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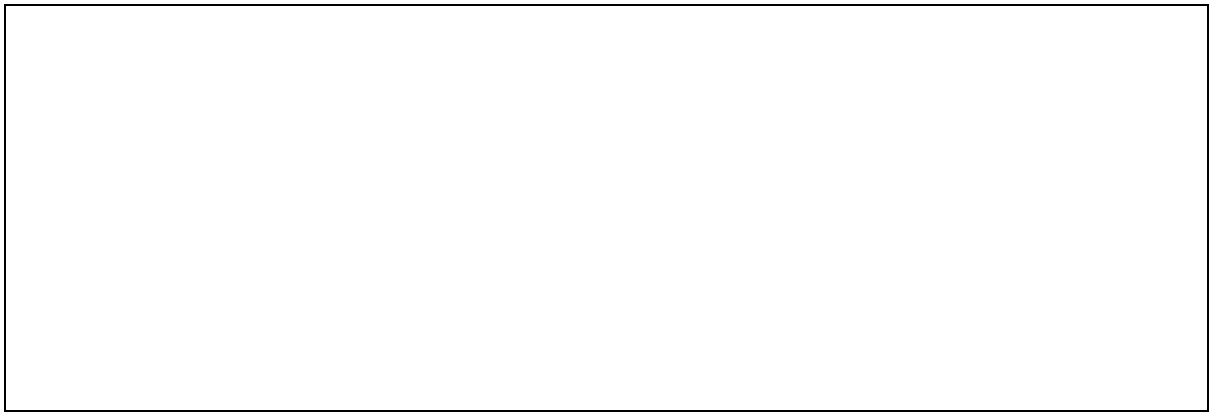

Empirical analysis of innovation and trade in Europe: a gravity model approach

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Abstract: This paper examines the relationship between innovation and trade in Europe. Applying the gravity model R&D expenditures and patent counts, both subdivided into sectors have been used as proxies for innovation. The results imply that innovation is a significant determinant for imports and exports; however, this relationship is not significant in every sector. Furthermore, the results suggest that innovation-output, captured by the number of patents, is associated with bigger effects on trade than innovation-input, in the form of R&D expenditures. The robustness tests indicate that endogeneity does not bias the results.

Keywords: innovation; patents; R&D expenditures; exports; imports; gravity model.

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1 Introduction

The developed countries are continuously seeking higher standards of living thereby aiming to increase income and wealth of the citizens. One way to improve the standards of living of a country is through international trade, a topic that has been examined since the beginning of the 18th century with the theory of absolute advantages developed by Adam Smith. Innovation plays a crucial role in international trade. The importance of this relationship is emphasised in international trade theory (Fagerberg, 1997; Posner, 1961; Frankel and Romer, 1999; Schumpeter, 1944; Vernon, 1966).

This study exploits the gravity model of trade to examine the impact of innovation on international trade in the European zone for the period between 1990 and 2006 using data from Organization for Economic Co-operation and Development (OECD) and Centre d'Études Prospectives et d'Informations Internationales (CEPII). The gravity equation

has been used in international economics for more than 40 years to estimate the pattern of international trade between countries by regressing a number of explanatory variables on trade volume. In this paper innovation is proxied by patents and R&D expenditures. Imports and Exports as percentages of GDP are used to reflect international trade flows.

The results suggest that the number of patents is associated with bigger effects on imports and exports as opposed to R&D expenditures. The effects for both measures of innovation increase until the third full year after the implementation. The results are robust to the inclusion of country-specific linear time trends. The small and insignificant leads are consistent with the notion that endogeneity is not biasing the estimates. The effects of patents are biggest in magnitude and precision in the biotech sector but are insignificant in the nanotech sector. The estimates of R&D expenditures in the business sector dominate the estimates in all other sectors.

A series of recent studies has examined the relationship between innovation and trade. Wakelin (1998) analysed the impact of innovation on the export behaviour using a single censored Tobit model for a sample of UK firms including both innovating and non-innovating firms. This approach is chosen in order to see if the determinants of trade behaviour vary across the two groups. The use of innovations is negatively related to the propensity to export for the non-innovating firms and has no significant role for the export probability of both groups. The number of past innovations has a positive impact on the probability of exporting of an innovative firm. Moreover the R&D expenditures are significant for all firms.

Márquez-Ramos and Martínez-Zarzoso (2010) analysed the impact of technological innovation on exports using a gravity model of trade. The technological achievement index (TAI) and its four components, creation of technology, diffusion of old innovations, diffusion of recent innovations and human skills, are used as proxies for technological innovation. The findings indicate a positive and non-linear effect of technological innovation on export performance, which implies that there are thresholds for occurrence of positive signs. The authors conclude that for higher exports, countries have to consider not only acquisition and assimilation capabilities, but also transformation and exploitation capabilities once a minimum level of potential absorptive capacity has been achieved.

Reçica (2010) investigated the relationship between innovation and export intensity in Central and South Eastern Europe and possible differences between the regions of Western Balkan, South Eastern candidate countries for European Union (SEE candidate), Central Eastern Europe and Baltic countries controlling for the various factors which may affect a firms export behaviour. The results point out that innovation is a significant and positive determinant of export intensity and that Western Balkan countries have a higher degree of export intensity than SEE candidate countries but lower than others, while innovative firms of Western Balkan show a higher degree of export intensity in comparison to the other three regions.

2 Background

Sustainability is crucial for the survival of mankind since the satisfaction of the needs in the present has also to allow the next generations to satisfy their needs. However, the whole world faces a sustainability problem because of increasingly growing population

and industries, resulting in the annihilation of all living organisms if the situation will not change. Innovation can help to overcome this difficult problem by allowing a more efficient exploitation of the environment (Perman et al., 2011; Wong and Zeng, 2015; Kersan-Skabic, 2011).

In addition to that, innovation plays a very important role when looking at the competition between the developed and developing countries. The developing nations are able to produce at lower costs and consequently to gain competitive advantages. As a result the developed countries became contingent upon knowledge, since it is fundamental for economic growth and competitiveness. Knowledge can be created through investment in innovative activities, e.g. research and development (R&D). Innovation is therefore part of the knowledge creating process in a country (Lange, 2009). Thus both international trade and innovation are vital for the sustainability of the whole world and the increase of welfare and competitiveness of every country.

Joseph Schumpeter was one of the first economists who stated the meaning of innovations. In 1934 he proposed a list of different types of innovation. Inter alia, introduction of new products, introduction of new methods of production, opening of new markets, development of new sources of supply for raw materials or other inputs, and creation of new market structures in an industry were defined as innovation.

In 1939, Schumpeter (1939) defined innovation wider and argued that innovation means doing things different. In the meantime various attempts have been undertaken in order to define the term innovation. Thereby the authors interpreted this term in a way they needed at the moment. However optimal measurement of innovation needed consistent standards. OECD while trying to achieve this goal created the Oslo Manual. This manual is the foremost international source of guidelines for the collection and use of data on innovation activities in industry. The 3rd edition of Oslo Manual defines innovation as the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method.

A product innovation is the implementation of a new good or service that is new or significantly improved with respect to its characteristics or intended uses. Such improvements can be done in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. In addition to that, the development of a new use for a product with minor changes to its technical specification is also a product innovation, the development of new design, however, is not.

A process innovation is the introduction of a new or significantly improved production or delivery method. This includes significant modifications in techniques, equipment and/or software. Process innovations also cover new or significantly improved methods for the creation and provision of services and new or significantly improved techniques, equipment and software in ancillary support activities, such as purchasing, accounting, computing and maintenance.

