CHAPTER FIVE

5.1 Empirical Analysis

The primary purpose of this paper is to look at the impact of inflow of FDI as an effect of increasing of patents right protection index (IPRS) as stipulated in the TRIPS agreement[28].

In this section the impact of TRIPS agreement and its effect of FDI for the 56 selected pooled cross-country sample data will be examined. In reality, many factors might be influence the decisions to invest in FDI. The connection of IPRS, R&D intensity and level of market transparency to FDI has extensively gain interest from many researchers.

As Maskus (2000) note, the influence of IPRS to FDI are complex, and strong IPRS alone is not sufficient to attract investor to invest in a country. However, Smarzynska (2002) has found that weak protection intellectual property regime encourages investors to undertake project focusing on distribution rather than local production.

[28] Article 7, under objectives of TRIPS agreement 1994: WIPO Publication, No. 223(E)

Patent protection and impact of FDI which are covered in the literature will be used as a benchmark to compare with the finding in this paper. Park and Lippoldt (2003), Maskus (2002), Smarzynska (2002), Glass and Saggi (2002) and Mansfield (1995) has found the relationship between intellectual property rights and FDI in their findings. Most of the studies above vary from the perspective of level of countries development (Park and Lippoldt: 2003) and economic transitions (Smarzynska: 2002), firm level and industry analysis (Maskus: 2002, Fink and Braga: 1999),), product cycle model (Glass and Saggi: 2002) and technology transfer among developed nations (Mansfield: 1995).

Park and Lippoldt (2003) has found that an increasing of patent protection index have two different impact to the ratio of FDI stock to GDP. The main difference is that the estimated impacts are larger for the poorer economies (with weaker patents regimes). But as a nation developed and have stronger patents regime, a reforms in patents laws has a smaller impact on FDI. [Provide explanations for the rest of the references mentioned]

The impact of domestic R&D expenditure (RDEXP) to inflow of FDI could be viewed as a signaling process that the countries move towards producing more of scientific and technological products. This will motivate big multinational companies (MNCs) to invest more into the countries, given the expectation of gain profit and market power expansion throughout an FDI enterprise in the receiving economies in the connections with stronger IP law protections namely patents protection. Since the impact is involving causal and effect analysis, therefore the evidence is rather disperse on how the domestic R&D activity will bring greater influence for the high technology investors to invest into host country.

Although the relationship between R&D activity and FDI to the host countries is explained by the process called transmission mechanism, but the target is to highlight what is the investor's attentions to bring their technology (i.e to gain profits or to increase market power) and what factors stimulate the interest, given the host countries resources and policy regimes intact.

Since the relationship between R&D activity and level of FDI received by hosts' country is subject to transmission mechanism process, therefore it is worth to note here that the final impact should be focuses on economic growth and total factor productivity. The literatures that explain on how R&D activity contributes to economic growth, process of technological transfer and/or capital spillover is quite robust in nature. Most literatures concentrated on how, why and to what extent it can stimulates the final output. The literature varies from the issues on how R&D activities of foreign firm affected by the location factor provided by the hosts' countries (Kumar: 1996), why the globalization of R&D activity benefited to hosts' countries (Serapio and Dalton: 1999) and to what extent that the R&D spillover affect the economic growth (Bayoumi et.al:1999, Coe and Helpman: 1995) and productivity (Liu and Wang: 2003, Wakelin: 2001, Maskus and McDaniel: 1999, Eaton and Kortum: 1996).

Kumar (1996)[29] in his paper found that the location factors (one of the prominent factors mentioned in eclectic theory) played an important role in determining the location factor of overseas R&D activities by United States multinational enterprises (MNEs). The model developed based on several location factors namely scale and nature of local production, (viz. market size, technology intensity of local operations, market orientations of local production), host country resources (viz. technological resources and infrastructure, supply of low-cost personnel and communications infrastructure) and policy environment in the host country which include intellectual property protection, trade policy and host country performance requirements.

Using the Benchmark survey data on Direct Investments Abroad conducted by the US department of Commerce for 1977, 1982 and 1989, the analysis divides into three stages. First stage is to examine the general determinants of R&D intensity of affiliates of US MNEs and second stage concentrated on the analysis of level of countries developments viz. industrialized and developing countries and final stage concentrated on the manufacturing groups (i.e the chemical and food products industries) in which the US R&D activity actively involved. Based n the model developed, the author found that US MNEs prefer

[29] In this paper, R&D is dependent variable and US FDI is one of the explanatory variables.

to locate their R&D activities in countries (irrespective of level of development) that able to offer larger market, technological resources and better infrastructure. The developing nations are chosen by most of US MNEs since they offer highly technological capability. However the relative strength of patent protection did not found significant to explain the magnitude.

