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Capital Goods Export to Developing Economies: Implication from Exporter's Level of Technology and Destination Country's Threat of Imitation

(Eksport Barangan Modal ke Ekonomi Membangun: Implikasi daripada Tahap Teknologi Pengeksport dan Ancaman Tiruan di Negara Destinasi)

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ABSTRACT

This article estimates the trade effect of capital goods exports from 19 OECD into 57 developing and emerging economies trade partners for the period 1990 to 2010. The impact of capital goods exports from the OECD countries is assessed using panel gravity model analysis. We examine the possibility of market-power or market-expansion related to capital goods export into the trading partners hypothesized using the intellectual property right (IPR) index, level of exporters' technology and imitation threats in the destination country. Our empirical result shows some consistencies on the evidence of market-expansion effect towards capital goods exports which is directly observed from both exporters' level of technology and destination country's IPR protection level. Indirectly, a diminishing effect on market expansion is observed when conditioned on one interacting variable. We also predict a consistent market-power effect observed from threat of imitation over time.

Keywords: Capital goods exports; patent rights protection; triadic patent; threat of imitation; developing economies

ABSTRAK

Kajian ini menganggar kesan perdagangan eksport barangan modal dari 19 buah negara OECD ke 57 buah negara rakan dagangan di kalangan negara membangun dan negara baru muncul untuk tempoh 1990 hingga 2010. Kesan eksport barangan modal dari negara-negara OECD dinilai dengan menggunakan model analisa panel graviti. Hipotesis berkenaan kewujudan kuasa pasaran atau pengembangan pasaran berkaitan dengan eksport barangan modal ke atas rakan dagang diuji dengan menggunakan indeks perlindungan harta intelek (IPR), tahap teknologi pengeksport dan ancaman tiruan di negara destinasi. Hasil empirikal menunjukkan wujud beberapa bukti yang konsisten terhadap kesan langsung pengembangan pasaran eksport barangan modal diperhatikan dari kedua-dua tahap teknologi pengeksport dan tahap perlindungan IPR negara destinasi. Pengurangan terhadap tahap kesan tak langsung pengembangan pasaran diperhatikan tertakluk kepada satu pemboleh ubah berinteraksi. Keputusan kajian meramalkan kesan kuasa pasaran daripada ancaman tiruan yang konsisten dari masa ke semasa.

Kata kunci: Eksport barangan modal; perlindungan harta intelek; paten triadic; ancaman tiruan; negara-negara membangun

INTRODUCTION

Global trade in foreign capital goods has dominated the landscape of growth, innovation and knowledge spillovers among trading partnersacross the globe for years.The importance of foreign capital and its impact on higher growth or productivity to the trade partner has been predicted by a number of important empirical studies[1]. As emphasized by Eaton and Kortum (1997, 2001), R&D (research and development) intensive activity to produce capital goods are only dominated by a few advanced countries, for example the USA, Germany and Japan, but the impact of the R&D capital significantly contributes to a higher output growth or productivity to the trade partner. The impact of this R&D capital is huge because this capital embodies new technologies that spill over into productivity growth. For the next century, it is expected that imports of capital goods will continue its role as a channel for knowledge spillover among the importers, and initiatives to improve the IPRs (intellectual property rights) policy are expected to provide greater technology access.

Knowledge spillover brought through imported capital into developing countries can be monitored when

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protection of intellectual property rights (IPR) in the developing countries are forced to be standardized. The initiative to standardization of IPR in terms of protection, coverage and instruments came to fruition when commitment to enforce the World Trade Organisation-Trade related aspect of intellectual property rights protection (WTO-TRIPS) agreement came into force in 1995. The wave of such reforms however has been important to both developing and developed economies although more critical to the former. Although most developing countries have shown their commitment to reform IPRs protection, the impact on trade however is much related to and depends on other economic distortion of the destination countries.

As far as the relationship of IPR protection towards trade is concerned, the literatures acknowledge that there is an ambiguous effect (i.e., gain or reduction) on export volume as a result of IPR policy exercised at the destination countries (Maskus & Penubarti 1995). The effect on exports as a result of IPR protection may be a reduction or expansion and known as market-power (reduction in exports flows) or market-expansion (expansion in export flows), respectively. Moreover, recently the literature has acknowledged that exporter's level of technology may also explain the interchange between market-power or market-expansion effect in the exports market. This evidence has recently been outlined in a study by Shin et al. (2016). The authors argue that, the trade-off between market-power or market-expansion exist between trade partners due to the interplay effects between both exporter's level of technology to produce goods for exports and also related to destinations country's IPR protection level. Notwithstanding destination country's IPR protection level, Smith (1999) provide detailed theoretical explanation on how the level of imitative capability in the destination country may cross-interact to generate a similar effect on trade, extending the evidence found in Maskus and Penubarti (1995).

The objectives of this study are to examine the possible impacts of destination country's IPR protection and exporter's level of technology on exports of capital goods for a group of 19 OECD countries to a group of 57 developing countries. We use a refined measure of patent statistics namely triadic patent family counts to represent exporter's level of technology. In addition, we examine the likelihood effects on such exports by proposing an alternative measure of imitation capability to represent the imitation incidences in the destination countries.

The contribution of this study is two-fold. Firstly, most studies that relate to the issue of trade and IPRs protection covers either accumulated total exports or imports (see Awokuse & Yin 2010; Salim et al. 2014) or segregated exports or imports either across sectors or industries (see Maskus & Penubarti 1995; Smith 1999, 2001, 2002), Rafiquzzaman (2002), Awokuse and Yin (2010), Ivus (2010) and Kabir and Salim (2016) and to the best of our knowledge there is limited study using the specific category of capital goods, which embody technology. Therefore, this becomes our first contribution in this study. This relates to the hypothesis of whether capital goods exports from developed countries are purely related to stronger IPR protections in the destination countries. Capital goods are largely produced in more advanced countries and the market for capital goods produced comprise of a group of developing and emerging economies due to their need to support industries and growth. By studying the exports of capital goods from more advanced countries we hope to shed light on the issue of whether the increase of IPR protection in the destination countries is indeed important in attracting incoming capital goods.

Our second contribution relates to the variable used to represent the level of technology and also a new measurement to represent imitative capability, which differentiates from previous empirical work. In this study, we use an alternative variable to measure the technological strength of the exporter's country that differentiates our work from Shin et al. (2016). Shin et al. (2016) use total patent granted worldwide and total patent granted in the US, two measurements on patent count statistics to represent exporter's level of technology. In this article we prefer to use the triadic patent family count to mirror the technology level of exporter instead of taking a single region as a source for count or measuring strength on technology an approach taken by Shin et al. (2016). In this study a more refined patent count measure to represent level of technology, i.e., the triadic patent will be used. Unlike trilateral patent counts, which suffer from repeated counting on similar patent across three regions, triadic patent is considered high in quality because similar patent registered in three-triad region is considered as one patent count instead of three. The frontier regions known to protect quality patents are USA, Europe and Japan. Since repetition is totally avoided in the counting process, the use of triadic patent family counts reduces the home-country bias if patent counting is made in each single region or patent office's such as USA, Japan or Europe respectively.

In addition, we also introduce an alternative variable to represent threat of imitation to differentiate from Smith (1999). The author use the interaction between the Rapp and Rozek (1990) IPR protection index and R&D capacity of a country to represent threat of imitation, i.e., by grouping both variables into its low and high category and using a cross-interaction category to estimate the effects on level of exports. However, in this study we use a single continuous measurement instead of cross-interaction dummy groups by overlapping the measurement of IPR protection index of the destination countries and its level of human capital to represent *relative unobserved* threat of imitation. Our measures on threat of imitation reflect the relative strength between individual imitative capability and institutional stringency of protecting technology; the individual imitative capability from the labor force represented by the index of human capital and strength of IPR protection to represent institutional quality in preventing infringement. The institutional quality of IPR protection used in this study in fact differ from Smith (1999) who uses the original index of Rapp and Rozek (1990) but we use a modification of Ginarte and Park (1997) and Park (2008) as a proxy that simulates institutional efforts to combat infringement.

This article proceeds as follows: Section 2 reviews the literature on IPR protection and trade; Section 3 outlines the proposed model, estimation procedure and data coverage. Section 4 presents the results and Section 5 concludes the study.

LITERATURE REVIEW

Generally, the literature acknowledges that protection on intellectual property rights (IPRs) affect international trade flows when knowledge-intensive or high technology goods leave the exporters or enter the importers national boundaries. The importance of IPR for trade related to high-technology goods has gained significance as volume of trade of high technological content product has increased considerably in world trade especially involving trade among the Northern region (see Eaton & Kortum 1996) or between the Northern to the Southern region (see Eaton & Kortum 2001).