A marketing innovation is the realisation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. New marketing methods can be applied to both new and existing products. Seasonal, regular and other routine changes in marketing instruments are generally not marketing innovations. For such modifications to be marketing innovations, they must involve marketing methods not previously used by the firm.

An organisational innovation is the introduction of a new organisational method in the firm's business practices, workplace organisation or external relations. Changes in business practices, workplace organisation or external relations that are based on organisational methods already in use in the enterprise are not considered as organisational innovations. Nor is the formulation of managerial strategies in itself is viewed as an innovation. However, organisational variations that are implemented in response to a new managerial strategy are defined as an innovation.

The proxies for innovation in this paper are R&D expenditures and patent counts. The R&D spending of different countries is a measure of innovation-input and will cover product innovation, because R&D is expected to lead to the creation of new products and the improvement of existing, as well as process innovation that improves the cost structure of the firms. R&D will to some extent also cover marketing innovations, since a number of new innovating product designs and packaging can be expected to come from official R&D departments. Organisational innovation is most likely not captured by R&D expenditures. The patent counts as opposed to R&D are measures of innovation-output. Lange (2009) argues that patent counts cover product innovations and some process innovations, yet they will not cover any marketing or organisational innovations. These proxies for innovation are expected to capture the most aspects of innovation.

Using these innovation indicators, however, is not free of criticism. It is important to mention that the proxies for innovation can raise problems for empirical work and lead to bias estimates of the effect of the innovation. Since innovation processes are not exogenous using R&D expenditures and number of patents as independent variables may lead to endogeneity issues. Furthermore, innovation may not have an immediate effect on trade flows.

Greenhalgh et al. (1994) argue that there might be a significant lag between the R&D spending and the actual production of marketable products possibly leading to a biased estimate, because of the reverse impact of exports on innovation. Greenhalgh et al. (1994) and Lachenmaier and Wössmann (2006) also claimed that not all R&D expenditures lead to successful products and consequently cause an overestimation. On the other hand Wakelin (1998) mentioned that the R&D spendings might underestimate the contribution of the smaller enterprises without a separate research department but do engage in innovation activity or firms in sectors where innovations are produced as part of the production process, e.g. the engineering. Besides Kleinknecht et al. (2001) argue that the share of R&D in total innovation expenditure is higher in manufacturing than in services. Therefore the innovation in services is underestimated.

Lachenmaier and Wössmann (2006) mention that the use of patent counts can also lead to biased results since a lot of innovations are never patented and some enterprises use patents as a strategic tool to prevent competitors from using the same technology. Kleinknecht et al. (2001) also argue that certain types of technology are even not patentable. Additionally some patents can reflect minor improvements of little economic value whereas others are extremely valuable. Therefore it is doubtful if these differences are adequately captured by citation analyses. Kleinknecht et al. (2001) also mention four types of systematic mistakes that are likely to be made using patents as an innovation indicator. First the innovation in low technological opportunity sectors is underestimated. Second the innovative activity among firms that collaborate on R&D is over-estimated. Third the rate of small enterprises that innovate is underestimated. And finally the innovation intensity of small-sized patents holders is overestimated. Thus the proxies can

be used in order to analyse the impact of innovation only if the empirical strategy accounts for the mentioned weaknesses. However it is necessary to carefully consider these drawbacks by interpreting the results of the analysis.

There are many reasons why firms engage in innovation. Their goals may involve products, markets, efficiency, quality or the ability to learn and to implement changes. The globalisation process is also a powerful driving force for innovation. International competition forces companies to increase their efficiency. Therefore one of the most important reasons for innovation is to produce rents. A new product or process can be a competitive advantage for the innovator allowing lower prices and higher mark-ups. Consequently the firm can gain more market shares and increase profits. Another reason is to defend the competitive position and not to lose market shares to an innovative competitor or to gain a strategic market position by enforcing higher standards. Increasing demand or reducing costs play also an important role. Thereby the organisational innovation is essential in order to improve the efficiency and quality of the operations (OECD, 2005).

There are contrary opinions regarding which environment will make firms innovate more. Some economists argue that more competitive markets will lead to less innovation and enterprises with monopoly power will tend to innovate more, as they exploit the economies of scale more efficiently. On the other hand there are opinions that competitive environments will force the firms to innovate more using an example of a cost-reducing innovation. In this connection the monopoly rents created by the cost-reducing innovation are the greatest incentives for innovation (Lange, 2009).

3 Identification strategy

To examine the relationship between innovation and trade a gravity model has been used. The inspiration for the model comes from physics, more precisely from the law of gravity which states that the force of gravity between two objects is proportional to the product of the masses of the two objects divided by the square of the distance between them. In trade economics the force of gravity is replaced by the value of bilateral trade and the masses by GDPs of the trade partners. Distance is measured as the distance between the partner countries and is used as a proxy for all information and transaction costs. Tinbergen (1962) and Pöyhnen (1963) were the first who used gravity model as an empirical tool. However these works lacked a clear theoretical basis. Inter alia Anderson (1979) and Deardorff (1995) provided theoretical fundamentals and showed that the gravity equation is consistent with theories of international trade. Over time many variables have been added: population, GDP per capita, free-trade agreements (FTAs), common border, landlocked, common language, transportation infrastructure etc.

The empirical specification of the gravity model used in this paper has the following form:

$$Y_{ijt} = \beta_0 + \beta_1 INV_{it} + X_{it}\beta_2 + Z_{jt}\beta_3 + u_i + v_j + w_t + \theta_i \times t + \varepsilon_{ijt} \quad (1)$$

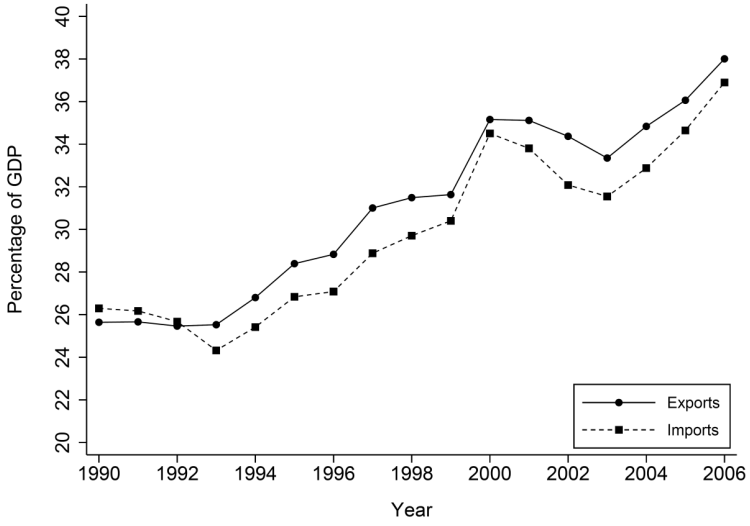
where Y_{ijt} is an unidirectional export or import flow form country i to country j at time t, INV_{it} is an indicator for innovation, represented by patents or R&D expenditures of country i at time t, X_{it} and Z_{jt} are vectors of exporter and importer specific controls, u_i and v_j are exporter or importer fixed effects, w_t is a time fixed effect, and country-specific linear time trends are captured by $\theta_i \times t$.[1]

Anderson and van Wincoop (2003) argued that the bilateral trade not only depends on trade barriers between two trading partners, but also on trading barriers they face with the rest of their trading partners. Thus the model is estimated with country specific dummies that control for omitted variables that do not change over time. Baldwin and Taglioni (2006) suggested using time-invariant country-pair fixed-effects, because they found to work better than nation dummies. Yet this implies that the time-invariant parameters (e.g. distance) cannot be estimated and hence are not used in this paper. In order to control for omitted variables that change over time and are varying across countries, country-specific linear time trends are included to test the robustness of the results.

