities *(von Zedtwitz, in UNCTAD, 2006)*. In this context, activities of fundamental research and S&T services also get impacted from pressure of globalization and international integration in S&T sectors. Governments in developed countries have trends to reduce condition free supports for fundamental research activities and, instead of that, to orient more priorities to activities of technological innovations (social pressures from the roles of science-technology for economic growth and competitiveness, and limited finance sources make great challenges to these activities). In this context, S&T organizations need to intensify the exchange of new knowledge, technological know-hows and use of basically trained human resources *(Lee 1996, in Sharif and Baark, 2009)*. The exploitation of new knowledge is oriented to advanced knowledge producing sources in the world since developing countries get always aware of the nature of globalization and integration of S&T knowledge *(Sharif and Baark, 2009)*. For individual S&T organizations, the international integration is viewed as integration at the broadest level. According to that, the organizations would face one of the biggest difficulties which is the incompatibility in organizational standards, methods of evaluation of activity results as well as management mechanism *(Zajac C., 2009)*.

International integration in S&T sectors in Vietnam

Since early the years 1990s, the international integration in S&T sectors in Vietnam has attentions, together with economic integration. The disintegration of the USSR and East-European socialist countries caused the great deficiency and the loss of important sources of supports for S&T (including the ones of training, technological machines and finances), disturbances of main and traditional cooperation ties. In this context, the issuance of numerous policies, including the Resolution on strategic orientations of S&T development in period of industrialization-modernization and tasks up to 2000, the Politbureau Resolution No. 07 on international economic integration, the Government Action Plan for implementation of Resolution No. 07 and others made the national economy gradually integrated into the international economy. The S&T sectors have become a component in this process of economic integration. The first Law on S&T was promulgated in June 2000 and it confirmed one of the duties of Vietnam S&T as "Absorbing the world's S&T achievements to create and to apply effectively new technologies, to produce highly competitive products, to develop Vietnam S&T to the

advanced level in the region and to approach the world level which is the background for development of modern industries" *(Term 3, Article 4)*. The Law also stipulates the international cooperation in S&T sectors *(Part 5)*. The Law on S&T amended in 2013 noted clearly the main content of international integration (instead of traditional way of international cooperation as it was before) which includes the principle of "Developing S&T in compliance with international standards and binding it with needs of socio-economic development and national security-defense assurance" *(Term 3, Article 70)*, or "Continuing selectively the application of experiences of advanced nations, profiting in maximum opportunities to enhance capacities for scientific research and technology development, especially the ones of high techs" *(Term 4, Article 60)*. A series of other documents by the Government was issued to focus efforts for promotion of S&T international integration such as the Project of Vietnam S&T international integration up to 2020, Strategies of S&T Development for 2011 - 2020 periods. They all confirmed that "the S&T international integration is the objective and, at the same time, the important solution to give contributions to make Vietnam achieve early the international level".

Vietnam has produced a net shift in awareness of policy makers and then gradually established legal frameworks as well as basic policies to push up the S&T international integration of Vietnam. Actually, we are in stage of enhancement of capacities and approaches to international standards which is the trends to follow gradually the common "rules of games" in the world's S&T activities. Research data, however, show that actually the driving forces to push up the S&T international integration of Vietnam mainly remain at low medium level. *From the view of driving forces of competitiveness for economic development,* the capacities and contributions of S&T in Vietnam for enhancement of competitiveness of the national economy, in comparison to the global level, remain still in low level not only in the world scale but is in the lowest rank in comparison to the top 5 ASEAN industrial nations. The Global Competitiveness Index (GCI) by the World Economic Forum (WEF) providing the survey figures of 2012-2013 period shows that Vietnam is 144-th ranked among 144 surveyed nations (10 ranks lower than the one of 2011-2012 period and is the lowest ranked among the 5 industrial nations of ASEAN *(Nguyen Ngoc Anh et al., 2013)*. The rate of products with use of low technologies among export goods in 2000 - 2008 periods made 65% of export commodities. *From the view of driving forces for creation of new knowledge for the world,* it is possible to see that, despite the annually increasing trends of the rate of international publications of Vietnam (from 287 in 1996 to 2130 in 2011), Vietnam, however, makes only 0.09% of international publications, according to statistically based rating by Scopus. The number of Vietnam scientific