Production of capital goods are dominated by a few developed countries (as mentioned in Eaton & Kortum 1997, 2001) which also relates to its level of technology (Shin et al., 2016) and serve the market largely from countries in the developing region. Due to the nature of capital goods, which can engender productivity growth, the need to improve IPR policy among the importing countries facilitates technology transfer and spillovers. The improvement on IPR policy among developing regions in this context not just facilitates knowledge spillover between nations, it is also portrayed as efforts to lessen threat of imitation, an issue which is of perennial concern to developed economies. Discussion in this section therefore relates to the literature on the effect of destination country's IPR protection and incidence on threat of imitation and also relates to the effect of exporters level of technology on high-technology goods trade in the technology transfer and spillover process. Commonly, literature discussing the effect of IPR protection on trade either through export or imports between the North and the South has found some ambiguity effect, i.e., there exist the opposing effect between market expansion and market power (Maskus & Penubarti 1995). While stringent IPR protection in the destination country may in fact improve the access of trade flow across borders, another stream of literature also point to the imitation threat as a mediating factor in luring future trade flows into the destination country. Accordingly, threat of imitation in a country is reflected by its IPR protection strength, i.e., it may reduce or increase future trade flows if imitation threat is found to be respectively high or low(Smith 1999). Similarly, previous literature also acknowledges the effect of imitation being ambiguous in this context.

The ambiguity or indeterminate effect on trade as a result of stringent IPR protection exercised in the destination country has brought this interesting issue to be examined within the empirical context. From the theoretical point of view, the protection of IPR in the destination country grants monopoly power to the capital exporting firm by providing exclusive rights to products and technology. An increase in the strength of IPR provides the capital-exporting firm with enhanced market power to exploit its rights. The market power arising from stronger IPR induces the capital-exporting firm to operate more monopolistically, and hence restricting the quantity of export to the foreign market and increasing the unit price of the exported product. The market power effect of IPR reduces the elasticity of demand facing the exporter and of course, market power can arise for reasons other than IPR, that is, when markets are segmented and only few close substitute products are available (Smith 1999).

On the other hand, stronger IPR protection in the destination country reduces the ability of local firms to imitate foreign technology. The stronger the protection of IPR, the lower is the level of local firms' infringing activity and the higher is the demand curve facing the exporting firm. Accordingly, the larger are the markets available for exports. The increase in demand induces the exporting firm to supply more capital exports into the destination countries; the evidence of the market expansion effect of stronger IPR. Since the market power and market expansion effects are offsetting one and another, an ambiguous prediction effect on the direction of trade may emerge in a world of varying IPR regimes. Hence, the impact of stronger IPR on trade is an empirical issue when involving North-South trade. As explained by Smith (1999), market power and market expansion effects are countervailing, therefore the direction of the relationship between IPR and trade is indeterminate. In fact, according to Smith (1999), under the two effects, the exporters will respond to the threat of imitation in the destination country, which finally determine the net effect. Differences in national IPR regimes can stimulate or reduce trade, i.e., a lax IPR regime can encourage imitation of patented technology and reduce imports of capital goods.

The threat of imitation is simply assumed as a trade distortion arising from national differences in IPR as well as imitation capabilities of the workforce of a country. Accordingly, the threat of imitation is weakest in countries that have weak imitative capabilities and strong IPR. The threat of imitation is strongest in countries that have strong imitative capabilities and weak IPR[2]. According to Smith (1999), the relationship of threat of imitation is strongly related to market power and market expansion of exports which explain why the effect of IPR protection on trade is ambiguous. Studies by Rafiquzzaman (2002) and Awokuse and Yin (2010) reveal that the effects of the imposition of stronger IPR on trade is indeterminate, because trade volume could simultaneously rise and fall through market expansion and the market power effects. Hence, the flow of a country's exports across destination countries depends on the relative importance of the market expansion and market power effects. Maskus and Penubarti (1995) find strong evidence of the market expansion effects of IPR on the distribution of OECD exports across large and small developing countries. Smith (1999, 2001, 2002) finds similar evidence of market expansion effect of IPR on U.S. state exports across countries with strong imitative abilities, however, she finds evidence of the market power effect across countries with weak imitative abilities.

Smith (2001) studies the effect of IPR on bilateral exchange[3] and extends the analysis on factor flows to affiliates, i.e., capital and labor within the ownership, location and internalization concepts that are central to FDI motivation in the 'eclectic paradigm'. Smith (2001) finds that the enhanced ownership advantage from strong foreign IPR increases bilateral exchange on average across all countries. The positive market expansion effect is large across countries with strong imitative abilities. Strong foreign IPR protections confer a location and internalization effect advantage which increases affiliate sales and licenses relative to exports. The author also found that strong foreign IPR increase the location effect of knowledge factors outside the source country and the effect is particularly strong across countries with strong imitative abilities. On the other hand, weak foreign IPR increase the internalization of knowledge factors inside the source firm, i.e., weak foreign IPR increase the employment of US citizens within the US affiliates although the effect is insignificant.

In a study based on Canadian exports, Rafiquzzaman (2002) found similar results indicating that stronger patent rights laws induced more Canadian exports to countries with strong threat of imitation, an evidence of market expansion effect. Awokuse and Yin (2010) conduct a study based on Chinese aggregate and sectoral imports on two group of products, that is, imports on knowledge-intensive product mainly outputs from science-based industries including the Electrical and Electronic industries and non-knowledge-intensive products mainly outputs from traditional or low-tech industrial sectors. Awokuse and Yin (2010) found evidence of market expansion effect at the aggregate level and this finding further confirms earlier support for the market expansion hypothesis at the disaggregated level. The market expansion effects tend to be stronger and larger on average in knowledge-intensive sectors, i.e., chemicals, electronics, instruments and machinery, the sectors with significantly higher R&D investment[4]. The authors also found strong evidence of the market expansion effect on imports of knowledge-intensive sectors product from OECD countries. This is in contrast to results for the imports of OECD countries, where the IPR strength exhibits the market expansion effect on imports of non-knowledge-intensive products from non-OECD developing countries[5].

Recently, Shin et al. (2016) find that the level of exporter's technology relates to the ability to gain export into the developing economies markets. The authors argue that, with recent development in the TRIPs agreements, the global system of IPR regime has reinforced advantages of countries with high levels of technology to export more. The author noted that since the year of 2000, the IPR protection gaps between developing and developed countries have narrowed down, which become another plus factor pushing exports into the developing countries. Notwithstanding the exporter's level of technology, the authors hypothesize that level of IPR protection in the destination countries plays a role in determining export penetration; export from developed countries may increase or decrease once interaction with exporter's level of technology is taken into account in the analysis. This according to the authors weighs the effects of either market-expansion or market-power, which dominates the total export penetration, resulting from destination country IPR. In fact, by including the interaction terms, the direct and indirect impacts of IPR on trade and level of technology on trade can be easily assessed, a novel approach in examining the ambiguous opposing effects of stronger IPR in the destination country, a channel which the authors claims has not explicitly been considered in the literature.

The above literature discussion leads us to conclude that the linkage between trade, exporter's technology capability, level of importing countries' IPRs and imitation threat is a purely empirical question which only can be investigated through empirical investigation. In this regard, this article differ from previous studies in several ways. The classification of exported goods from developed economies used in this study is one that differ entirely from previous research. Moreover, the chosen classification of exported goods is specifically related to exporter's level of technology. The use of triadic patent family count, a proxy to exporter's level of technology is another novelty approach in this study. In fact, this study also introduces a continuous variable measure to reflect *unobserved* threat of imitation in the importing countries, an alternative approach which has not been considered previously in the literature.

METHODOLOGY AND DATA

TRADE PANEL GRAVITY MODEL

This study employs panel analysis of 19 exporter countries exporting capital goods into a group of 57 developing countries for the period of 1990 to 2010. The chosen time frame is limited due to data availability. The data section describes the details of the data used and chosen time frame of the study. Our method follows the standard setup of the gravity trade model as in the literature. The structure of exporter-to-trade destination in this study however is structured as *many-to-many*, i.e., multiple exporters countries matched to a group of trade partners observed over the 21 years. Due to its complexity, we differentiate each identity of exporter-destination pair by matching each element of exporters-destination and sort it through years of the observation. We arrived at a total of 1,026 unique pairs of exporter-importer countries with unbalanced total observations of 12,427 over the 21 years.

The standard specification of the panel gravity model in logarithm form is as follows:

$$\ln EXP_{jkt} = \alpha_0 + \alpha_1 \ln GNI_J + \alpha_2 \ln GNI_K + \alpha_3 \ln TR_{jk} + \delta_1 \ln DIST + \delta_2\, COL + \delta_3\, LO + \delta_t + \lambda_j + \lambda_k + \varepsilon_{jkt} \quad (1)$$

Where EXP_{jkt} is exports of capital goods of country j to country k at time t; GNI_J and GNI_K are the per capita income (*GNI*) of country *j* and *k* in real term. The per capita income (*GNI*) of both exporter and destination country is used to capture the concept of marginal propensity to export (import) for exporter (destination country), a modified modeling version of Smith (1999)[6]. We expect that, both per capita *GNI* will have the positive impact on export, reflecting a positive marginal propensity to export (import), a relationship to reflect direction between income size and volume of trade. The *TR* denotes the average tariff imposed on imported goods by destination country. It is expected that *TR* will have a negative impact on trades, as higher tariff causes imported goods to be more expensive and reduce total trade.