4 Data

The analysis relies on data from 1990 to 2006. The data on imports and exports is retrieved from OECD. The values are expressed as percentages of GDP. Customs are the main source of the data and are recorded by the international merchandise trade statistics. Figure 1 shows the imports and exports as percentage of GDP between 1990 and 2006. Both imports and exports are characterised by an upward trend in the time period under consideration.[2]

Figure 1 Imports and exports as percentage of GDP in Europe 1990–2006



Data on R&D expenditures is also obtained from OECD. In order to account for the scope of the country's economy R&D expenditures as percentages of GDP are used in the analysis. Figure 2 indicates that the R&D expenditures followed no clear trend between 1990 and 2006. In order to better understand what drives the trade flows the R&D expenditures are subdivided into four sectors. OECD (2002) defines these sectors as follows. Business sector includes all firms, organisations and institutions whose primary activity is the market production of goods or services (other than higher education) for sale to the general public at an economically significant price. Government sector comprises all departments, offices and other bodies which furnish, but normally do

not sell to the community, those common services, other than higher education, which cannot otherwise be conveniently and economically provided, as well as those that administer the state and the economic and social policy of the community.[3] Private and non-profit sector is presented by non-market private nonprofit institutions serving households (i.e. the general public) including private individuals or households. High education sector contains all universities, colleges of technology and other institutions of post-secondary education, whatever their source of finance or legal status is.

Figure 2 R&D expenditures as percentage of GDP in Europe 1990–2006

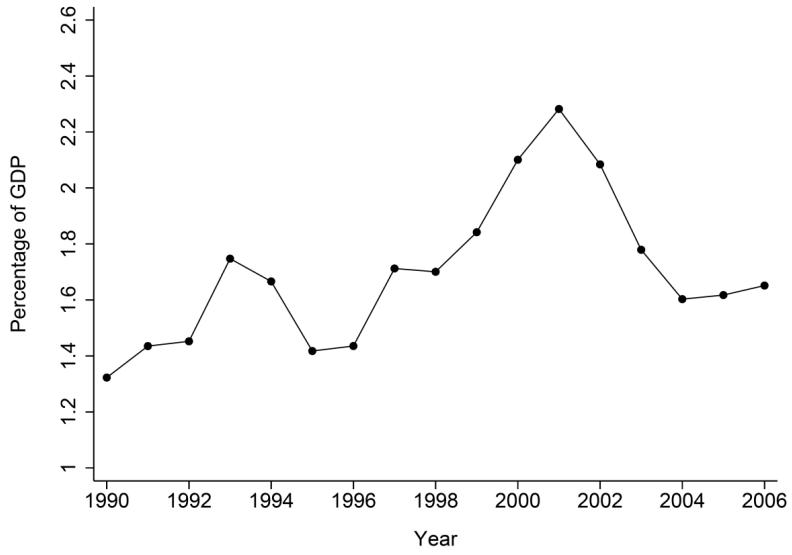
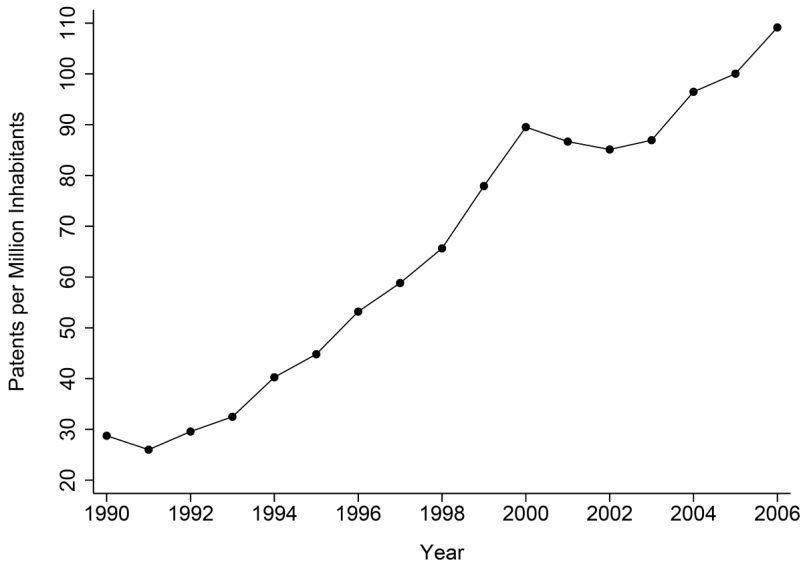


Figure 3 Patents in Europe 1990–2006



The number of patents is retrieved from OECD and is measured as the number of patents per million inhabitants to account for the size of the economy. Figure 3 shows the number of patents per million inhabitants between 1990 and 2006 indicating an upward trend. The patent counts are also subdivided into the following levels: green technologies, biotech level, nanotech level, and ICT (information and communication technology) level.[4]

The rest of the control variables is obtained from the CEPII institute. CEPII institute is a French research centre in international economics, the CEPII produces studies, researches, databases and analyses on the world economy and its evolution. The gravity data set provided by CEPII is used to obtain data on GDP and GDP per capita, various measures of distances between countries, indicator for colonial relationship, population, measures of common language, area of the country, and geographic position.

5 Results

The gravity model is now formally used to estimate the effects of innovation, captured by R&D expenditures and patent counts, on imports and exports in the European area. Separate regressions are estimated with ordinary least squares (OLS) for imports and exports using either R&D expenditures or number of patents as the 'treatment'. Various regressions have been estimated using both R&D expenditures and number of patents as regressors to formally test if patents represent innovation-output and R&D expenditures innovation-input. However this approach did not provide any insights mainly due to multicollinearity.[5] Furthermore as mentioned in Section 2, R&D expenditures lead to innovation not only through patents.

Turning to the regression results Table 1 through Table 6 shows the estimated effects of innovation on imports or exports. The regressions are estimated as log-log models and the standard errors are corrected for clustering at the country level (Bertrand et al., 2004). All specifications have been estimated using time- and country-fixed effects and the standard controls that are usually included in a gravity model.[6] Furthermore to test the robustness of the results some specifications have been estimated with country-specific linear time trends thereby controlling for unobservables that change across time for each country differently. To check for endogeneity some specifications have been estimated with leads. Lags have been used to determine if the effects of innovation are immediate or distant.

Table 1 presents the estimates of the relationship between the number of patents and imports. The baseline estimate suggests that 1% increase in patents per million inhabitants is associated with a 0.923% increase in imports as percentage of GDP.[7] When the country-specific linear trend is included, the estimate of β_1 retains its magnitude but is no longer significant at conventional levels ($p = 0.164$). In columns 3–5 the number of issued patents is lagged. The patent lags are jointly significant and are, without exception, positive. However, there is evidence that the impact of innovation captured by patents eventually wanes. The estimated coefficients increase in absolute magnitude until the third full year after a patent has been issued. In column 5 of Table 1 a series of leads is added to the model. The estimated coefficients are small and jointly insignificant implying that reverse causality is not biasing the results.