publications, domestically made, is high but the statistic figures show that, by November 2012, Vietnam had no scientific research work recognized by Scopus and Vietnam was behind the 5 ASEAN nations, including Singapore, Malaysia, Thailand, Indonesia and Philippines *(Ha Quang Thuy, 2012)*. In addition, the capacities of creation, absorption and propagation of new knowledge of Vietnam are low ranked. The Knowledge Index (KI) of Vietnam by 2012 in an evaluation by World Bank was 3.6 which made Vietnam 104th ranked in the world *(WB, in Nguyen Ngoc Anh et al., 2013)*. *From the view of driving forces for application of international S&T standards,* Vietnam is gradually applying certain international standards in S&T statistical activities and peer review procedures. However, the system of evaluation of international research papers or the IF and the H-Index are not compulsorily required to be applied for evaluation of S&T research products or individual scientists but remain at the level of encouragement of use.

Since the driving forces to accelerate the S&T international integration of Vietnam remain at low level, we do not see clearly that the process of S&T international integration of Vietnam can be pro-active to create great impacts positively for S&T development in particular and to make contributions for socio-economic development in general. However, the trends of S&T globalization and international integration permanently cause impacts to force the Vietnam S&T system either to change in lines with international standards or, otherwise, to be left behind or, more dangerously, to be rejected from "the common game". In this context, the possibility for the S&T sectors to play the roles of driving forces for socio-economic development would face more challenges.

The S&T system of Vietnam, so, has passed many phases of change and adjustment according to development orientation of every period. However, we can see the core line which goes through these reforms and changes in the unified objectives to make science-technology serve the socio-economic development, and create new knowledge to serve social progress. The S&T international integration has created a pressure and, at the same time, driving forces to force the S&T sectors of Vietnam to make adjustments and reforms in direction to enhance their capacities through numerous bilateral and multilateral international cooperation activities (such as participating in/hosting S&T cooperation projects in bilateral and multilateral frameworks), to follow gradually the international "rules of game" (such as regulations to rank capacities, international research publications, filing for IP protection and etc.), to promote the commercialization of research results, to accelerate technological

innovations in order to increase intensively the added values for Vietnam made commodities in international markets.

In summary, the S&T international integration is an unavoidable process. This process is pushed up by economic factors, nature of internationalization of knowledge, challenges of S&T globalization and common "rules of game" which are observed largely in international S&T communities. The S&T international integration brings in new development opportunities, including: (i) access to advanced S&T knowledge in a full and fast way; (ii) access to diversified finance sources for implementation of S&T activities from international sector to domestic sector, and from State sector to private sector. In addition, however, the S&T international integration causes also great challenges for S&T organizations, including: (i) difficulties in maintaining the development rate because of loss of competing capacities in S&T activities, especially in R&D activities; (ii) low contributions for creation of new and advanced S&T knowledge for the society, local and international communities; (iii) impossibility to create or to train high quality human resources in the country which leads to the short of human resources of excellence and the process of brain drain; and (iv) waste of national resources and a slowdown of development rhythms of economy and social progress. In this context, the S&T sectors of all nations, including Vietnam, are forced to make shifts and reforms to benefit well offered opportunities and, at the same time, to fix the pressure and challenges emerging from the process of S&T globalization and international integration. The main directions of reforms include the enhancement of capacities of implementation and quality of research products, application of international standards and market demands as gauges to measure effectiveness of S&T activities, links of cooperation between S&T organizations and enterprises and between local S&T organizations and international ones, training and attraction of high quality human resources and development of binding ties with international S&T communities for creation of new knowledge./.

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