In this study, we use distances (*DIST*) between the exporter to destination country to represent transport cost, dummy variable to represent common official language (*COL*) and variable to indicate either similarity or differences on the history of legal origin (*LO*), as a control for heterogeneity between pair. The country-pair depending on trade direction; for example, country *j* legal origin may be similar or different to destination country *k* with other non-observable time-invariant factors between countries being captured by the constant term α_0. The λ_j and λ_k account for fixed exporter and fixed destination countries, capturing the specific time-invariant characteristics to control for the multilateral resistance term and δ_t is the time effect controlling for common business cycle shock.We expect to have a negative impact of *DIST* on trade, because the longer the distance the higher the transportation cost. The effect of *COL* and *LO* may be negative or positive, because both variables are not policy-driven variables similar to *DIST*. In the literature, a common language is thought to facilitate communication between trade partners; therefore a positive relationship is expected. The *LO* variable is to capture the impact of similarity (or differences) on background history on legal origin for each trade partner. We expect to see a mixture of positive and negative impact on capital export trade in either similarity or differences in *LO*.

We augment Eq. (1) to include threat of imitation ($IMIT_{kt}$), level of IPR protection in the destination countries (IPR_{kt}) and level of technology of the exporters country (TL_{jt}). We also include the interaction terms between destination country's IPR protection level and exporter's level of technology ($IPR_{kt} \times TL_{jt}$).

$$\ln EXP_{jkt} = \alpha_0 + \alpha_1 \ln GNI_J + \alpha_2 \ln GNI_K + \alpha_3 \ln TR_{jk} + \alpha_4\, IMIT_{kt} + \alpha_5 \ln IPR_{kt} + \alpha_6 \ln TL_{jt} + \alpha_7 (\ln IPR_{kt} \times \ln TL_{jt}) + \delta_1 \ln DIST + \delta_2\, COL + \delta_3\, LO + \delta_t + \lambda_j + \lambda_k + \varepsilon_{jkt} \quad (2)$$

As higher tariff causes imported goods to be more expensive and reduce total trade, the impact on higher imitation threats (*IMIT*) is expected to create a similar inverse effect on flow of export trade. The destination country IPR protection level uses the index developed by Ginarte and Park (1997) and Park (2008). The exporter's level of technology uses the triadic patent family count, a variable to measure the level of technology of the exporting country. Previous literatures predict the effect of IPR on trade as either positive or negative, with positive signs denoting market expansion and negative signs implying market power effect or reduction in trade volumes (Maskus & Penubarti, 1995). The *TL* variable represents level of technology of the exporters. Higher *TL* means higher capacity of producing goods by the exporter, specifically relevant to capital goods, which we intend to explore in this study. We include the interaction term of IPR protection (*IPR*) level of the destination country to level of technology (*TL*) of the exporting country to measure the interaction on indirect effects of both *IPR* and *TL* towards capital goods export respectively. According to Shin et al. (2016), the interaction term coefficient will determine the interplay between destination's IPR protection and exporter's *TL*, because of ambiguity (either market expansion or market power) from the expected coefficient α_5, (i.e., destination country's IPR protection) even though a positive relationship is expected from the coefficient of α_6.

Unlike Shin et al. (2016)[7], we proxy the *TL* using the triadic patent family count to reduce a home-country bias when using the locally counted or foreign counted patents in the domestic market. The triadic patent family is basically a count of identical invention (patent) made outside the territorial economic boundaries, the region known to be at the world technology frontier, i.e., the USA, Europe and Japan. Since, our dataset also includes the US, Japan and countries in the European region as the exporter of capital goods, therefore using the triadic patent family count to represent *TL* may in fact reduces the home-country market effect. Moreover, in this study, we use the triadic patent family count based on the inventor's country of residence, an indication of inventive performance of labor force of the respective countries. We also use total number of patent applied in the US for robustness check of *TL* in this respect. Detailed discussions on triadic patent family count and its source of data is discussed in the data section.

The threat of imitation (*IMIT*) variable that we include in this study is one of the key variables of interest in addition to the alternative variable of *TL* that we described earlier. For this purpose, we gather a series of variables to capture the ability to imitate existing technology such as the research and development (R&D) expenditure as a percentage of GDP, total number of scientists, engineers and technicians engaged in R&D sector to match our dataset. These variables are also applied by Smith (1999, 2001) in their analysis. Unfortunately, due to a large number of missing observations, most of the measures cannot be used. Hence the most likely measure to capture imitation capability is the human capital (*HC*) index. The use of *HC* index to capture imitation capability is an alternative measure to human development index used previously in Smith (1999, 2001) studies.

The *IMIT* variable that we used in this article is measured as the overlap between two proxy variables to represent relative *unobserved* different level of imitation capability, i.e., human capital (*HC*) and level of IPR protection in the destination country. Both variables represent imitation capability viewed from two different perspectives, i.e., capability to imitate existing technology through quality of human capital and stringency on law protecting a new invention from being infringed or quality of institutional factors to safeguard technology in a country. Unlike previous studies (Awokuse & Yin, 2010; Smith, 1999, 2001, 2002)the use of interaction between the IPR protection index and research and development (R&D) capacity of a country to represent threat of imitation, i.e., by grouping both variables into its low and high category and using cross-interaction category to estimate the effects on export level. Our measure of *IMIT* however, use a different approach, i.e., creating a single continuous measurement to represent *unobserved* threat of imitation by overlapping both variables, instead of the cross-interaction categorizing approach as used in the previous empirical research. We use the weights of *relative precisions* (or inverse of the variances) on two variables in the overlapping process to generate *unobserved* threat of imitation (*IMIT*) variable, the same technique applied in Park (2013). Our measure of *IMIT* is defined by the following expression:

$$IMIT_{kt} = \theta_{HC} \times HC_{kt} + \theta_{mod\_IPR} \times Mod\_IPR_{kt}$$
$$\theta_{HC} + \theta_{mod\_IPR} = 1$$
$$\theta_{HC} = \frac{var(HC)^{-1}}{var(HC)^{-1} + var(mod\_IPR)^{-1}} < 1 \qquad (3)$$

The θ_{HC} and θ_{mod_IPR} represent the weight ratio of relative variations of human capital (*HC*) and IPR protection (*IPR*) to total variations to indicate measure on relative precisions. The estimate of *IMIT* is a summation of relative weightage to the respective original value of *HC* and *IPR*. We modified the IPR protection index of GP&P so that higher (lower) value represent lower (higher) protection to safeguard the technology, in line with the definition of higher imitation capability when higher *HC* value is observed across all samples. Our measure at the lower *IMIT* value is the continuous combination of higher institutional protection with lower individual imitative capability and higher *IMIT* value is associated with lower institutional protection and higher individual imitative capability. In contrast to Smith (1999) approach, we only tested two hypothesis in this study, i.e., lower and higher value with respect to *IMIT* index. In fact, *IMIT* can be used to test the effect towards capital goods exports over time and also interaction with either exporter's or destination country time-invariant variables.

DATA SET

The exporters (indexed by *j*) are 19 OECD countries with 57 export destinations (indexed by *k*) observed over 1990 to 2010 (refer Appendix Table A1 for lists of countries). All data are gathered from various secondary sources and represented as Table A2 in the appendix. The chosen time frames of 1990-2010 are due to several reasons. The observations on exported capital goods (*EXP*) from 19 OECD countries as reported in the OECD STAN Bilateral trade database only started in 1988 with latest observation in 2011, but due to a large number of missing values for data in 1988 and 1989 and also in 2011, we decided to use observation 1990 to 2010 as our final time frame[8]. In fact, for1990-2010, the dataset still have some missing observations especially from countries residing in the African region. The *EXP* trade flow only consists of a single class category of capital goods classified under D26T28-Machinery and Equipment industry of International Standard of Industrial Classification (ISIC) version 4. In the process of estimating the gravity equations, we have a total of 1,026 matching pair between exporter-destination country with a total number of observations of 12,427 and this figure therefore is used as a basis in our data description and in the empirical discussion.

Data on capital goods exports (*EXP*) are extracted from OECD STAN Bilateral trade database. Data for GNI per capita (*GNIP*) for *j* and *k* are gathered from the World Development Indicator (WDI), the World Bank and Penn World Table, ver.8 (PWT8.0). Distance () between country *j* and *k* adopted from *GeoDist* database of CEPII (*Centre d`EtudesProspectives et d`InformationsInternationales*-Institute for Research on the International Economy), based on compilation data by Mayer and Zignago (2011). The *GeoDist* database representing bilateral distances using latitudes and longitudes of economic centers to calculate the great circle distances between countries, a proxy to representing transportation cost.