Table 1 Patents and imports in Europe 1990–2006

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
PCT	0.923***	0.811			
	(0.033)	(0.791)			
3 Years before					0.031
					(0.027)
2 Years before					0.015
					(0.024)
1 Year before					0.074
					(0.052)
Year of PCT			0.710**	0.514	0.615
			(0.271)	(0.391)	(0.542)
1 Years after			0.854**	0.655	0.674
			(0.341)	(0.768)	(0.544)
2 Years after			0.914**	0.779*	0.721*
			(0.423)	(0.346)	(0.372)
3 Years after			0.938**	0.818	0.883*
			(0.458)	(0.689)	(0.337)
Joint significance of lags (*p*-value)			0.001***	0.087*	0.076*
R^2	0.621	0.638	0.625	0.678	0.689
Country-specific linear time trends	No	Yes	No	Yes	Yes

Notes: The dependent variable is equal to the natural logarithm of imports as percentage of GDP in country *i* and year *t*. Standard errors, corrected for clustering at the country level, are in parentheses. Year fixed effects, country fixed effects, and country covariates are included in all specifications. PCT is the natural logarithm of the number of patent applications per million inhabitants in country *i* and year *t*. $N = 4643$; ***, **, and * indicate significance at 1%, 5%, and 10% levels.

The estimates of the relationship between number of patents and exports are shown in Table 2. The baseline estimate of 0.994% is only a little bit higher than the effect on imports. Columns 3 and 4 of Table 2 show the lagged effects. The estimated coefficients increase in magnitude till the third full year after a patent has been issued. However these coefficients are bigger in magnitude compared to the model with imports as the dependent variable. The inclusion of country-specific linear time trends does not alter the magnitude of the coefficient of interest but decreases the precision due to the decreased degrees of freedom. The inclusion of leads in column 5 of Table 2 provides reason to believe that endogeneity is not an issue when using this identification strategy.

Table 2 Patents and exports in Europe 1990–2006

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
PCT	0.994**	0.743			
	(0.312)	(0.821)			
3 Years before					0.013
					(0.032)
2 Years before					0.009
					(0.023)

Table 2 Patents and exports in Europe 1990–2006 (continued)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
1 Year before					0.004 (0.037)
Year of PCT			0.831*** (0.191)	0.653 (0.586)	0.595 (0.614)
1 Years after			0.963** (0.473)	0.765* (0.384)	0.691 (0.734)
2 Years after			1.032* (0.503)	0.817* (0.346)	0.731* (0.352)
3 Years after			1.110** (0.548)	0.864 (0.743)	0.858 (0.737)
Joint significance of lags (*p*-value)			0.000***	0.091*	0.094*
R^2	0.733	0.743	0.752	0.781	0.787
Country-specific linear time trends	No	Yes	No	Yes	Yes

Notes: The dependent variable is equal to the natural logarithm of imports as percentage of GDP in country *i* and year *t*. Standard errors, corrected for clustering at the country level, are in parentheses. Year fixed effects, country fixed effects, and country covariates are included in all specifications. PCT is the natural logarithm of the number of patent applications per million inhabitants in country *i* and year *t*. $N = 4643$; ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Tables 3 and 4 show the estimated effects of the relationship between R&D expenditures and imports or exports, respectively. The estimated effects are smaller in magnitude compared to the effects of the number of issued patents. The baseline estimate of 0.336% is smaller in magnitude for imports than the baseline estimate of 0.413% for exports. Following the same pattern as the model for patents the effects of R&D expenditures increase in magnitude till the full third year after the expenses. When country-specific linear time trends are included β_1 retains its magnitude but is no longer significant at conventional levels. The small and insignificant leads in column 5 of Tables 3 and 4 suggest that the effect of R&D expenditures on imports and exports is causal.

Table 3 R&D expenditures and imports in Europe 1990–2006

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
RD	0.336** (0.131)	0.314 (0.432)			
3 Years before					0.003 (0.029)
2 Years before					0.029 (0.012)
1 Year before					0.006 (0.043)
Year of RD			0.296* (0.141)	0.214* (0.102)	0.259 (0.361)
1 Years after			0.316* (0.147)	0.246* (0.124)	0.261 (0.128)

Table 3 R&D expenditures and imports in Europe 1990–2006 (continued)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
2 Years after			0.375**	0.237	0.273
			(0.124)	(0.346)	(0.332)
3 Years after			0.445*	0.264	0.283
			(0.208)	(0.743)	(0.431)
Joint significance of lags (*p*-value)			0.000***	0.073*	0.079*
R^2	0.913	0.942	0.951	0.983	0.984
Country-specific linear time trends	No	Yes	No	Yes	Yes

Notes: The dependent variable is equal to the natural logarithm of imports as percentage of GDP in country *i* and year *t*. Standard errors, corrected for clustering at the country level, are in parentheses. Year fixed effects, country fixed effects, and country covariates are included in all specifications. RD is the natural logarithm of the R&D expenditures as percentage of GDP in country *i* and year *t*. *N* = 6860; ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Table 4 R&D expenditures and exports in Europe 1990–2006

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
RD	0.413*	0.401			
	(0.221)	(0.525)			
3 Years before					0.012
					(0.049)
2 Years before					0.007
					(0.235)
1 Year before					0.011
					(0.031)
Year of RD			0.372*	0.325	0.336
			(0.175)	(0.430)	(0.476)
1 Years after			0.402*	0.364	0.375
			(0.203)	(0.434)	(0.332)
2 Years after			0.435*	0.397*	0.401*
			(0.204)	(0.182)	(0.203)
3 Years after			0.476*	0.425	0.432
			(0.238)	(0.234)	(0.397)
Joint significance of lags (*p*-value)			0.001***	0.064*	0.081*
R^2	0.893	0.904	0.935	0.958	0.971
Country-specific linear time trends	No	Yes	No	Yes	Yes

Notes: The dependent variable is equal to the natural logarithm of exports as percentage of GDP in country *i* and year *t*. Standard errors, corrected for clustering at the country level, are in parentheses. Year fixed effects, country fixed effects, and country covariates are included in all specifications. RD is the natural logarithm of the R&D expenditures as percentage of GDP in country *i* and year *t*. *N* = 6860; ***, **, and * indicate significance at 1%, 5%, and 10% levels.

To better understand what is driving the results R&D expenditures and patent counts have been subdivided into sectors that were described in Section 4. Tables 5 and 6 provide the results of this exercise. An increase in number of patents in the biotech sector is associated with the biggest effect of 0.394% on exports. Both the ICT and the 'green' sector lead to positive and significant effects on imports and exports. The only sector that does not provide significant estimates is the nanotech sector. This result could occur because of large time lags that are present in the nanotech industries.[8] Nanotech sector contains technologies that are relatively new and that are not ripe for the market. Hence, it takes time, on and off even decades until these technologies can be transformed into marketable products and consequently will cause higher exports. For example the first patent for radar was recorded in 1904 and the first radar device was in use for the first time in 1930s implying a lag of nearly 30 years. The results in Table 6 for the R&D sectors indicate that the expenditures in the private and non-profit sector and in the government sector are only associated with positive and significant effects on imports. Since these sectors are mainly targeted at the domestic market the exports enterprises in these industries are very close to zero, explaining the estimates. R&D expenditures in business sector lead only to higher exports and do not affect imports. The high education sector is characterised by no effects both on imports and exports.