The decisions to invest in FDI are determined by many factors. The decision might be stimulates by factors that should exist in the hosts' countries to attract FDI (viz. level of growth, market size and level of protection) and some stimulates by factors that less likely to exist in the economic market environment (viz. risk of investment default, black market activity, volatility of exchange rate, tariff and non-tariff barrier and corruption).

Literatures concerning this kind of issues are broad in categories and level of discussion. The categories ranging from trade flow or economic openness and its effect to economic growth among countries (Gould and Gruben: 1996), corruption (Smarzynska and Wei: 2000 and Wei and Wu: 2001) and currency crisis (Wei and Wu: 2001). Some other researcher look at the country risk and tariff rate (Park and Lippoldt: 2003) and also exchange rate distortion (Gastanga et.al: 1998)

The black market index (BMI) and its impact to inflow of FDI seen has an inverse effects. The larger the indexes the lower the FDI flow. The transparency and efficiency of domestic market were strongly depends on the market conditions. If domestic market were largely dominated with illegal activity, such as smuggling, piracy and the supply of agriculture and manufacturing product in an illegal market, foreign investors will adversely affect in terms of confidence and profits loss.

Gould and Gruben (1996) had proved the negative relationship between economic openness[30] and its interactions with level of economic growth. The consistencies of negative sign reveal that a nation's trade policy (degree of openness) has influence the degree to which intellectual property rights enhances growth.

Based on the previous discussion, both designed institutional factor have two different sign. The IPRS positively related to inflow of FDI and BMI inversely related to inflow of FDI. The RDEXP is positively affected the inflow of FDI.

[30] Economic openness defined by black market exchange rates premium, real exchange rate distortion, and composite index of trade regime indicators taking value of zero for open economies and one for closed economies. The value assigned are based on median index value (countries above the median index assigned with zero-open economies and countries below the median index value assigned with one-closed economies) for each of definition of economic openness. The dummy variable is interacted with level of patent protection

As a preliminary examination we present the summary statistics (Table5.1) for each variable used and tested in this analysis.

Table 5.1: Summary Statistics*

	FDI	IPRS	RDEXP	BMI
Mean	17272.07	3.213393	1.155357	2.553571
Median	3650.000	3.240000	0.795000	2.500000
Maximum	195122.0	4.860000	3.800000	5.000000
Minimum	13.00000	0.920000	0.010000	1.000000
Std. Dev.	35474.10	0.910141	0.983753	1.374040
Obs	56	56	56	56

*FDI, inflow foreign direct investment; IPRS, patents protection index; RDEXP, domestic R&D expenditure; BMI, black market index

Table 5.2: Pair-Wise Correlation Matrix

	FDI	IPRS	RDEXP	BMI
FDI	1.0000			
IPRS	0.4691	1.0000		
RDEXP	0.4451	0.6089	1.0000	
BMI	-0.3903	-0.6159	-0.6216	1.0000

Table 5.1 and Table 5.2 above represent the summary statistics and pair-wise correlation matrix for each of the variable used in the model. The variable used in the model exhibit heteroscedastic pattern especially involving FDI and BMI since data were obtained from cross country sample and variations of variable are rather disperse. The preliminary examination about the nature of the data, motivate us to choose the appropriate model to examine the effect of FDI.

5.2 Model specification test

Before proceed to analysis we test the model specification[31]. Model specifications are widely discussed in many literatures and incorrectly specified the model will mislead the results and so the statistical inferences.

Thus, according to RESET methodology[32], logarithms model are better explained the variations of FDI and the explanatory variables. However, RESET methodology has one drawback; although the model passed the misspecification test, it cannot detect and automatically correct the heteroscedasticity problem that might exist in the model.

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[31] Model specification test are attached in the appendix 5.0

[32] In this paper we used Ramsey's RESET (1969) methodology. The idea of using this methodology is motivated by (1) the methodology is easy to conduct (2) many literature use this kind of methodology. RESET adds polynomials in the OLS fitted values to the estimated equation to detect general kinds of functional form misspecification. The null hypothesis is that the OLS (1) is correctly specified. Therefore if the F statistic for testing the parameter of fitted value (i.e $\delta_1(\hat{FDI})^2$ and $\delta_2(\hat{FDI})^3$) is significant, it suggest some sort of functional form problem. Testing the OLS (1) equation, shows that the F statistic is found statistically significant at least at 2 percent level. Therefore, it might suggest that the model specification need to be improved. Then in OLS (2) equation, by taking logarithms terms, it is found that the RESET test fail to reject the null hypothesis that the model has wrongly specified at least at 30 percent level.

