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R&D Spillovers, Trade Integration and Expansion of Trade Flows in East -West Asia and Pacific

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Abstract

Globalization is a complementary pattern beyond borders that brings about international investment, foreign trade, expansion of information and technology, convergence of production and consumption and integration of financial markets. Economic integration is an aspect of globalization which causes a decrease in prejudicial preventions among countries. In addition, it leads to the simplification of more extensive consumption markets, proficiency in production, use of capital and financial sources, use of technology spillovers, access to foreign investment and international cooperation. In this paper we focus on spillovers, arising from R&D development, trade relations and technology transfer. This study investigates the relationship between R&D spillovers, trade integration and their cross effects on expansion of trade flows in East - West Asia and Pacific. Accordingly, we use an augmented gravity trade model and estimate it the panel data approach to analyze the impacts of R&D spillovers and other determinants on bilateral trade relations among the selected Asia-Pacific countries over the period of 1995-2008. The results indicate that R&D spillovers and integration accelerate the trade flows.

Keywords: R&D Spillovers, Trade integration, Gravity model, Trade Flows.

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1- Introduction

Globalization is a pattern out of border activities that brings about international investment, flows of foreign trades, development of information and technology, income convergence and enhancement of financial markets.

In this context economic integration and trading implementation in the world which proceed toward the global economy are the onset of presence of developing countries in the arena of economic globalization. Also economic integration can be one of the ways that prevent the globalization process from sudden effects of entrance and keeps many developing countries economics from world rivalry.

Economic integration leads to the decrease or omission of trade barriers between integrated countries, access to more expanded consumption markets, proficiency in output, use of capital and financial sources, use of technology spillovers and access to foreign investment and international cooperation. Indeed economic integration theory implies that countries enjoy from their commonwealth strategies and trade arrangements. Moreover, they decrease the trade constraints between the membership countries and expose other countries to protection trade policies.

Consequently, integration may result in the trade diversion. But if it is flowed by specific purpose (transmission in technical sector and technology transmission and R&D), it creates trade expansion on the basis of blocks trade. Furthermore, it increases trade and economic cooperation and integrates economic sources of the countries resulting in economies of scale. This process in accordance with a decrease in transaction costs and optimal resources allocation lead to an increase in production, trade and welfare for an integrated block members.

As mentioned above, benefiting from spillover effects is one of the gains arising from trade integration implementation that implies impressibility of the position and direction of an economy from others. For less developed countries, it is more important to investigate the ways of benefiting from spillovers and accessing more chances, because these countries have to find the ways to access higher growth rate and survey growth paths and development quickly until they attend the global economic arena.

Spillovers are created by a number of channels from which R&D is important. For developing countries, however, efforts for technology improvement through domestic research and development sectors are very slow and costly, while technology spillovers will quicken the improvement process of technology and increase of productivity when countries find more effective presence in globalization.

Developing countries can improve their productivity by trade with industrial countries which have high level of knowledge. This process will be accomplished by the imports of intermediate goods and capital equipment which involve technical knowledge. However, most empirical studies have covered such developments on developed nations due to their dominant roles in the global trade.

In this study we explore this question to see how this process is realized in East and West blocks of Asia. This can lessen the lack of studies conducted on Asian developing countries. Hence, we are testing the possible relationship between R&D spillovers, trade integration and the interaction of them on expansion of trade flows in the selected East -West Asian countries with emphasis on Iran in the period 1995-2008. Section 2 reviews the related literature. Section 3 introduces an empirical framework based on a gravity model through which the effects of determinants of trade flows in Asia and Pacific are analyzed in Section 4. Section 5 concludes remarkable points of this study.