Table 5 Patents by sector, imports, and exports in Europe 1990–2006

	Imports		*Exports*	
	(1)	*(2)*	*(3)*	*(4)*
PCT green	0.176**	0.184	0.197*	0.201
	(0.087)	(0.130)	(0.097)	(0.213)
PCT ICT	0.184*	0.206	0.282*	0.310
	(0.095)	(0.174)	(0.143)	(0.289)
PCT biotech	0.249	0.253	0.394**	0.413
	(0.243)	(0.239)	(0.198)	(0.278)
PCT nanotech	0.207	0.219	0.297	0.310
	(0.187)	(0.203)	(0.251)	(0.292)
R^2	0.674	0.691	0.761	0.793
Country-specific linear time trends	No	Yes	No	Yes

Notes: The dependent variable is equal to the natural logarithm of imports or exports as percentage of GDP in country *i* and year *t*. Standard errors, corrected for clustering at the country level, are in parentheses. Year fixed effects, country fixed effects, and country covariates are included in all specifications. R&D is the natural logarithm of the number of patent applications per million inhabitants in a given sector in country *i* and year *t*. $N = 3658$; ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Table 6 R&D expenditures by sector, imports, and exports in Europe 1990–2006

	Imports		*Exports*	
	(1)	*(2)*	*(3)*	*(4)*
R&D business	0.092	0.103	0.162*	0.169
	(0.194)	(0.232)	(0.094)	(0.101)
R&D government	0.018*	0.026	0.093	0.096
	(0.009)	(0.053)	(0.103)	(0.241)

Table 6 R&D expenditures by sector, imports, and exports in Europe 1990–2006 (continued)

	Imports		*Exports*	
	(1)	*(2)*	*(3)*	*(4)*
R&D high education	0.013 (0.044)	0.054 (0.063)	0.116 (0.191)	0.129 (0.211)
R&D private and non-profit	0.051** (0.026)	0.083 (0.133)	0.021 (0.094)	0.027 (0.057)
R^2	0.712	0.741	0.695	0.703
Country-specific linear time trends	No	Yes	No	Yes

Notes: The dependent variable is equal to the natural logarithm of imports or exports as percentage of GDP in country *i* and year *t*. Standard errors, corrected for clustering at the country level, are in parentheses. Year fixed effects, country fixed effects, and country covariates are included in all specifications. R&D is the natural logarithm of the R&D expenditures as percentage of GDP in a given sector in country *i* and year *t*. $N = 5060$; ***, **, and * indicate significance at 1%, 5%, and 10% levels.

6 Conclusion

Using the gravity model this paper examines the relationship between innovation and trade in the European zone between 1990 and 2006 with exports or imports as the dependent variable. R&D expenditures and patent counts, both subdivided into sectors have been used as innovation proxies representing the innovation-input and innovation-output respectively.

In comparison to R&D expenditures the impact of patents on imports and exports is stronger in magnitude. The effects of both innovation proxies increase until the third full year. This pattern is not given if the patents and R&D expenditures are subdivided into sectors. The results remain the magnitude and precision after the inclusion of country-specific linear time trends implying that omitted variables that are changing differently across the countries do not bias the results. The small and insignificant leads indicate that reverse causality is not a confounding the estimates. Patents in the biotech sector are associated with biggest effects on the trade flows in terms of magnitude and precision as opposed to nanotech, ICT and 'green' sector. In contrast to the private and non-profit, government, and high education sector R&D expenditures in the business sector have the biggest effects on exports and imports.

Looking at the coefficients for R&D expenditures and number of patents one can conclude that innovation-output (patents) is more important than innovation-input (R&D expenditures) for trade. These results however do not imply that R&D should be dismissed as goal to improve innovation. These results actually suggest that innovation-output, in the form of patents should be the focus. Yet it is difficult because R&D is needed to develop patents. Therefore it is necessary to create better environments in which R&D can be performed more efficiently.

References

Anderson, J.E. (1979) 'A theoretical foundation for the gravity equation', *The American Economic Review*, Vol. 69, No. 1, pp.106–116.

Anderson, J.E. and van Wincoop, E. (2003) 'Gravity with gravitas: a solution to the border puzzle', *The American Economic Review*, Vol. 93, No. 1, pp.170–192.

Baldwin, R. and Taglioni, D. (2006) *Gravity for Dummies and Dummies for Gravity Equations*, NBER Working Paper Series, No. 12516.

Bertrand, M., Duflo, E. and Sendhil, M. (2004) 'How much should we trust differences-in-differences estimates?' *Quarterly Journal of Economics*, Vol. 119, pp.249–276.

Deardorff, A.V. (1995) *Determinants of bilateral trade: does gravity work in a neoclassical world?*, NBER Working Paper Series, No. 5377, December.

Fagerberg, J. (1997) 'Competitiveness, scale and R&D', in Fagerberg, J., Hansson, P., Lundberg, L. and Melchior, A. (Eds): *Technology and International Trade*, Edward Elgar, Cheltenham.

Frankel, J.A. and Romer, D. (1999) 'Does trade cause growth?', *The American Economic Review*, Vol. 89, No. 3, pp.379–399.

Greenhalgh, C., Taylor, P. and Wilson, R. (1994) 'Innovation and export volumes and prices: a disaggregated study', *Oxford Economic Papers*, New Series, Vol. 46, No. 1, pp.102–135.

Kersan-Skabic, I. (2011) 'FDI, trade and integration in the Western Balkan Countries: is there any causality?', *International Journal of Trade and Global Markets*, Vol. 4, No. 4, pp.420–436.

Kleinknecht, A.H., van Montfort, K. and Brouwer, E. (2001) 'The non-trivial choice between innovation indicators', *Economics of Innovation and New Technology*, Vol. 11, No. 2, pp.109–121.

Lachenmaier, S. and Wössmann, L. (2006) 'Does innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data', *Oxford Economic Papers 58*, pp.317–350.

Lange, P. (2009) *On Innovation and Exports*, Aarhus School of Business, Aarhus University.

Márquez-Ramos, L. and Martínez-Zarzoso, I. (2010) 'The effect of technological innovation on international trade', *Economics*, Vol. 4, 2010-11 (April 8, 2010). Available online at: http://www.economics-ejournal.org/economics/journalarticles/2010-11

OECD (2002) *Frascati Manual. Proposed standard practice for surveys on research and experimental development*, 2002.

OECD (2009) *OECD Patent Statistics Manual*, 2009.

OECD and Eurostat (2005) *Oslo Manual. The measurement of Scientific and Technological Activities. Guidelines for Collecting and Interpreting Innovation Data*, 3rd ed., 2005.

Perman, R., Ma, Y., Common, M., Maddison, D. and Mcgilvray, J. (2011) *Natural Resource and Environmental Economics*, 4th ed., Addison-Wesley.

Posner, M.V. (1961) 'International trade and technical change', *Oxford Economic Papers 13*, pp.323–341.

Pöyhnen, P. (1963) 'A tentative model for the volume of trade between countries', *Welwirtschaftliches Archiv*, Band 90, Heft 1 (1963a), pp.93–100.

Reçica, F. (2010) *Impact of innovation on export performance: evidence from transition economies*, Staffordshire University Business School, Stoke on Trent, UK.

Schumpeter, J.A. (1939) *Business Cycles. A Theoretical, Historical and Statistical Analysis of Capitalist Process*, McGraw-Hill Book Company.

Schumpeter, J.A. (1944) *Teora del desenvolvimiento econmico*, Fondo Cultura, Mexico.

Tinbergen, J. (1962) *Shaping the World Economy: Suggestions for an International Economic Policy*, The Twentieth Century Fund, New York.

Vernon, R. (1966) 'International investment and international trade in the product cycle', *Quarterly Journal of Economics*, Vol. 80, pp.190–207.

Wakelin, K. (1998) 'Innovation and export behaviour at the firm level', *Research Policy*, Vol. 26, pp.829–841.

Wong, W.M. and Zeng, X-Y. (2015) 'Price and quality of remanufactured products related to consumer behaviour', *International Journal of Trade and Global Markets*, Vol. 8, No. 1, pp.17–26.