Data on tariff (*TR*) are gathered from the World Development Indicator (WDI) the World Bank database. *TR* is measured as the ratio of total imports duty (i.e., total customs and other import duties) over the value of merchandise imports for the period of 1990 to 2010. We use the log (1 + *tariff ratio*) to represent *TR* in our analysis. The correction process is needed to avoid negative values when implementing the logarithm transformation. The IPR data to represent IPR protection level in the destination country is adopted from Ginarte and Park (1997) and Park (2008), hereafter referred to as GP&P with updated data for 2010. The GP&P study uses national patent law to construct their index. GP&P construct the index using a scoring point method between zero (no protection) and five (maximum protection) into five categories of national patent laws, i.e., (i) extent of coverage (patentability), (ii) membership in international patent agreement (including the TRIPS agreement which is updated in Park (2008)) (iii) protection against loss rights (such as compulsory licensing), (iv) enforcement mechanism, and (v) duration of protection. Each category takes on a value between "0" and "1". The sum of values from these five categories gives the overall value of the patent right index. Similar to *TR*, we also use the similar approach in transforming the variable into its logarithmic form.

The triadic patent family count gathered from OECD patent statistics database (a proxy of country innovation strength) represent exporter's level of technology (*TL*). The use of series of patent count statistics has long been considered a well-grounded proxy of innovation[9] with an earlier survey of the literatures by Basberg (1987) and Griliches (1990). The triadic patent family counts refer to single identical invention with applications made and/or granted outside the territorial economic boundaries. Three economically important regions in which the triadic patent count was measured are North America, i.e., the United States Patent and Trademark Office (USPTO); Europe, i.e., at the European Patent Office (EPO); and East Asia specifically the Japan Patent Office (JPO). All patent applications and/or granted in these three IP offices are considered to be of high economic value since they worth the costly application process on the world most important regional markets of newly invented technology. As patent-based statistics have been widely regarded as indication of innovative performance of a country, it is also subject to various criticisms. Empirical studies in the past have recognized that patent statistics may provide a home-country bias estimate[10]. Hence, the use of triadic patent family may avoid or reduce these problems. Another advantage is that, triadic patent is an outcome of a result of R&D initiatives undertaken. In this article, we use the triadic patent family count based on the inventor's country of residence. This measurement is considered to be an appropriate measure of *TL* because it measures the inventive performance of a country. We also use total patents granted in the USA as an alternative measure of *TL*.

Threat of imitation index ($IMIT_{kt}$) captures the possibility of threats to imitate foreign technology in the destination country. We combine two aspects of measurements to portray severity of imitative threats in the destination country. One aspect of imitative threat may appear from the quality of institutional law protecting the patented technology and another comes from the individual capability (knowledge level) to replicate new or existing technology. The *IMIT* index is represented by overlapping the weight of *relative precision* on two threat variables to measure *relative unobserved* imitative threat incidences in the destination country. In this respect, we use a combination between a modified GP&P index of IPR protection and human capital (*HC*) index. We used the conversion of "five" *minus* the original GP&P index to modify the original IPRs index of GP&P, so that higher values are associated with lower institutional protection or higher imitation threat. The value on *IMIT* represents the *relative unobserved* imitation threat level, in which a low value of *IMIT* is associated with the combination of high institutional level on IPR protection with low individual (*HC*) imitative capability, whereas a high value of *IMIT* is associated with higher threat from a combination of low institutional protection on IPR protection with high individual (*HC*) imitative capability.

The *HC* index is gathered from latest dataset of Barro and Lee (2013). We are aware that, by using the Barro-Lee dataset, the imitation capability of imitators in the destination country, may not be a suitable proxy. However, it is the only complete available proxy to capture imitation capability for two reasons; (i) data on *HC* are fully available for all country sample in our analysis; (ii) as described in the literature, human capital will enhance knowledge spillovers, where a higher human capital stock signify the ability of the workforce to learn, absorb and work with new technology and hence, improve the R&D spillovers and higher productivity across the industries. Our argument is that the ability to absorb and learn new technology is the key factor for *unobserved ability* to replicate existing foreign technology. The measure on *IMIT* depends on the weights on each . Higher variation on *HC* is observed compared to modified IPR index with values of θ_{HC} and θ_{mod_IPR} equal to 0.74 and 0.26 respectively. This variation determines the dispersion on *IMIT* index.

The common official languages (*COL*) data is adopted from Melitz and Toubal (2012), a dataset compiled at CEPII[11] used as control variable. In addition, we also include another control variable represented by the history on legal law origin (*LO*) adopted from La Porta et al. (1999) extended from the study of La Porta et al. (1998). La Porta et al. (1999) identify the legal origin of each country based on value equal "1" if the origin is English common law, "2" if the origin is the French commercial code, "3" if the origin is the German commercial code, "4" if the origin is Scandinavian civil law and "5" if the origin is Socialist/Communist law.

There are no exporter countries classified under group "5" but two destination countries, i.e., China and Vietnam are countries with Socialist/Communist law. We use the coding properties to classify the *LO* between exporter-destination country into its similarity and its differences based on information in La Porta et al. (1998) and La Porta et al. (1999). We classify *LO_11* if both exporter and destination *LO* is English common law and *LO_23* if exporter *LO* is French commercial code and destination *LO* is German commercial code. We managed to identify 16 pairs of *LO* in this process (Refer Appendix A Table A3 for cross-tabulation of *LO* across exporters and destination countries).

Table 1 show the statistics describing all variables included in this research. As in Table 1, for the period of 1990-2010, capital exports from the 19 OECD countries into the 57 developing economies estimated on average amounts to $US 140 million. The average of gross national income per capita is $US 33 million (GNIP) recorded for the 19 OECD exporter countries, with only $US 4 million GNIP recorded for all destination economies over the same period. This figure shows that, the income gap between group of exporters and destination economies deviate to nearly 8 times for the 21 years. Our dataset also records an average of 2.5 million triadic patent family counts registered in the triad region and nearly 8.3 million (on average) of patent registered in the US Patent and Trademark office (USPTO) alone over the stipulated period. On the other hand, the patent rights protection (IPR) index among the developing countries is recorded around 2.7 on average over the 21 years. The role of destination country's IPR is expected to positively relate to capital exports, with similar effects expected from exporter's level of technology (*TL*).

As explained by Shin et al. (2016), the tendency for developed countries to penetrate export markets in the developing countries are related to both *IPR* and *TL*. Even though the higher *TL* country has the capacity to produce capital-intensive products to serve export markets, the penetration impact also relates to destination countries IPR protection. As IPR protection in the destination country converging to its supportive level, higher exports from developed trade partners are expected to increase. As shown in Figure B1 and Figure B2 in Appendix B, only three exporters, i.e., USA, Germany and Japan show an upward trend in capital exports into the developing economies and the level of *TL* over the 21 years. These economies are considered to have the highest capacity in terms of producing high-technological content product for export markets (Eaton & Kortum 1996). In fact, our results also point to a similar conclusion.

Previous literature also recognizes the incidences of imitations in the destination country as a threat to export entry from the developed region (Smith 1999, 2001, 2002; Weng et al. 2009). In this study, we use a continuous measure on threat of imitation to test the hypothesis. Data measuring threat of imitation (*IMIT*) for all developing countries is recorded at around 2.2 on average over the stipulated time frame with minimum and maximum values of *IMIT* ranging from 1.05 to 3.28 respectively. It is expected that, as higher (lower) *IMIT* is observed in the destination countries, lower (higher) *EXP* from the developed countries will be observed. However, previous empirical research (for example Smith (1999)) also found that high penetration of exports from trade partners is observed despite strong imitation incidences.

We differentiate the capital goods export from the OCED based on level of exporter's technology (*TL*) at one standard deviation from its logarithm mean value (i.e, mean ln*TL*±1SD). We also differentiate the exporter's level of technology (ln*TL*) based on a similar approach. The capacity to penetrate destination export markets are dominated by three OECD exporters as portrayed in Figure B1 and Figure B2 with Germany (DEU), Japan (JPN) and the United States of America (USA) appearing as the highest (above mean) performers in terms of exports volume and level of *TL*. A total of $US 1,270 billion of capital goods are exported into the developing economies for the period of 1990 to 2010, with Japan contributing $US 560 billion followed by USA ($US 409 billion) and Germany ($US 296 billion). Over the

TABLE 1. Data description, 1990-2010 (Average)

Variable	Mean	Std. dev	Min	Max
EXP	140838.60	790949.70	0.02	33300000.00
GNI_k	3791.60	5965.05	160.00	35660.00
GNI_j	33011.78	13780.92	7140.00	86830.00
DIST	8242.44	3469.87	561.64	18884.43
TR	33.89	120.46	0.00	1231.39
IPR	2.70	0.85	0.47	4.68
TL_triadic	2524.38	4574.95	0.67	18702.32
TL_USPTO	8332.71	25005.07	0.00	147648.50
IMIT	2.20	0.41	1.05	3.28
COL	0.13	0.34	0.00	1.00
LO	6.84	4.61	1	16

Source: Author data set

same period, a similar pattern is observed on the level of technology (*TL*). On average, the triadic patent count registered from the top three exporters are recorded highest for Japan (14,526) followed by the USA (14,261) and Germany at 5,867. These figures show that the tendencies for the exporters to export capital goods are positively related to its technology level.