2- Related literature

Coe and Helpman (1995) provide empirical evidence on trade-related international R&D spillovers by using panel data for 21 OECD countries and Israel over the period 1971-1990. Their main findings are that the domestic and foreign R&D capital stocks affect domestic total factor productivity (TFP) positively and that domestic R&D capital stock has a bigger effect than the foreign R&D capital stock on large countries, whereas the opposite holds for smaller countries. The more open the smaller countries are, the more likely they are to benefit from foreign R&D capital stock. Keller (2002) provides an excellent survey of empirical evidence on the role of technological diffusion on the evolution of countries' income, reviewing contributions that study the effect of trade, foreign direct investment or geography on international technology diffusion.

Bayoumi et al. (1999) conclude that a country can raise its total factor productivity by investing in R&D and countries can also boost their productivity by trading with other countries that have large ‘stocks of knowledge’ from their cumulative R&D activities. They suggest that R&D, R&D spillovers, and trade play important roles in boosting growth in industrial and developing countries.

Van Pottelsberghe and Lichtenberg (2000) have also extended Coe and Helpman analysis by treating foreign direct investment (FDI) as a channel of technology diffusion. They find evidence of significant R&D spillovers on FDI flows. As a result, the general picture emerging from this strand of literature supports the argument for positive and significant relationship between international R&D spillovers and productivity across countries, resulting in trade expansion.

Tayebi (2007) has developed a theoretical relationship between total factor productivity, outsourcing and foreign direct investment (FDI) and then empirically examines this relation among 150 selected developed and developing countries during 1990-2003. He shows that there has been positive relation between R&D capital stock and TFP in the OECD countries. In fact, most countries around the world try to benefit from Trade and FDI spillovers in their economic developments.

Mendi (2007) has used a sample of 16 OECD countries from 1971 to 1995 and shown that there is strong relation between TFP and international diffusion of technology. The analysis shows that the effect of trade in disembodied technology on the importer’s productivity varies across countries. Specifically, within OECD countries not in the G7 group, technology imports increase the host country’s total factor productivity, being an important factor of trade pattern.

Keller (1998) scrutinizes the role of trade pattern in determining the extent of R&D spillovers. He focuses on weights (actual import shares) used by Coe and Helpman (CO) to compute foreign spillovers and shows that randomly generated import ratios can lead to similar or even higher international spillovers. He further shows that ignoring the import ratio altogether and assigning equal weights to all trading partner’s R&D capital stocks also leads to larger spillover effects than those reported by CH.

Lichtenberg and Van Pottelsberghe (1998) show that CH’s weighting scheme also biases the estimates of spillovers coefficients. They extended

CH analyses by treating foreign direct investment (FDI) as a channel of technology diffusion. They use only 13 of the CH's 22 sample countries and apply panel co-integration test due to Pedroni (1999). They find evidence of significant R&D spillovers across countries in the long-run.

Diao et al. (2005) examine the progress of economic growth of Thailand which was well above world average from 1960 to the 1997 crisis. While the controversy over Thailand and East Asian growth has discussed the role of capital accumulation versus productivity, they analyze the general equilibrium interaction between productivity and investment in an inter-temporal growth model. The high growth is understood as a transition path with gradual tariff reduction and endogenous productivity driven by foreign spillover feeding capital investment. Counterfactual analyses show how protection would have reduced growth of the country with productivity and investment slowdown while shock liberalization would have raised immediate growth with faster convergence to steady state.

Lumenga et al. (2005) argue that trade promotes knowledge flows and technology transmission between trading partners. In their study they focus on direct research and development (R&D) spillovers which are related to the levels of R&D produced by trading partners. They show that indirect trade-related R&D spillovers also take place between countries, even if they do not trade with each other.

Engers and Mitchell (2006) in the paper "R&D with layers of economic integration" examine whether the optimal unilateral R&D policy for an open economy is a subsidy or a tax. They construct a general equilibrium model with three successive layers of international integration: (a) trade in goods (b) trade in technologies with international R&D spillovers and (c) internationally-coordinate R&D policy. Trade in technologies introduces the possibility that an R&D subsidy will have negative terms-of-trade effect that it harms domestic welfare.