Therefore, to remedy the heteroscedasticity, we apply White Heteroskedasticity-Consistent Standard Errors & Covariance (1980) methodology. Both reported standard error and t-statistic are now called robust standard error and t-statistics. Both values can be either increasing or decreasing.

5.3 Analysis of Model

An econometric model proposed in the previous section tested in order to identify the magnitude impact and its direction of what have been stipulated earlier. The results are as below:

Table 5.3: Pooled Cross-Country Regression

Dep.variable (FDI)	OLS 3	OLS 4	OLS 5
Constant	3.2354 (0.8072)*** [0.9742]***	5.4132 (1.1463)*** [1.4028]***	6.5896 (1.3263)*** [0.9689]***
IPRS	4.2657 (0.6921)*** [0.7896]***	2.7703 (0.8164)*** [0.9478]***	-1.1418 (2.4618) [1.4840]
RDEXP		0.5652 (0.2329)*** [0.2097]***	0.4797 (0.2345)** [0.2282]**
BMI		- 0.386576 (0.4944) [0.5656]	-0.2343 (0.4943) [0.5643]
$(IPRS)^2$			2.2487 (1.3377)* [1.0651]**
Adj-R^2	0.4020	0.4863	0.5038
RESET test:			0.0608 {0.9411}
Wald test		5.2985 {0.0080}***	4.4571 {0.0397}**
White test ~ (χ^2_6)		14.1478 {0.1171}	20.97615 {0.0734}
BG test: LM(2)		3.5846 {0.1665}	2.4037 {0.3006}
No. of obs.	56	56	56

Note:

(i) Both OLS (3; 4) regression estimated using logarithms term.

(ii) The usual OLS standard errors are in parentheses, ( ) and the heteroscedasticity-robust standard errors are in brackets, [ ].

(iii) Value indicates with { } is p-value.

(iv)The value of Wald coefficient test, White heteroscedasticity test and BG space correlation test are reported after the model corrected for the existence of heteroscedasticity.

(v) *,**,*** indicates the coefficients significant at 10%, 5% and 1% respectively.

For OLS (3) of Table 3, the usual standard error and robust standard error are reported in parenthesis and bracket, respectively. The coefficient for IPRS is statistically significant at least at 1 percent level for both robust and non-robust equations. As 1 percent increase in patent protection will increase the inflow of FDI to around 4 percent.

The OLS (4) equation conducted with including two additional explanatory variables and the robust and non-robust standard error reported in bracket and parenthesis respectively. The explanatory power of OLS (4) equation is around 48 percent. The sign of each variables parallel with earlier hypothesis. Two explanatory variables (i.e IPRS and RDEXP) found significantly different from zero at least at 1 percent level and BMI is not. To test the significant of inclusion additional explanatory variables we apply Wald coefficient restriction test[33]. Wald test shows that both additional explanatory variables significant at least at 1 percent level and this is an indicator that the additional explanatory variables are belong to the model.[34]

[33] The Wald test computes the test statistic by estimating the unrestricted regression without imposing the coefficient restrictions specified by the null hypothesis. The Wald statistic measures how close the unrestricted estimates come to satisfying the restrictions under the null hypothesis. If the restrictions are in fact true, then the unrestricted estimates should come close to satisfying the restrictions.

[34] As stated earlier, if heteroscedasticity exist in the model, it will misinterpret the results. Therefore, to confirm, we conduct White (1980) heteroscedasticity LM test (with cross term interaction). The chi square (χ^2_6) test fails to reject the null hypothesis of homsscedasticity at least at 11 percent level. Therefore, we might say that the heteroscedasticty robust version is now alleviated from heteroscedasticity problem.

The problem of autocorrelation is also tested. In this paper we will conduct general autocorrelation test allowed for higher order autoregressive. The autocorrelation problem usually exists in time series observation, but it might exist in space for cross sectional observations. In this paper we conduct methodology developed by Bruesch (1978) and Godfrey (1978), known as Bruesch-Godfrey (BG) LM test and allow for second order autoregressive scheme. The BG test asymptotically follows the chi-square test with AR (p) degree of freedom. The test found that the null hypothesis of second order autoregressive coefficient has failed to reject with p-value 16 percent.

As we extend the model (OLS 5), by taking quadratic term for level of IPRs, it is found that, the explanatory power for this model increase slightly (around 50 percents) and the squared terms for IPRs significant at 5 percent (non-robust version) and 10 percent (for robust version) respectively. Thus this indicating those as the level of protection increase, level of FDI would also increase significantly after reaching some threshold level. Therefore the IPRs protections and its relations to FDI thus far are explained by a non-linear relationship[35].