RESULTS AND DISCUSSION

A panel gravity model of Eq. (2) is used to fit the dataset. We estimate pooled ordinary least squares (POLS) analysis, random effect (RE) panel and fixed effect (FE) panel. For each specified model all individual time-invariantand bilateral trade-pair characteristic of the individual exporters and destination country are included in the analysis. In this analysis, we adjust the standard error by number of cluster, so that each significant level reported in our empirical analysis are cluster-robust to heterogeneity across all panels. As discussed in the data section, we only managed to compile an unbalanced panel of 1,026 pairs with 12,427 total observations.

The empirical results based on POLS, RE and FE model specifications are shown in Appendix A, Table A4. We only present and discuss the empirical results estimated from fixed effect (FE) model to save space[12] and presenting the results from random effect for comparison purposes. In both RE and FE models, the general predicted coefficients and signs on standard gravity variables (i.e., *GNI, DIST* and *TR*) are consistent and stable, with the exception of a few variables with negative signs but insignificant. The coefficients of per-capita GNI are positive and significant, implying that higher per capita income in both exporters and destination country determined the exports level. In fact, the marginal propensity to import capital goods (i.e., the estimated coefficient of per capita income) in the destination country is higher than exporter's marginal propensity to export, reflecting the importance of capital goods in the destination economy. In addition, the sign of the coefficient on tariff (*TR*) and distance (*DIST*) are both negative and significant in accordance to the theory.

The coefficient representing bilateral time-invariant is also stable even though some deviations are also observed. The time dummy representing shock over time showing mixed signs being positive and negative and mixed between significance and insignificance. The common official languages (*COL*) appear to be positive and highly significance in both models implying that the role of common language as a medium of trade is important to facilitate global trade as in the case of capital goods export market. Our results also exhibit some mixed effect of historical legal law origin (*LOs*) on export trade and this also suggests that exports on capital goods are beyond the boundaries of historical legal law background.

As in Table 2, the direct effects of destination country's IPR protection level and exporter's level of technology (*TL*) on *EXP* are both positive and highly significant, supporting the evidence of export expansion. This result indicates that exporters are motivated to export more capital goods as level of own technology is higher (supporting evidence on the study by Shin et al. (2016)) and to countries with stronger IPR protection, confirming previous empirical results found in Maskus and Penubarti (1995), Smith (2001), Rafiquzzaman (2002) and Awokuse and Yin (2010).

As argued by Shin et al. (2016), we also estimate the indirect effects from both variables. We found that, the indirect effect of both destination countries' IPR protection level (*IPR*) and exporter's level of technology (*TL*) on capital goods exports entering the developing markets is found to be unique. In general, the indirect effect of *IPR* and *TL* point to the evidence of market-expansion but starts to diminish as variation above mean on each interacting variable is taken into account.

We use a linear combination (*lincom*)[13] test to estimate the effect of *EXP* with respect to destination country's *IPR*, exporter country's *TL* and interaction term of *TL* and *IPR*. We use three different values of *IPR* and *TL* in these tests to estimate the point elasticity, i.e, mean, one standard deviation from the mean value to represent lower and upper value (mean ±SD) of *IPR* protection level and *TL* respectively. The *indirect* effect of IPR_{kt} and $\ln TL_{jt}$ towards $\ln EXP$ is estimated based on partial derivative of $\frac{\partial \ln EXP}{\partial \ln IPR_{kt}}$ and $\frac{\partial \ln EXP}{\partial \ln IPR_{jt}}$ with percentage of *indirect* impact represented by $\alpha_5 + \alpha_7 \ln TL_{jt}$ and $\alpha_6 + \alpha_7 \ln IPR_{kt}$ respectively. Changes of elasticity on *EXP* now depends on two elasticity coefficients; the direct effect, i.e., α_5 and α_6 and also on the interaction terms effect of $\alpha_7 \ln TL_{jt}$ and $\alpha_7 \ln IPR_{kt}$. For the purpose of this study, we estimate the indirect effect towards EXP_{jkt} by imposing different conditional values of IPR_{kt} and TL_{jt} on the interacting terms, i.e, using the mean and one standard deviation (lower and upper value) around its mean value. In this case we can differentiate the lower deviation reflect below par protection and upper deviation reflect above par protection with respect to IPR protection in the destination country and level of technology (*TL*) from the exporter country respectively. The indirect effects on $\ln EXP$ from the both models RE and FE are presented in Table 3.

In Table 3, the indirect effect of *IPR* and *TL* on capital goods exports expansion diminished once we impose the conditional value on each of the interacting variables except for indirect effect of IPR in FE model. The *indirect* market expansion effect of destination country's IPR protection ($\alpha_5 + \alpha_7 \ln TL_{jt}$) on *EXP*as predicted in FE model has switched to market-power (–0.34%) as conditional level of *TL* deviate to its upper mean level. This result implying that, notwithstanding IPR protection level in the destination country, the FE model predicts

TABLE 2. Panel Gravity Model Comparing RE and FE, 1990-2010

	Random Effect (RE)		Fixed Effect (FE)	
Variables	Coefficient	*p*-val	Coefficient	*p*-val
lnGNI_k	0.795***	(0.000)	0.795***	(0.000)
lnGNI_j	0.358**	(0.030)	0.317*	(0.064)
lnTR	–0.133***	(0.009)	–0.134***	(0.009)
lnIPR_k	1.610***	(0.000)	1.656***	(0.000)
lnTL	0.379***	(0.000)	0.387***	(0.000)
lnIPR_k_lnTL	–0.231***	(0.000)	–0.241***	(0.000)
lnDIST	–1.295***	(0.000)	-	-
IMIT	–0.035	(0.527)	–0.054	(0.409)
COL	0.732 (0.000)		–	
LO	962.78 (0.000)		–	
Time effect	194.33 (0.000)		8.92 (0.000)	
Exporter specific	$\chi^2(15)$: 733.37***		-	
Importer specific	$\chi^2(53)$: 6046.94***		-	
Constant	12.554***	(0.000)	–2.863	(0.146)
No. Observation	12,427		12,427	
No. Group	1026		1026	
R squared (within)	0.239		0.239	
BP-LM test (POLS vs. RE)	$\bar{\chi}^2(1)$ = 10077.00***		–	
Robust Hausman test (RE vs. FE)	–		$\chi^2(72)$ = 12142.87***	

Notes: Both RE and FE model estimated with cluster- robust standard error. Both RE and FE model is estimated with both fixed exporter and importer effect, but to save some space only the overall effect is included.The statistics reported for *LO*, Time effect and overall fixed exporter and fixed importerare found to be highly significant. p-values is reported in parentheses (* p<0.1 ** p<0.05 *** p<0.01).

that higher level of exporter's TL has the significant tendency to extend their market-power (by reducing capital export) in the destination market. The positive indirect effect of exporter's *TL* ($\alpha_6 + \alpha_7$ lnIPR_{kt}) on *EXP* as appearing in FE model is found to be significant despite lower effect (0.13%) at lower level of IPR protection but decrease to 0.02 % as level of IPR protections in the destination country converge to its upper level. The evidence estimated from FE model indicates that, strong penetration or market expansion effect of *EXP* only dominates destination export market with relatively lower IPR protections and the effect starts to moderate once destination country's IPR protections converge to higher level (i.e., higher IPR destination country).

The evidence shows that strong exports of capital goods is indirectly determined by TL which implicitly point to the weak balancing power played by increasing IPR protection in equalizing the effect of exporter's *TL*. As level of IPR protection increases in the destination country (or at least converging to its highest levels), notwithstanding to the level of exporter's *TL*, there is a tendency of reduction on capital export. In fact, such tendency is observed from the RE model as well.