3- The Model

According to Anderson (1979), the most successful empirical trade advice of the last decades is the gravity equation, applied to a wide variety of goods and factors moving over regional and national borders under differing circumstances. It usually produces a good fit. Also it is proper for investigation of bilateral trade flows.

Anderson (1979) made the first formal attempt to derive the gravity equation from a model that assumed product differentiation. Helpman and Krugman (1985) used a differentiated product framework with increasing returns to scale to justify the gravity model. Cheng and Wall (1999) and Egger (2000) have also improved the econometric specification of the gravity equation.

The trade gravity equation is a flexible model, which includes required variables denoting Z as the main determinants gravity-based (GDP_i, GDP_j and D_{ij}, distance between country i and country j), Y as control variables (domestic and foreign R&D spillovers, S^d_{it} and S^f_{it}, respectively) and W as dummies for integration, trade blocks and so on. The functional form can be defined as:

$$T_{ij} = f(Z, Y, W)| \qquad (1)$$

where T_{ij} is trade flows between country i and country j (here, X_{ij} is proxied for trade between two trading partners: i and j). Regarding the aim of present study which investigates the effects of R&D spillovers and trade integration on trade flows of East-West Asia and Pacific, our model is generally specified as:

$$X_{ijt} = \alpha_0 (yp_{it})^{\alpha_1} (yp_{jt})^{\alpha_2} (D_{ij})^{\alpha_3} (S^d_{it})^{\alpha_4} (S^f_{it})^{\alpha_5} (A_{ijt})^{\alpha_6} U_{ijt} \qquad (2)$$

Where X_{ijt} is bilateral exports from country i to country j in time t. yp_{it} and yp_{jt} are per capita gross domestic production of country i and country j, respectively, in time t. D_{ij} is the geographical distance between country i and country j. S^d_{it} is domestic R&D capital stock at the time of t which calculated as follows [see Coe and Helpman (1995) and Coe et al. (1997)]:

$$S^d_{it} = \frac{E^{RD}_{it}}{g_{it} + \delta}$$

Where δ is depreciation rate (it was considered as δ=8 percent[1] for all countries), E_{it}^{RD} is initial R&D expenditures, g_{it} is the average annual growth rate of E^{RD}. S_{ijt}^{f} is foreign R&D capital stock from country *i* to country *j* at the time of *t* (R&D spillovers). We follow Lichtenberg and Van Pettelsberghe (1998) and compute S_{ijt}^{f} as follows:

$$S_{ijt}^{f} = \frac{m_{ijt} S_{jt}}{y_{it}}$$

where m_{ij} is imports from country *i* to country *j*, y_j is GDP of country *j*.

A_{ijt} denotes a dummy variable which stands for different trading blocs: ECO, APEC, ASEAN and D8. In order to investigate the interacted effect of and trade integration in these blocs, four new variables are measured by the multiplication of each dummy (as defined) by foreign R&D spillovers. They are defined as follows: *Deco* is used for the selected Asian countries that are the members of ECO (Iran, Turkey, and Pakistan) and *Dasean* is used for the selected ASEAN members (Indonesia, Malaysia, Philippines, Singapore and Thailand). *Dapec* stands for the selected Asian members the APEC (China, Hong Kong, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore, and Turkey). Finally, *Dd8* is used for the selected Asian *D8* members including Indonesia, Iran, Malaysia, Pakistan and Turkey. The justification behind such country selection relies on the reliable trade relationships between Iran and other selected Asian countries which are partly members of such blocs.