Notes

1 The vectors X_{it} and Z_{jt} include GDP and GDP per capita, various measures of distances between countries, indicator for colonial relationship, population, measures of common language, area of the country, and geographic position.

2 The following countries have been used as exporters: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, UK. Provided that a trade relationship consists the following countries have been used as importers: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK.

3 Public enterprises are included in the business enterprise sector.

4 More detailed description of the levels can be found in OECD (2009).

5 The correlation coefficient between number of patents and R&D expenditures is equal to 0.992 leading to very high standard errors and insignificant results.

6 These covariates are described in Section 3.

7 Between 1990 and 2006 in the countries used for the analysis the average exports and imports as percentage of GDP were 31.02% and 29.83% respectively.

8 There are no significant results even 10 years after a patent has been issued (results not shown).

World Trade Organization members' participation in mechanisms under the sanitary and phytosanitary agreement

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Abstract: Non-tariff measures are increasing their visibility in international trade. Among them, sanitary and phytosanitary measures (SPS) aim to protect food safety, animal and plant health. In order to limit their potential impact on trade, the World Trade Organization (WTO) fostered the signature of a multilateral agreement, which sets up mechanisms to promote transparency, consensus and dispute resolution. The objective of this paper is to present the divergences in participation of WTO country members in the previously mentioned mechanisms according to their income level. The results obtained evidence that, with some particular exceptions, high income countries have been much more active than developing and least developed.

Keywords: international trade; World Trade Organization; non-tariff measures; sanitary and phytosanitary measures; food safety; animal health; plant health; agri-food sector; multilateral agreements; transparency; notifications; specific trade concerns; disputes; country members; development level.

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1 Introduction

International trade regulation has been characterised in recent decades by an increase in the visibility of non-tariff measures (Hoekman and Nicita, 2008; Nicita and Gourdon, 2013). Some of these measures are enforced in order to have an impact on the quality of traded products (WTO, 2012). Within this last category sanitary and phytosanitary requirements (SPS) stand out. They are designed to address perceived market failures, such as information asymmetries, externalities, and the lack of provision of public goods (Hobbs, 2010; van Tongeren et al., 2009).

Despite their role in the mitigation of market failures, the implementation of the aforementioned requirements may also involve higher production costs. In this sense, some authors conclude that SPS constrain international trade (e.g. Beghin and Melatos, 2012; Disdier and Marette, 2010; Disdier and Fontagné, 2010; Hoekman and Nicita, 2008; Penello, 2014). However, others suggest that these measures may actually constitute a stimulus for exports for producers that are able to meet requirements (e.g. Crivelli and Gröschl, 2012; Ferro et al., 2015; Song and Chen, 2010; Wilson and Bray, 2010). In addition, today the roles of public and private sectors in standards implementation are blurred. In recent years there has been a significant increase in the amount of private certification schemes on food and agricultural products, progressively favoured by certain major retailers when importing, constituting a new form of agrifood system governance (Kalfagianni, 2015; Olper et al., 2014).

Nonetheless, in order to rationalise the potential impact of technical requirements on import/export flows, during the Uruguay Round the WTO fostered the signature of a multilateral agreement on Sanitary and Phytosanitary Measures (SPS). The main objective of the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) is to ensure that countries can adopt and enforce the appropriate measures to protect human, animal and plant health, without this being used for protectionist purposes. In order to achieve this, the SPS Agreement urges that requirements adopted by signatory countries be based on scientific evidence.

Among the principles regulated by the SPS Agreement is transparency, according to which members shall notify the initiation of (or changes to) sanitary and phytosanitary measures. One of the objectives of this obligation is that the other countries can present comments and amendments to measures before (and after) they enter into force. In this same sense, the Agreement establishes an SPS Committee, which organises regular meetings where members can, *inter alia*, raise concerns about the SPS requirements enforced by other members; known as Specific Trade Concerns (STCs).

Recent research on the impact of SPS on international trade has commonly used econometric models (such as gravity equations) in which the existence of notifications is an explanatory variable. Nevertheless, in some investigations authors have considered SPS-STCs instead of SPS notifications as the explanatory variable; as they assume STCs

may refer to those measures which have actually been seen by governments and exporters as a real or potential barrier to their trade (Crivelli and Gröschl, 2012; Fontagné et al., 2013). However, as indicated by Horn et al. (1999), the SPS Committee is not authorised to formally settle the matter causing an STC. In addition, many STCs could be described as 'trivial'; for example, a request for clarification about a measure. As a consequence, when a member believes that another country is not respecting the clauses in the SPS Agreement, it can also take the case to the WTO Dispute Settlement Body.

The investigations referred hitherto, did not clarify what the determinants are that explain why a country makes more frequent use of the aforementioned WTO mechanisms for SPS. However, in the specific case of notifications, there is some research on the determinants of the countries' submissions. In this sense, Aisbett and Pearson (2012) showed, after applying an econometric model, that a lower tariff level negotiated by a country is related to the raising of additional SPS measures. However, environmental variables, such as regulation stringency or governance level, were also evidenced as being significant. These results differ from those obtained by Besedina and Coupe (2015) in the case of Russia, where the most significant factor for SPS notifications is the stakeholders' political pressure. Meanwhile, Ghodsi (2014) emphasised, in addition to the causes listed, the importance of the countries' technological level.

Meanwhile, there is conversely extensive literature on factors that would affect a country's use of the GATT/WTO Dispute Settlement mechanism in general. Some of these are: (i) economic power (Sattler and Bernauer, 2011), (ii) legal capacity (Busch et al., 2008; Conti, 2010), (iii) diversity and value of exports (Horn et al., 1999; Holmes et al., 2003), (iv) fear of retaliation (Bown, 2004), (v) past experience in WTO litigation (Davis and Blodget, 2009), (vi) political status (Fadiga and Fadiga-Stewart, 2005), (vii) size of exports implied in the dispute (Bown, 2005), (vii) financial, human and institutional resources (Bohl, 2009; Guzmán and Simmons, 2005) and (viii) bilateral assistance dependency (Besson and Mehdi, 2004). None of the previous research was focused specifically on an economic sector. However, in a novel investigation Götz et al. (2010) sought to define which factors affected WTO dispute initiation related to food products. The estimations conducted showed that a country's market restrictiveness, as well as the amount of years of participation in the WTO, were both of significant influence.

Considering these results, we can suggest *a priori* that developing and especially least developed countries (DCs and LDCs) may have lower participation in WTO mechanisms than developed countries. In fact, after analysing the principal trends in WTO disputes from 1995 to 2012, Leitner and Lester (2013) evidenced that the USA and the EU have been by far the most frequent complaining and responding parties. Some of the reasons mentioned to explain the lower participation of DCs and LDCs are: narrow range of cases of interest (Elsig and Stucki, 2011); WTO Dispute Settlement own operation (Alavi, 2007; Kim, 2008; Mosoti, 2006) and the consideration of the balance between possibilities of winning and expected gains (Allee, 2008). With regard to the latter, at least as a third party, this would be significantly related to the number of countries that are already participant (Johns and Pelc, 2012). In fact, after applying a quantitative analysis, Bown (2009) showed that once a dispute is ended the gains, in terms of market access, were very similar for both the complainant and the developing countries which participated as a third party.