Since the analysis (using double log model) cannot identified the optimum level of IPRs protections, we construct simple analysis with several interval value for each of explanatory variables[36]. Then we map the interval value accordingly to the country sample sets. The interaction in the analysis now gives unique features of countries characteristics and its relations to inflow of FDI into the host's countries respectively. It is worth to emphasize that as the model developed, the complexity of FDI impact will be revealed. The interaction term for each equation will give the explanations of why some countries received massive FDI investment compared to other and what benchmark [lies behind the investors decisions] that investors look for when deciding to invest in certain counties given other factor remain unchanged.

[35] This finding reveal that for the 56 sample involved in the analysis, the patterns of patent protections is some what follows the "U" shape analysis. However since the model consist of various countries and the equations developed are in double log analysis, we are unsure about the break point level of the IPRs. One possible measure to detect such break point is to divide the level of IPRs of those countries into its unique classifications.

[36] Including Dummy for income classifications as represented by E.q.2.0 to E.q.2.2

5.3.1 The Interactions analysis

The regression equations as describe in Chapter 4 (involving E.q.1.2 to E.q.2.2), tested for the 56 sample sets. However for simplicity the results presented as in Table 5 only provide the analysis for partial interaction between variables. Since the interactions terms differ by way of interpretations and implications to the host's countries, the remaining analysis will developed into several subsections and discussed intensely into this matter.

To examine the interaction between explanatory variables and its effect to FDI inflow, we developed four dummy variables involving patents protection level (DIPRS), domestic market condition (DBMP), income classification based on newly release data from World Bank (as July 2003) and R&D intensity. We estimates eleven extended regression model with interaction term (including other explanatory variables) to examine the effect of inflow of FDI. The summaries of the results are shown as on table 5[37].

[37] The interaction terms are examine based on the equation E.q.1.2 to E.q.2.2 and the results are attached in the Appendix 5.1

5.3.1.1 Interaction on dummy IPRs (DIPRs)-[level of patent protection]

The results of interaction term of each of dummy variables are mixed for all set of extended regression version. For level of IPRS protection, country with higher level of IPRS benefited from such protection compared to country with lower protection index. 17 countries were identified benefited from such stronger protections (i.e. significant at 10 percent level) however only two developing countries (i.e. Korea and Singapore) included in the list.

The R & D activity increases as level of protection increase. As depicted in table 5, for all IPRS classifications, countries started significantly benefited from such activities when the patent protection index reach or equal to two and above. From this result, 50 countries were increasingly benefited from such situations and an increase in the patent protections, significant level increase in 5 percentage point. The significant relationship between protection levels to R&D activity has the similarity to the results found by Varsakelis (2001).

The interaction term between dummy IPRS and BMP gives a complex view for the cross country sample set. With accordance to table 5 above, the interaction of patent protection index to BMI for DIPRS three and below give positive impact to the FDI inflow. While, the impact to FDI inflow is negative as IPRS index increase. The reason behind the results might be awful, but when examining the real data, we found that, since the interaction term of IPRS index and BMP index move together, therefore, the effect to inflow of FDI also move accordingly. But the effect of FDI inverse at which the level of IPRS reach three and above.

5.3.1.2 Interaction on dummy BMP (DBMP)-[level of bmp]

For interaction between dummy BMP and other two explanatory variables, it seems that level of BMP is not the factors that determine the level of inflow of FDI for the given set of countries. The effect is positive for all interaction between DBMP and IPRS level. By given the level of patent protection level, a country which falls under first three groups (i.e "very low", "low" and "moderate" black market activity) has a 1 percent significant impact to the inflow of FDI. However, as a black market activity increase the significant level effect for FDI slightly decrease. Therefore the investors' decision to invest in FDI is not affected by the level of BMP in certain country.

The interaction results between DBMP and RDEXP is rather mixed. Although the activity of R&D significant when the level of BMI is "very low" (significant at 10 percent level), but as the BMI level increase, country interaction term inversely affect the decision to invest in FDI. Therefore once again, level of BMI is not the important factor look by the investor to increase their investment at least for this selected sample set.