Thus, Equation 2 is re-specified by a log linear form, and then is estimated by the panel data approach in four cases, while each case includes Deco, Dasean, Dapec and Dd8, respectively:

Case I,

$$\ln X_{ijt} = \alpha_1 + \alpha_{1ij} + \alpha_{11}\ln yp_{it} + \alpha_{12}\ln yp_{jt} + \alpha_{13}\ln D_{ij} + \alpha_{14}\ln S_{it}^{d} + \alpha_{15}\ln S_{ijt}^{f} + \alpha_{16} Deco + U_{1ijt} \quad (3)$$

Case II,

$$\ln X_{ijt} = \alpha_2 + \alpha_{2ij} + \alpha_{21}\ln yp_{it} + \alpha_{22}\ln yp_{jt} + \alpha_{23}\ln D_{ij} + \alpha_{24}\ln S_{it}^{d} + \alpha_{25}\ln S_{ijt}^{f} + \alpha_{26} Dapec + U_{2ijt} \quad (4)$$

Case III,

1- Following Coe & Helpman (1995), we compute R&D capital stocks using 8% depreciation rate.

$$\ln X_{ijt} = \alpha_3 + \alpha_{3ij} + \alpha_{31} \ln yp_{it} + \alpha_{32} \ln yp_{jt} + \alpha_{33} \ln D_{ij} + \alpha_{34} \ln S_{it}^{d} + \alpha_{35} \ln S_{ijt}^{f} + \alpha_{36} Dasean + U_{3ijt} \quad (5)$$

Case IV,

$$\ln X_{ijt} = \alpha_4 + \alpha_{4ij} + \alpha_{41} \ln yp_{it} + \alpha_{42} \ln yp_{jt} + \alpha_{43} \ln D_{ij} + \alpha_{44} \ln S_{it}^{d} + \alpha_{45} \ln S_{ijt}^{f} + \alpha_{46} Dd8 + U_{4ijt} \quad (6)$$

α_k , α_{kij} and U_{kijt} (k = 1, 2, 3, 4) are respectively intercept, individual effects and the equation error term.

4- Empirical Results

We apply panel data to estimate the specified equations, using data from 13 Asian and Pacific countries. The empirical period depends on the availability of data, where the time period used is 1995-2008. Required data have obtained from the ‘World Economic Indicators, CD-ROM 2005 and 2009, ‘Country Statistical Information Database of the World Bank (http://www.worldbank.org/data/countrydata/), International Monetary Fund (http://dsbb.imf.org/Applications/web/gdds/gddscountrylist/ IMF/), and compiled by the authors. All variables used are in natural logarithms.

In many applications of panel data, periods of time series have been expanded. Accordingly, investigations into the unit root in panel data have recently attracted a lot of attention. Abuaf and Jorion (1990) point out that the power of unit root tests may be increased by exploiting cross-sectional information. In addition, in contrast to individual unit root tests, which have complicated limiting distributions, panel unit root tests lead to statistics with a normal distribution in the limit.

Levine et al. (2002) propose a panel-based ADF test that restricts parameters γ_i by keeping them identical across cross-sectional regions as follows:

$$\Delta y_{it} = \alpha_i + \gamma_i y_{it-1} + \sum_{j=1}^{k} \alpha_j \Delta y_{it-j} + e_{it}, \quad (9)$$

where *t=1 …T* time periods and *i =1 . . . N* members of the panel. LL tests the null hypothesis of $\gamma_i = \gamma = 0$ for all *i*, against the alternate of $\gamma_1 = \gamma_2 . . . = \gamma < 0$ for all *i*, with the test based on statistics $t_\gamma = \hat{\gamma} / s.e.(\hat{\gamma})$. For the above reason, Im, Pesaran and Shin (IPS) (1997) relax the assumption of the identical first-order autoregressive coefficients of the LL test and allow γ varying across regions under the alternative hypothesis. IPS test the null hypothesis of γ_i =0 for all *i*, against the alternate of $\gamma_i \prec 0$ for all *i*. The IPS test is based on the mean-group approach, which uses the average of the t_{γ_i} statistics to perform Z statistic, which tests the panel unit root of a variable.

Hadri (2000) argues differently that the null should be reversed to be the stationary hypothesis in order to have a stronger power test. An alternative approach to panel unit root tests uses Fisher's (1932) results to derive tests that combine the p-values from individual unit root tests.