Considering all of the above-mentioned, the general objective of this research is to present an approximation to the relationship between the development level of WTO members and their participation in SPS mechanisms. In order to do so, data was compiled and synthesised from the WTO I-TIP, SPS-IMS and Dispute Settlement Gateway databases. All the SPS notifications, Specific Trade Concerns and disputes from the period 1995–2012 were considered. This data was then grouped according to the development level of the member(s) involved, using for it the World Bank annual classification (high income country, upper-middle income country, lower-middle income country and low income country).

2 The SPS agreement: general background

Although the present WTO SPS Agreement has been an important milestone, the treatment of technical non-tariff measures is not a new subject in terms of multilateral regulation. The General Agreement on Tariffs and Trade (GATT) recognised, in its article XX, the members' authority to take the necessary measures regarding imports for the protection of human and animal life and health and/or for plant preservation. In the same way, the Agreement on Technical Barriers to Trade that emerged after the Tokyo Round in 1979 (also known as 'Standards Code'), referred to different aspects of the adoption of standards and technical regulations in sanitary and phytosanitary matters. However, the application of this Agreement was limited by its low adhesion. In fact, it was signed by only thirty-two countries (GATT contracting parties) of the ninety that were in the Round (though the signatories covered a high percentage of international trade at that time).

As a consequence, in order to make further progress in this area, the Punta del Este Declaration (1986), which initiated the Uruguay Round, established reducing the negative impact of technical non-tariff measures on trade as one of the subjects of negotiation in terms of the agricultural sector. For this, a 'Working Group on Sanitary and Phytosanitary Regulations' was formed in 1988. The final text of the Agreement on the Application of Sanitary and Phytosanitary Measures is adopted during the closure of the Uruguay Round in 1994 by every participating country.

As expressed in its preamble, the main objective of the SPS Agreement is that 'no member should be prevented from adopting or enforcing measures necessary to protect human, animal or plant life and health'; however, this is 'subject to the requirement that these measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between Members where the same conditions prevail or a disguised restriction on international trade'. In order to accomplish this, the SPS Agreement is based on the application of the following principles: non-discrimination, harmonisation, equivalence, scientific evidence, regionalisation, transparency and technical assistance and special treatment to developing members. A brief description of each one of these principles is presented below.

2.1 Non-discrimination

The non-discrimination principle in the SPS Agreement responds to the Most Favoured Nation and National Treatment Clauses at the 1947 GATT (articles 1 and 3).

In a more specific way, the SPS Agreement foresees that in terms of sanitary and phytosanitary measures on imported products, equal treatment will be given to national and other importer products (article 2.3). Therefore, the aim of this principle is to avoid the application of unjustifiable asymmetrical requirements between domestic production and imports, which as a result may have protectionist effects.

2.2 Risk assessment and scientific evidence

The SPS Agreement establishes that sanitary and phytosanitary measures shall be justified by a risk assessment properly adapted for each case (article 2.2). One of the main elements to take into account in this risk assessment is existing scientific evidence. However, in the case of measures aimed at protecting animal or plant health, economic effects relating to potential damage to production and sales should be considered, in addition to the costs and expected outcomes of the alternative actions taken to mitigate the risk (article 5.3).

2.3 Harmonisation

The principle of harmonisation in the SPS Agreement is very similar in spirit to that of the 1979 TBT Agreement (and its 1995 successor). In this sense, it is established that countries should give priority to the use (full or partial) of international standards, guidelines or recommendations where they exist, as a basis for their own national sanitary and phytosanitary measures (article 3.1). However, the Agreement itself enables the establishment of more stringent national measures as long as scientific evidence or risk assessment properly justifies it (article 3.3).

In order to enhance viability of and compliance with the above it is stated in the Agreement that countries shall participate, in accordance with their resources, in the operations of the international standards-setting organisations (article 3.4). The Agreement explicitly references the international institutions that are considered. In particular: the Codex Alimentarius Commission, the International Office of Epizootics (from 2003 onwards renamed as the World Organisation for Animal Health) and the International Plant Protection Convention. These are known as the ‘three sisters’ in the context of SPS regulation.

In this sense, existing literature ratifies that SPS harmonisation contributes to the mitigation of possible restrictive effects on trade (Disdier et al., 2012; Drogué and DeMaria, 2012; Munasib and Roy, 2013; Murina and Nicita, 2014), this being legitimised for consumers when they are not familiar with national standards (Sawyer et al., 2007).

2.4 Equivalence

Complementary to the principle of harmonisation, the Agreement encourages members to recognise the sanitary and phytosanitary measures of other members as equivalent to their own, despite any possible existing differences, provided an appropriate level of protection is obtained (article 4.1.). In the same way, requested members shall initiate the negotiation of a bilateral or multilateral agreement on the recognition of SPS measures’ equivalence (article 4.2).

2.5 Regionalisation

Sanitary and phytosanitary issues need not be bound to a country's borders; they can also affect just a part of a country or several countries (entirely or partially). In the same respect, the SPS Agreement establishes that measures shall be designed to consider the characteristics of the area of origin and destination of the product (article 6.1).

The Agreement also states that members shall consider pest/disease free or low prevalence areas when appropriate based on, for instance, physical factors (geography and ecosystems) as well as any control and surveillance measures taken (article 6.2). However, if it is an exporting country, which claims the abovementioned consideration, the Agreement establishes that it shall have to provide supporting evidence, and even allow access to personnel from the importing country for the purpose of conducting inspections (article 6.3).

2.6 Transparency

On transparency, under the SPS Agreement, countries undertake to: i) announce publicly their intention to introduce a measure, ii) notify through the WTO Secretariat the contents of the measure, iii) upon request of another member, provide further details about the measure, iv) allow time for comments from other members, discuss them if required and consider this process in the final proposal (Annex 2, Par. 5). The Agreement itself establishes exceptions to this in cases where the aforementioned process can be counterproductive, since urgent problems related to sanitary and phytosanitary issues can arise. However, in these cases the imposing country should notify through the WTO Secretariat what the urgent problems are as justification. Likewise, the full text of the measure in question should also be provided upon request and the rest of the members should be allowed to make comments and discuss it, taking into account the results of both processes (Annex 2, Par. 6).

2.7 Technical assistance and special and differential treatment

The Special and Differential Treatment principle is contained in various WTO agreements such as the 'special concessions' for members from developing countries. In the specific case of the SPS Agreement it is reflected, on the one hand, in the obligation to facilitate the provision of technical assistance to developing members that so request it for issues relating to: a) compliance with requirements, b) generating national institutions in SPS and c) participation in international institutions (article 9). Similarly, the Agreement states that every member should take into account the particularities of developing countries in what concerns the preparation and application of SPS measures (article 10.1). The SPS Committee may even grant, in cases where it is found appropriate, exceptions from obligations for developing members, although always for a limited period of time and upon request of the country concerned (article 10.3).

In this sense, recent investigation shows that in fact SPS measures affect more severely the value of exports from developing and least developed countries (Maskus et al., 2005; Disdier et al., 2008; Hoekman and Nicita, 2008; Penello, 2014; Wilson and Bray, 2010). The aforementioned could be related to the level of participation of these countries in the enforcement of SPS compared with more developed countries. The results obtained in this regard (plus STCs and disputes) are presented below.