Figure 3a and Figure 3b below reproduced from coefficients estimated in Table 3, represent the indirect effect on both ln*IPR* and ln*TL* from FE specification. The indirect effect largely point to a mixed support evidence of market power and market expansions once conditional

TABLE 3. The estimated indirect effect of ln*TL* and ln*IPR* on ln*EXP*

Indirect effect of	Cond. on	RE Model Lower	RE Model Mean	RE Model Upper	FE Model Lower	FE Model Mean	FE Model Upper
lnIPR:	ln*TL*	0.57*** (3.26)	0.13 (0.94)	–0.30** (–1.94)	0.57*** (3.19)	0.12 (0.82)	–0.34** (–2.09)
lnTL:	ln*IPR*	0.14** (1.94)	0.08 (1.09)	0.02 (0.32)	0.13* (1.85)	0.07 (1.00)	0.02 (0.24)

Source: Authors Estimate from coefficient in Table 2.
Notes: Lower: 1SD lower from Mean value. Upper: 1SD higher from Mean value
Value in parenthesis indicate t-value
*, **, *** Indicate the significant level

The Indirect Effect of *lnTL* on *lnEXP*	The Indirect Effect of *lnIPR* on *lnEXP*

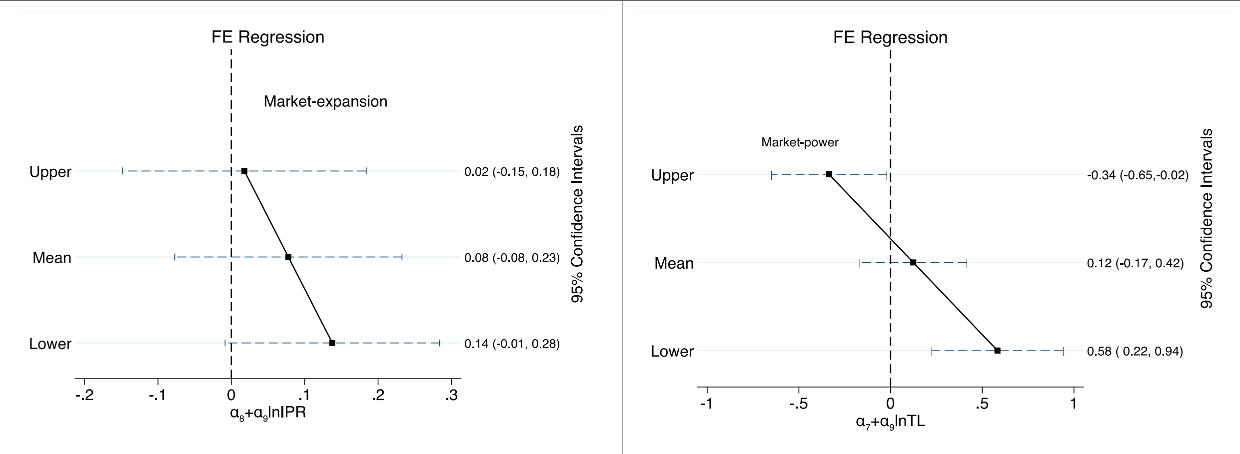

FIGURE 3a. Conditional on *lnIPR*	FIGURE 3b. Conditional on *lnTL*

FIGURE 3. The indirect effect of *lnIPR* and *lnTL* on *lnEXP* (FE specification)

value of ln*IPR* and ln*TL*, taken into consideration. The estimated elasticity of *EXP* with respect to *IPR* (*TL*), calculated as $\alpha_5 + \alpha_7$ lnLT_{jt} ($\alpha_6 + \alpha_7$ lnIPR_{kt}) with value of *TL* (*IPR*) such that the lower level is one standard deviation (SD) lower than mean and the upper level is one SD higher than mean.

As in Figure 3b, the estimated elasticity of *EXP* with respect to IPR is sharply reduced from 0.57 per cent (from market-expansion at oneSD lower from mean *TL*) to –0.34 percent once exporter's *TL* is observed at one SD higher from its mean value (significant evidence on strong market-power effect). This result shows that exporter with higher *TL* have the tendency to exercise their market-power (by reducing export flows) even though higher IPR protection is observed in the destination country. Surprisingly our dataset points to three top exporters, i.e., Germany, Japan and the USA. In fact this result implicitly re-emphasize the evidence that highest exporters of high technological R&D goods are Germany, Japan and USA as portrayed by Eaton and Kortum (1996).

In addition, the estimated elasticity of *EXP* with respect to *TL* conditional on destination country's IPR also show a similar reduction pattern on market-expansion effect once the level of *IPR* deviate to its upper level. In contrast to Figure 3b, the reduction on expansion effect shown in Figure 3a on *EXP* is much slower. This result indicates that, speed of convergence or improvement of *IPR* protection level in the developing country has slower impact to offset exporter's *TL* over time. This evidence implicitly shows that, the distributional impact of the TRIPS agreements on capital goods trade has largely skewed (benefited) only to a few advanced exporter country.

We also conduct the similar analysis using total patent registered in the USPTO as a proxy to *TL*. The result is appended in Appendix A, Table A5. Similarly by using USPTO total patent to represent exporter's *TL*, our result point to marginal reduction pattern on market-expansion once interacting variable is set to converge to one SD higher from it's mean value (i.e., either from destination country's IPR level or USPTO exporter's *TL*). In fact, in contrast to evidence found in Table A5 (i.e., using USPTO patent as proxy to exporter's *TL*), the use of triadic patent is found to be more appropriate measure to indicate exporter's *TL* level compared to USPTO patent and producing robust results.

A similar result is observed as we turn to the analysis on threat of imitation. Initially, our result point to a weak evidence of market-power effects towards exports of capital goods as predicted from both RE and FE model (Refer to *IMIT* coefficient in Table 2). In fact, segregating the index into its lower and higher segments also points to similar directions. Since the index of imitation that we propose in this study is considered as continuous, we do some interaction with time to identify the trend on *IMIT* incidences over time. The result is presented in Figure 4 below.

We found that, *IMIT* impact on OECD's capital goods exports predicted from the FE specifications show some consistencies in exports reduction. We see that there is a tendency of short-run reduction on market power effect (Figure 4). These results implicitly point to long run declining trends on capital exports from the developed countries, evidence supporting the long run market-power effect as threat of imitation increases over time. Intuitively, over time as level of imitation threats increase (as portrayed by Figure 4); developing countries have to face higher export costs due to reduction on export flows, i.e., there is a tendency that exporters may exercise their monopoly power with charging higher price on its exports. In fact, from the exporter countries perspective, seeing this threat as an opportunity instead of *real* threat to capital goods exports because developing countries has the ability to finance such exports as the marginal

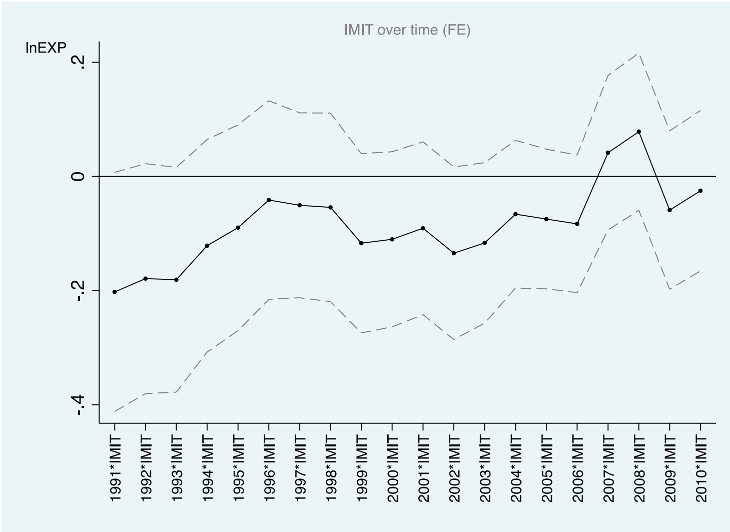

FIGURE 4: The Estimated time effects of *IMIT* on *EXP*(FE)

propensity to import over time is nearly as high as 0.78% as predicted by FE specification (See Appendix A, Table A6).

From another perspective, the evidence also point to the benefits of having stronger institutional of IPRs protection between developed and developing countries where it may reduce the tendencies of imitation incidences in the destination country. However, in this particular case, improvement on the institutional IPR protection does not translated effectively to minimize the market-power effect. The evidence from Table A6 shown that, while higher elasticity on direct effect of *IPR* on *EXP* is recorded at 1.6 % (i.e., the highest coefficient recorded in FE specification), total *indirect* effect of *IPR* on average conditioned to exporter's level of technology however has only an insignificant impact on capital goods trade (i.e., estimated only 0.22%).Although the effects from threat of imitation reduces overtime, this reduction however has only slight impact on trade flow except for the year 2007 and 2008 but found to be insignificant except for time-window of 1990-1994 a period before TRIPS was implemented in 1995. Again we also conduct the similar analysis using total patent registered in the USPTO as a proxy to exporter's *TL*. The time interaction of *IMIT* for FE model is appended in Appendix B, Figure B3.

CONCLUSION

In this study, we show that the export market of capital goods from 19developed OECD into 57 developing countries over the 21 years is sensitive to both to exporter's level of technology and also imitative threat capabilities in the destination country. The tendency of the OECD exporters to exploit (i.e., tendency to exercise market-power)into the exports market of capital goods is highly dominated by only a few advanced countries such as Germany, Japan and the USA. We also show that, while strong IPRs protection is indeed important as a channel to attract more incoming capital goods via exports, the effect is indirectly diminished once higher *TL* exporters enter the export market and start to exercise their monopoly market power. We also found that, exporters with higher *TL* have the tendency to exploit capital goods exports over time either directly or indirectly and this trend will probably increase over time. Since domination on capital goods export is skewed towards only a few advanced countries and with strong dependency on capital goods by the developing economies to support their industrial needs, we expect that this trend will be continuously repeated for the next decade.