Hence, Table 1 represents the results of panel unit root tests obtained by these methods. The figures reported in the table, which are based on individual effects and individual linear trends, show that at the 5 % significance level at least a test referred here rejects the null of non stationary variables of the model in level forms.

Table 1: Results of Panel Unit Roots Tests for the Model Variables

tests / Variables	LLC[1]		IPS[2]		ADF-Fisher		Hadri		Breitung t-stat	
	Individual effects	**Individual effects & individual liner effects**	**Individual effects**	**Individual effects & individual liner effects**	**Individual effects**	**Individual effects & individual liner effects**	**Individual effects**	**Individual effects & individual liner effects**	**Individual effects**	**Individual effects & individual liner effects**
$\ln yp_{it}$	3.861	0.967	3.505	1.348	2.890	4.643	3.520	4.809	-1.737*	3.564
$\ln yp_{it}$	-3.856*	-3.690*	-2.315*	-1.546	9.634	11.175	-0.313*	-1.027*	-4.159*	-4.168*
$\ln D_{iit}$	7.599	2.853	7.908	4.009	5.405	1.035	3.437	3.098	-5.609*	5.756
LS_{it}^{d}	-0.689	-3.289*	1.773	-0.417	0.098	5.541	4.743	0.509*	-0.845	-0.096
LS_{iit}^{f}	-1.623	-3.339*	1.709	-0.443	0.089	3.760	2.558	0.417*	-0.940	-0.196
Deco	2.986	1.901	2.878	3.091	2.856	3.603	4.093	6.009	-1.753*	3.509
Dapec	-3.906*	-3.609*	-2.455*	-1.509	10.034	7.098	-0.423*	-1.549*	-5.159*	-5.106*
Dasean	-4.591*	2.853	7.908	4.009	5.441	1.935	2.990	3.388	-3.160*	5.156
Dd8	-0.603	-3.221*	1.903	-0.409	0.010	5.936	4.616	0.629*	2.845	-0.209

1- Levin, Lin & Chu t*   2- Im, Pesaran and Shin W-stat

*Rejects the null hypothesis of non stationary variables at the 5% level.

Source: Authors

Estimating Equations 3 to 6 by panel procedure, we summarize the results in Table 2, indicating the impacts of the domestic and foreign R&D spillovers, per capita GDP of both exporter (country *i*) and importer (country *j*) and trade integration on bilateral trade flows (exports from country *i* to country *j*) between selected Asian countries and Pacific. The results are classified into four cases, indicating the role of trade integration in Asia-Pacific. The results show that all of the estimated coefficients are significant and have the expected signs; implying that the dependent variable (export flows) is impressed by all of the explanatory variables as specified. As the values of F-test (F-Leamer) shows, the null hypothesis of the same individual effects cannot be acceptable, implying that the OLS results are biased and, more specifically, there exists heterogeneity for each pair of trade partners. It means that the problem of heterogeneity should be controlled thorough considering different individual effects in the panel estimation process. According to the Hausman test, the estimation results are consistent with the fixed effects in which they are more reliable than other methods.

Table 2: Panel estimation results for trade flows in Asia and Pacific

Explanatory Variables	Case I	Case II	Case III	Case IV
$\ln yp_{it}$	.0657868 (2.45)*	.0527978 (2.19)*	.0726626 (2.59)**	.0663943 (2.44)*
$\ln yp_{jt}$	.2036776 (4.89)**	.1601852 (3.77)**	.2005774 (4.76)**	.2061198 (4.92)**
$\ln D_{ijt}$	-1.174451 (-8.25)**	-1.130001 (-8.20)**	-1.04692 (-6.78)**	-1.142523 (-8.08)**
LS_{it}^{d}	.3287416 (8.80)**	.3064198 (8.24)**	.3365815 (8.93)**	.3279763 (8.77)**
LS_{ijt}^{f}	.2129645 (10.72)**	.2140682 (10.82)**	.2105665 (10.51)**	.2133848 (10.71)**
Deco	-1.192288 (-2.68)**	-	-	
Dapec	-	.7740634 (3.45)**	-	-
Dasean	-	-	.7198132 (2.74)**	-
Dd8	-	-	-	-.1568189 (-2.40)*