Table 5.4: The Partial Interaction of Protection Level, Market transparency, Income Classification and R&D per GNP activity to FDI inflow

			IPRS	RDEXP	BMI
I	Dummy IPRS	DIPRS[0, 1)	Negative	Negative	Positive
		DIPRS[1, 2)	Positive	Positive	Positive
		DIPRS[2, 3)	Positive	Positive*	Positive
		DIPRS[3, 4)	Positive	Positive*	Negative
		DIPRS[4, 5)	Positive*	Positive**	Negative
II	Dummy BMP	DBMP1	Positive***	Positive*	-
		DBMP2	Positive***	Negative	-
		DBMP3	Positive***	Positive***	-
		DBMP4	Positive**	Positive	-
		DBMP5	Positive	Positive	-
III	Dummy R&D	DRND[0,1)	Positive**	Positive**	Negative
		DRND[1,2)	Positive***	Positive	Positive
		DRND[2,3)	Positive***	Positive	Negative
		DRND[3,4)	Positive**	Positive	Negative***
IV	Dummy Income	Hinc-OECD	Positive**	Positive*	Negative
		Hinc-nonOECD	Positive	Positive	Negative***
		UMinc	Positive***	Positive	Positive
		LMinc	Positive**	Positive	Negative
		LOinc	Positive	Positive**	Negative

Note:

DIPRS is dummy variable for level of protection
DIPRS [0, 1): 1 country
DIPRS [1, 2): 5 countries
DIPRS [2, 3): 17 countries
DIPRS [3, 4): 16 countries
DIPRS [4, 5): 17 countries

DBMP is dummy variable for domestic market transparency
DBMP1: 18 countries
DBMP2: 10 countries
DBMP3: 13 countries
DBMP4: 9 countries
DBMP5: 6 countries

DRND is dummy variable for R&D per GNP
DRND1: [0, 1): 30 countries
DRND2: [1, 2): 14 countries
DRND3: [2, 3): 9 countries
DRND4: [3, 4): 3 countries

Country Income Classification, World Bank (as July 2003)
Hinc-OECD: High income Country – OECD (23 countries): US$ 9076 or more
Hinc-nonOECD: High Income Country – NonOECD (3 countries): US$ 9076 or more
UMinc: Upper Middle Income Country (11 countries): US$ 2936 to US$ 9075
LMinc: Lower Middle Income Country (14 countries): US$ 736 to US$ 2935
LOinc: Lower Income Country (5 countries): US$ 735 or less

The sign with *,** and *** are the significant level at 10, 5, and 1 percent respectively.

5.3.1.3 Interaction on dummy R&D (DRND)-[level of r&D]

For most of the cases, the interactions of DRND variable enhance the analysis in terms of investor's decision. As the level of R&D activity increase, and given the level of patent protection (IPRS), the effects of FDI investment also increase significantly.

The level of R&D intensity for all groups is positive, but the significant effect from the sample set only significant at the low level of R&D activity group. However, for other classifications, the positive impacts were found insignificant.

However the interaction of DRND and BMI is rather mixed in results. All groups except for countries in DRND2 have a positive impact. The higher the group levels of R&D activity, the larger the impact (negatively significant at 1 percent level). The mixed results between interaction terms coefficient are due to the specific characteristics of each group across country and observation in the sample set.

5.3.1.4 Interaction on dummy income (Dinc)-[level of income]

Since income is seen as one of the indicator for level of economic prosperity and nation's development, an increase in income, will enhances the nation's standard of living and awareness of protecting the intellectual property rights up to the optimal level. Therefore, to scrutinize the country specific development level, we use the latest World Bank income classification (as of July 2003) to examine the impact of countries inflow of FDI.

The dummy for country's income are divided into five main groups' viz. high income-OECD, high income- Non-OECD, Upper middle income, Lower middle income and low income countries. The results of these interactions are viewed an important view point since it can provide better understandings about the nature of FDI.

For high income-OECD country, IPRS index and R&D activity play the effective role decision for investment in FDI. It is found that the IPRS and RDEXP positively affect the level of FDI investment (significant at 5 percent and 10 percent respectively). For the high income-OECD country, since the increase of FDI inflow is incorporated with low BMI index, but the inverse effect for this group is not significant.

For high income Non-OECD country set, the positive effect for both IPRS index and R&D activity is not significantly affecting the decision of attracting FDI. Most of the decisions are significantly dominated by the domestic market environment, where the negative effect is highly significant at 1 percent level. [Real data]

The decisions to invest in FDI in the upper middle country are due to the argument of stronger patent protections (significant at 1 percent level). However, the R&D activity for those countries found not as important as the protection index.

For lower middle income countries, the decision to invest in FDI is stimulated by a stronger patent protection level. It is shown that the positive effect is significant at 5 percent level. As patent protection increase, the impact of FDI inflow also increase, but it is not as important as IPRS level. The negative effect of BMP is not rejected at any significant level, although it is parallel to the early hypothesis.

For lower income country, the decision to invest in FDI is explained by the intensity level of R&D activity (significant at 5 percent level). Although the decision also affected by the other factors, but it cannot be proved to be significant in the model.