Since capital goods is costly to produce by the developing nations due to constraints of capacity in terms of knowledge and resources, accessibility to global trade specifically served through importation is the option available to serve industrial needs. Therefore, as part of the policy recommendation, we propose that a long run policy targeted to improve human capital development along with the efforts to continuously strengthen the IPR policy seem essential to serve the export market environment better. An inclusive long run policy for educational system either at primary, secondary or tertiary level should be put in place as a channel to improve human capital development. The effect of quality of educational system can be at least observed from two interrelated aspect, i.e., firstly, to increase the talented quality of human resource to critically serve various important economic and services sectors related to science and technology, and secondly, to provide expertise in the legal, businesses and other critical economic sectors in the IPR related area in order to serve future bilateral or trilateral free trade agreements. In fact if these policies are seriously and effectively taken into consideration, an improvement on institutional protection on IPRs and a reduction in imitative threats incidences in the destination countries may probably reduce the higher importing cost burden on importing capital goods.

Lastly, we suggest some avenues for future research. First, in this study we have not differentiated the exported capital goods into the destination countries into refined classifications across sector or industries instead of only using machinery and equipment (D26T28) as conducted in this research. However, such studies can be conducted if and only if a comprehensive database segregating exporters-to-destination integrating *TL* level from each exporter country to represent each class of capital good is available. Second, studies between South-South trades is also an interesting topic especially to examine the influence of China's imports or exports in the global capital goods trade and its level of imitative threats. If South-South trade in capital goods is considered, the triadic patent statistics to reflect quality of technology penetrations into the exports market is highly recommended. In fact, this approach can be used to study the impact of the sectoral level as proposed earlier.

NOTES

1 Readers are encouraged to refer to studies by Bayoumi et al. (1999), Coe and Helpman (1995), Coe et al. (1997, 2009) and Keller (1998)for extensive coverage on the impact of foreign capital towards productivity growth.

2 For details refer to Smith (1999)on page 155-156.

3 Smith (2001)refers to bilateral exchange as a mean of servicing foreign markets through export; affiliate sales and license of knowledge assets to an unaffiliated foreign firm.

4 Although the electrical and electronics industries are classified as science based; there is a possibility that imports in the electronics industry may comprise of imported intermediate goods for further processing and not due to market expansion effects as a result of stronger patent protection.

5 According to Awokuse and Yin (2010), the finding is not too surprising because developing countries often have comparative advantage in the production and exports of products that are less capital and knowledge-intensive relative to the OECD countries.

6 We modified the gravity model by excluding population (*POP*) from the equation as suggested by one of the reviewer due to the contradicting inverse relationship of *POP* towards capital goods exports. In fact once *POP* variable excluded from the original equation, the empirical results appear to be identical in terms of signs but the magnitude of marginal propensity to import is clearly improved. This explains further the confounding effects between per capita income and population size as proxy to market size. In addition, the gravity equation now includes only one variable to represent common language, i.e., common official language (*COL*) and exclude common native language and common spoken language from the original equation. By excluding these two common languages, the results seem robust and stable across all specification.

7 Shin et al. (2016), uses four different measures of patent count to represent exporter's *TL*, with the first two measure used as a basis in their main discussions i.e., total patent granted abroad (worldwide granted patent) and total patent granted at the US territory. Another two measures of patent count used as a robustness check, i.e., patent granted in the European Patent Office (EPO) and the trilateral patent, namely those patents that are filed in the three major markets: the USA, Japan and the European Patent Office (EPO). The use of trilateral patent for robustness check is only involved when they discussed on the case of trade from South (developing) to North (Developed) for controlling the level of quality of technology initiated from the South.

8 Over the time period of 1990-2010, the original total unbalanced panel is 1,240 pair of exporter-destination with total number observations of 26,015 over the 21 years.

9 Refer to studies by Eaton and Kortum (1996, 1997, 1999), Ang (2010), Madsen et al. (2010) and Park (2013) for different applications of patent-count statistics.

10 The home-country bias in patent statistics appears when using domestic patent statistics as a measure of technological capability. Therefore, to reduce the bias, most researchers used either foreign patent application/ registered in the domestic countries or the triadic patent count, measures that we will use in this research. The used of triadic patent family counts is basically referring to the total number of patents observed at the earliest priority filing for each countries i.e., based on inventor countries of residence or residence country of the applicant observed at the earliest priority date.

11 Description on common official language (COL) dummy are discussed in Melitz and Toubal (2012).

12 The Breusch and Pagan LM (BP/LM) test for random effects reject the POLS model with high significant level, so RE model is preferred. However for the purpose of comparison we include all models in Appendix 1. We also use robust Hausman test between FE and RE model, the test statistically propose FE model to be efficient, but since we are also interested to see variations on some control variable as predicted in RE (i.e., dummy or factor variables or time invariant), we decide to include both RE and FE models in our analysis.

13 Linear combinations of parameters (*lincom*), one of the native command used in Stata ® statistical package to test any linear combination of coefficients, a post-estimation after any regression model.

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APPENDIX A

TABLE A1. List of exporter and destination countries

Australia*	Portugal*	Cyprus	Mexico	Syria
Austria*	Sweden*	Dominican Rep.	Mali	Thailand
Canada*	USA*	Ecuador	Mozambique	Trinidad & Tobago
Switzerland*	Argentina	Egypt	Mauritius	Tunisia
Germany*	Benin	Ghana	Malaysia	Turkey
Denmark*	Bangladesh	Guatemala	Niger	Tanzania
Spain*	Bolivia	Hong Kong	Nepal	Uganda
Finland*	Brazil	Honduras	Pakistan	Uruguay
France*	Central Africa	Indonesia	Peru	Venezuela
United Kingdom*	Chile	India	Philippines	South Africa
Ireland*	China	Iran	Paraguay	Zambia
Italy*	Cote. D' Ivore	Jordan	Rwanda	Zimbabwe
Japan*	Cameroon	Kenya	Senegal	
Netherland*	Congo	South Korea	Singapore	
Norway*	Colombia	Sri Lanka	El Salvador	
New Zealand*	Costa Rica	Morocco	Sudan	

Note: * Exporter countries

TABLE A2. Variable and Source of Data

Variable	Source of data
EXP	Export of capital goods; OECD STAN Bilateral trade database
GNI_k	Per capita GNI importer; World Development Indicator (WDI), the World Bank and PWT 8.0
GNI_j	Per capita GNI exporter; WDI, the World Bank and PWT 8.0
DIST	Distance; *GeoDist* database of CEPII, Mayer &Zignago (2011)
TR	Tariff rate; WDI, the World Bank
IPR	Patent rights index; Ginarte and Park (1997) and Park (2008) or GP&P
TL triadic	Triadic patent of exporter; OECD Patent Statistics
TL USPTO	USPTO patent of exporter; OECD Patent Statistics
IMIT	Threat of Imitation index; relative precision technique (Park, 2013) on modified patent index (GP&P) and human capital index of Barro& Lee (2010)
COL	Common official language (dummy);Melitz and Toubal (2012)
LO	Legal origin (dummy); La Porta et al. (1998, 1999)

Note: *LO* refer to dummy variable History on Legal Origin. 1 is English common law, 2 is French commercial code, 3 is German commercial code, 4 is Scandinavian civil law, 5 is Socialist/Communist law. The cross-tabulation or combinations of *LO* is presented as in Table A3.

TABLE A3. Cross-Tabulation dummy Legal origin between Exporter and Destination countries

		Exporter LO				
	1	2	3	4	Total	
Destination LO	1	1,589	1,307	840	1,077	4,813
	2	2,291	2,009	1,232	1,596	7,128
	3	126	105	63	84	378
	5	36	30	18	24	108
	Total	4,042	3,451	2,153	2,781	12,427

Source: Author dataset

Note: LO refer to dummy variable History on Legal Origin. 1 is English common law, 2 is French commercial code, 3 is German commercial code, 4 is Scandinavian civil law, 5 is Socialist/Communist law.

TABLE A4. Pool OLS, Random Effect and Fixed Effect Gravity, 1990-2010

	POLS		RE		FE	
	Coef.	p-val	Coef.	p-val	Coef.	p-val
lnGNI_k	0.794***	(0.000)	0.795***	(0.000)	0.795***	(0.000)
lnGNI_j	0.554***	(0.002)	0.358**	(0.030)	0.317*	(0.064)
lnTR	–0.129***	(0.006)	–0.133***	(0.009)	–0.134***	(0.009)
lnIPR_k	1.222***	(0.009)	1.610***	(0.000)	1.656***	(0.000)
lnTL	0.338***	(0.000)	0.379***	(0.000)	0.387***	(0.000)
lnIPR_k#lnTL	–0.169***	(0.002)	–0.231***	(0.000)	–0.241***	(0.000)
lnDIST	–1.265***	(0.000)	–1.295***	(0.000)	-	-
IMIT	-0.012	(0.857)	-0.035	(0.527)	–0.054	(0.409)
COL	0.680***	(0.000)	0.732	(0.000)	-	-
LO	9.16***	(0.000)	962.78	(0.000)	-	-
Time effect	9.77***	(0.000)	194.33	(0.000)	8.92	(0.000)
Exporter specific	F (17, 1025): 37.92***		χ^2(15): 733.22***		-	-
Importer specific	F (54,1025): 116.18***		χ^2(53): 879.24***		-	-
Constant	5.679***	0.005	12.554***	(0.000)	-2.863	(0.146)
Obs.	12427		12427		12427	
Group	-		1026		1026	
R squared	0.862		-		-	
R squared (within)	-		0.239		0.239	
BP-LM test (POLS vs. RE)	-		$\bar{\chi}^2$(1): 10077.00***		-	
Robust Hausman (RE vs. FE)	-		-		χ^2(72): 12142.87***	

Source: Author estimates

Note: The statistics reported for Time effect, *LO* , fixed exporters and fixed importers are found to be highly significant. Values in parentheses indicate *t*-statistic.