Notes:
(a) The bias-corrected t-statistics are reported in parentheses. * (**) denotes significance at the 5% (1%) level.
(b) The F-Leamer statistic [F = 25.372, (Pr = 0.000)] approves the efficiency of panel data approach in the estimation process.
(c) The Hausman test [H = 56.139, (Pr=0.000)] rejects random effects, while panel results are obtained based on fixed effects.
(d) Diagnostic tests, LM and Wald tests, have been applied to check for AR(1) of the unbalanced panel and heteroscedasticity.
The results report no regarding problems.
Source: Authors

According to the results obtained, the per capita GDP in two countries under consideration has significant and positive effect on current exports of two partners. Estimation results obtained by FE (fixed effects) indicates that per capita GDP coefficients of both exporters and importers (for all cases) have the positive signs, and as expected, are statistically significant at the 5 percent significance level. Therefore, an increase in production of the selected countries causes a more increase in their export flows.

The coefficient of distance has been negatively in four cases, as expected, indicating. This is proxied for transportation costs which indicate the higher such costs the lower trade relations among the countries.

As seen in Table 2, the coefficients of the domestic R&D and R&D spillovers are significantly positive and have the expected effects on the bilateral exports of the Asian –Pacific countries in all cases. It reveals the fact that the R&D spillovers (from both domestic and international resources) can result in higher trade flows. By trading internationally in goods and technology, all domestic firms obtain the more chance to increase their production capacity.

Additionally, the results indicate that the interacted effect of R&D spillovers and trade integration appeared in the estimated coefficient values of *Dapec* and *Dasean* (in Cases I and IV) are significantly positive as expected. The results imply that trade relations in blocs such as APEC and ASEAN promote further spillovers and create further trade. However, due to the estimated significantly negative values of *Deco* and *Dd8* coefficients, the trade relations in blocs such as ECO and D8 have lead to trade diversion, meaning that countries like Iran cannot improve their trade flows by associating to these trade blocs.

5- Conclusion

Today economic and regional integration is an introduction for entrance to arena of globalization. In this context economic integration may lead to creation or deviation of trade patterns. All studies available in the literature show the importance of regional overflows, the role of contiguity, openness and integrated blocs in economic growth. Accordingly, trade is considered as a channel of spillover effects in which countries can be able to achieve productivity and growth. Implementation of integrated blocs provides a good chance for technology transfer and spillover diffusion particularly in R&D

patterns that will influence expansion of trade flows. Developing countries can benefit from expanding trade relations with industrial countries which have higher amount of knowledge obtained through ample research and development activities. This is possible through intermediate and capital imports, which provide developing countries with R&D and trade spillovers.

According to the empirical results obtained for the Asian-Pacific countries, the role of internal gross production of the countries has been significant in creation of trade. In order to improve trade flows, these countries including should increase domestic production capacity by using new technologies and innovation. Effect of technology in production process is not negligible and it can be influential for production of innovative products. As found by this paper, one advantage of integrated trade blocs is transfer of technology and achievement of international R&D spillovers. Research and development resources in international level lead to creation of spillovers, which result in production boost and acquiring technical knowledge and skills, production volume, and accordingly increasing trade volumes of the countries under consideration.

Finally, as our findings showed, the more internal and external shares of research and development, the more trade flows the countries observe. Therefore, policy making in the Asian developing countries should be in a way to make possibility of using these opportunities through their involvement in the global economy and being members of regional integrating blocs. However, our findings did not confirm the advantages of some blocs' (ECO and D8) membership, due to their unexpected results. The implication is that the Asian-Pacific countries like Iran should contribute to those of economic integrating blocs which guarantee their future economic improvements.

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