*, **, *** indicate significant level respectively at 10, 5 and 1per cent level.

TABLE A5. The estimated indirect effect of *lnTL* (USPTO patent) and *lnIPR* on *lnEXP*

Indirect effect	Cond. on	RE Model			FE Model		
		Lower	Mean	Upper	Lower	Mean	Upper
ln*IPR*: $\alpha_7 + \alpha_9 \ln TL_{USPTO}$	$\ln TL_{USPTO}$	0.35** (2.34)	0.23 (1.53)	0.11 (0.67)	0.33** (2.18)	0.22 (1.43)	0.11 (0.63)
$\ln TL_{USPTO}$: $\alpha_8 + \alpha_9 \ln IPR_{kt}$	ln*IPR*	0.009 (0.94)	–0.001 (–0.14)	–0.011 (–1.14)	0.009 (0.88)	–0.0003 (–0.03)	–0.010 (–0.85)

Source: Authors Estimate

Notes: Lower: one SD lower from mean value. Upper: one SD higher than mean value.

Values in parentheses indicate t-statistics.

*, **, *** indicate significant level respectively at 10, 5 and 1per cent level.

TABLE A6. Random Effect (RE) vs. Fixed Effect (FE) with time effects interaction on IMIT

	RE Model		FE Model	
lnGNI_k	0.781***	(0.000)	0.780***	(0.000)
lnGNI_j	0.323*	(0.039)	0.281*	(0.086)
lnTR	–0.136***	(0.008)	–0.137***	(0.008)
lnIPR_k	1.585***	(0.000)	1.622***	(0.000)
lnTL	0.381***	(0.000)	0.391***	(0.000)
*lnIPR_k*lnTL*	–0.234***	(0.000)	–0.243***	(0.000)
lnDIST	–1.295***	(0.000)	-	-
COL	0.729 (0.000)		-	
LO	948.18 (0.000)		-	
$\Sigma_{t=1990}^{2010}$ *IMIT**t	–1.205	(0.359)	–1.751	(0.258)
$\Sigma_{t=1990}^{1994}$ *IMIT**t	–0.595	(0.165)	–0.757	(0.122)
$\Sigma_{t=1995}^{1999}$ *IMIT**t	–0.131	(0.708)	–0.275	(0.501)
$\Sigma_{t=2000}^{2004}$ *IMIT**t	–0.385	(0.210)	–0.517	(0.151)
$\Sigma_{t=2005}^{2010}$ *IMIT**t	–0.093	(0.786)	–0.201	(0.610)
Specific exporter	$\chi^2(15)$: 743.44***		-	
Specific importer	$\chi^2(53)$: 5952.60***		-	
Constant	13.33***	(0.000)	–2.040	(0.560)
No of observation	12427		12427	
No of group	1026		1026	
R-square (within)	0.238		0.238	
BP-LM test (POLS vs. RE)	$\bar{\chi}^2(1)$: 10082.46***		-	
Robust Hausman (RE vs. FE)	-		$\chi^2(72)$: 10438.22***	

Notes: Tests for overall IMIT over time and across several time frame is carried out by invoking linear combination test. The statistics reported for *LO*, fixed exporters and fixed importers are found to be highly significant.

APPENDIX B

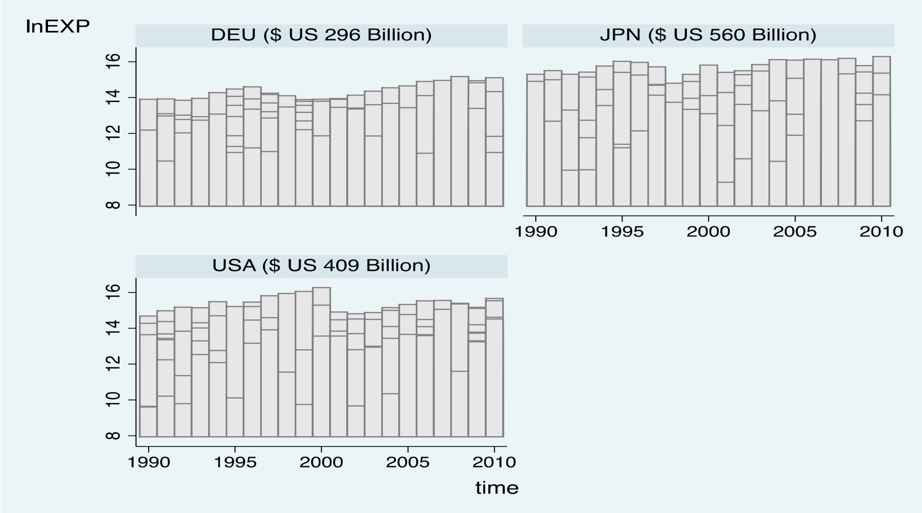

FIGURE B1. Highest Exporter of Capital Goods (ln*EXP*) based on Highest TL, 1990-2010

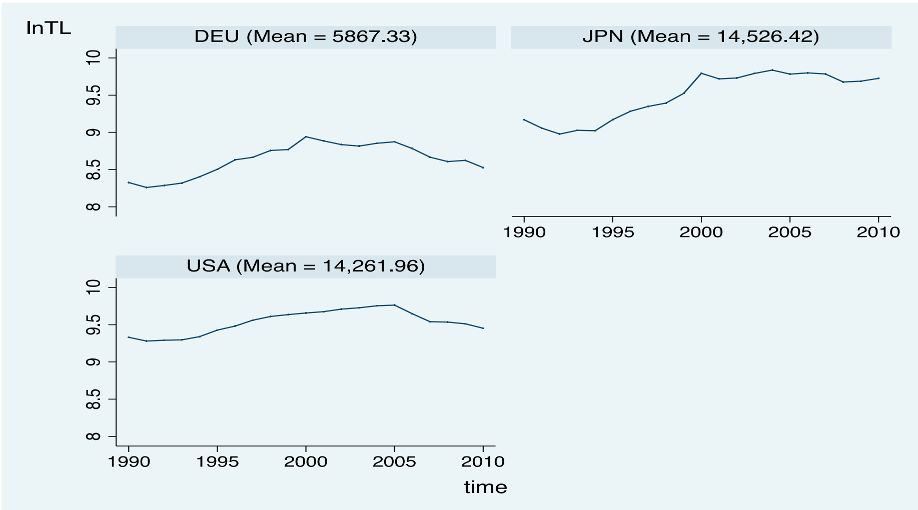

FIGURE B2. Highest Exporter Level of Technology (ln*TL*), 1990-2010

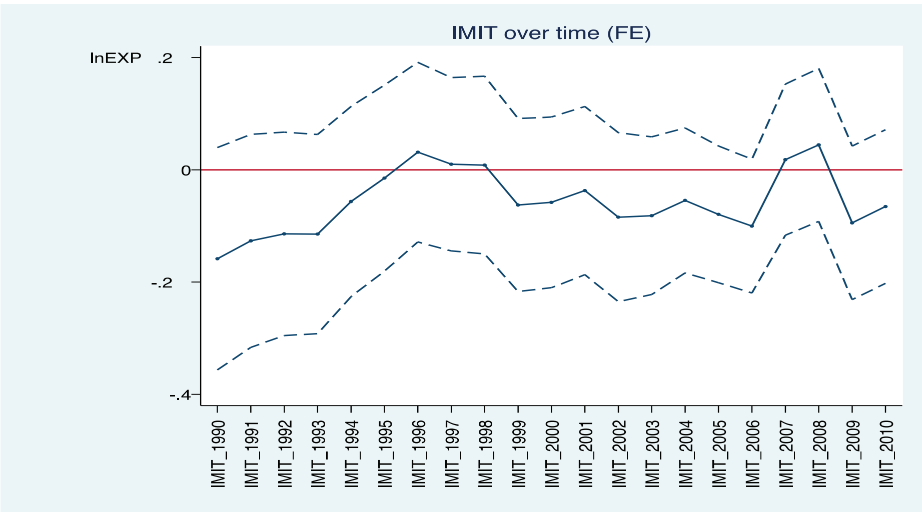

FIGURE B3. The Estimated time effects of *IMIT* on *EXP* (FE) using USPTO TL