3 WTO members' participation in SPS mechanisms

3.1 SPS notifications

From 1995 to 2012, a total of 14864 SPS notifications were informed to the WTO Secretariat. Of these, 3489 were presented by the USA, being the most prolific member in this regard. Meanwhile, eight Latin American countries: Brazil, Chile, Peru, Colombia, Mexico, Argentina, Costa Rica and El Salvador; were among the twenty members of the WTO with the highest number of notifications in the indicated period. The most prominent case is that of Brazil, third worldwide only after the US and Canada. In this regard, a study by da Almeida et al. (2010) concluded that the growth of the Brazilian economy has been the main determinant of the evolution of SPS notifications, suggesting the most demanding requirements of both consumers and producers as the cause. Besides those mentioned so far, other WTO members with high participation in SPS notifications are European Union (815), China (720), New Zealand (618), South Korea (509), Chinese Taipei (452), Australia (384), Japan (322), Philippines (310), Thailand (269) and Albania (162). Particularly striking is the case of China, because despite becoming a WTO member in December 2001, it is the fifth country in the world in terms of the number of SPS notifications. This might be because the country had already institutionalised a certification system for agricultural products long before its accession to the WTO, with food quality and safety as a declared priority for central government (OECD, 2005).

Table 1 Number of SPS notifications per country (1995–2012)

USA	3489	Japan	322	Nicaragua	90
Canada	1160	Philippines	310	Switzerland	81
Brazil	1132	Mexico	304	Dominican Republic	74
European Union	815	Thailand	269	The Netherlands	73
China	720	Argentina	196	Guatemala	65
New Zealand	618	Costa Rica	173	Indonesia	65
Chile	516	Albania	162	Egypt	59
Korea	509	El Salvador	131	Singapore	58
Peru	481	Bahrein	128	Honduras	57
Chinese Taipei	452	Ecuador	116	Panama	56
Colombia	405	Ukraine	109	Hong Kong	53
Australia	384	India	97	Other	1135

Source: Compilation based on WTO SPS-IMS database

The same inventory approach can be used to check members' participation in SPS notifications in accordance with their income level. As shown in Table 2, high income countries presented 8492 notifications between 1995 and 2012, i.e. 57.13% of the SPS measures informed in the studied period. Meanwhile, upper-middle income countries have 24.46% of the participation, with 3635 measures informed, and lower-middle income countries 16.97% of the participation, which corresponds to 2522 measures. Finally, low income countries presented just 215 notifications in the period studied.

Table 2 SPS notifications informed per year and member income level (1995–2012)

	High income		*Upper-middle income*		*Lower-middle income*		*Low income*		*Total*
	Number	*%*	*Number*	*%*	*Number*	*%*	*Number*	*%*	
1995	99	50.25	95	48.22	3	1.52	0	0.00	197
1996	146	60.58	73	30.29	14	5.81	8	3.32	241
1997	165	55.37	65	21.81	60	20.13	8	2.68	298
1998	155	46.27	133	39.70	44	13.13	3	0.90	335
1999	235	52.81	101	22.70	90	20.22	19	4.27	445
2000	336	71.79	68	14.53	47	10.04	17	3.63	468
2001	532	68.56	111	14.30	122	15.72	11	1.42	776
2002	464	57.28	73	9.01	268	33.09	5	0.62	810
2003	583	68.11	109	12.73	145	16.94	19	2.22	856
2004	649	70.09	43	4.64	209	22.57	25	2.70	926
2005	522	60.98	73	8.53	235	27.45	26	3.04	856
2006	660	57.04	251	21.69	211	18.24	35	3.03	1157
2007	715	59.78	255	21.32	226	18.90	0	0.00	1196
2008	662	52.29	336	26.54	253	19.98	15	1.18	1266
2009	489	47.99	330	32.38	197	19.33	3	0.29	1019
2010	664	47.16	615	43.68	117	8.31	12	0.85	1408
2011	673	48.38	556	39.97	158	11.36	4	0.29	1391
2012	743	60.95	348	28.55	123	10.09	5	0.41	1219
Total	8492		3635		2522		215		14,864

Source: Compilation based on WTO SPS-IMS database

3.2 SPS specific trade concerns

During the considered years (1995–2012) a total of 344 STCs were raised, of which 102 were solved. The period 2001–2005 was the most prolific in Specific Trade Concerns being presented before the SPS Committee.

The participation of different members in said concerns has been analysed considering the following three categories: concerned, maintaining and supporting countries, in accordance with their role in the presentation of the STC. It is important to clarify that more than one country can be involved in any of these categories for the same STC. As regards concerned countries, the two most important are the USA, with 80 STCs, and the European Union, with 71 STCs. They are followed by some middle income countries such as Argentina (39), China (28), Brazil (25) and India (13). On the other hand, as regards maintaining countries for SPS related STCs the European Union and the USA are once again the most important, with 67 and 40 STCs, followed by Japan (27), China (20), Australia (16) and Brazil (14). As supporting countries of the SPS STCs the European Union and the USA are also the most active, having participated on 39 and 36 occasions. Some Latin American countries such as Argentina, Chile, Brazil and Mexico are also in prominent positions.

Table 3 Participation in SPS-STCs as concerned country (1995–2012)

USA	80	Ecuador	8	Peru	3
European Union	71	Mexico	8	Senegal	3
Argentina	39	Colombia	7	Hong Kong	2
China	28	Hungary	5	Israel	2
Brazil	25	New Zealand	5	Nicaragua	2
Canada	24	Philippines	5	Norway	2
India	13	Switzerland	5	Poland	2
Australia	9	Costa Rica	4	Slovenia	2
Thailand	9	Uruguay	4	South Africa	2
Chile	8	Indonesia	3	Other	24

Source: Compilation based on WTO I-TIP database

Table 4 Participation in SPS-STCs as maintaining country (1995–2012)

European Union	67	Panama	7	Bolivia	3
USA	40	Chinese Taipei	7	Colombia	3
Japan	27	B. R. of Venezuela	6	Philippines	3
China	20	Chile	6	South Africa	3
Australia	16	Turkey	5	Thailand	3
Brazil	14	Czech Republic	5	Croatia	3
Indonesia	13	Israel	4	Honduras	3
Korea	12	Malaysia	4	Romania	3
Mexico	11	El Salvador	4	France	3
Canada	11	Poland	4	New Zealand	3
India	8	Slovak Republic	4	Other	47
Argentina	7	Spain	4		

Source: Compilation based on WTO I-TIP database

Table 5 Participation in SPS-STCs as supporting country (1995–2012)

European Union	39	Colombia	8	Indonesia	6
USA	36	Costa Rica	8	Jamaica	6
Canada	34	Korea	8	Japan	6
Australia	26	Switzerland	8	South Africa	6
Argentina	25	Bolivia	7	Malaysia	5
Chile	23	Cuba	7	Pakistan	4
New Zealand	23	Ecuador	7	El Salvador	3
Brazil	21	India	7	Guatemala	3
Mexico	17	Paraguay	7	Kenya	3
Philippines	14	Peru	7	Nicaragua	3
Uruguay	13	Thailand	7	Viet Nam	3
China	12	Dominican Republic	6	Other	32

Source: Compilation based on WTO I-TIP database

Table 6 Annual percentage of participation in SPS-STCs according to the members' income level (1995–2012)

	High income			*Upper-middle income*			*Lower-middle income*			*Low income*		
	Mant.	*Con.*	*Sup.*	*Mant.*	*Con.*	*Sup.*	*Mant.*	*Con.*	*Sup.*	*Mant.*	*Con.*	*Sup*
1995	100	100	50	0	0	50	0	0	0	0	0	0
1996	58.33	84.62	25	30.56	15.38	50	8.33	0	25	2.78	0	0
1997	62.5	60.71	23.33	25	28.57	70	8.33	10.71	6.67	4.17	0	0
1998	62.5	48.65	41.67	33.33	18.92	37.5	4.17	18.92	16.67	0	13.51	4.17
1999	42.86	64.29	80	35.71	28.57	20	7.14	7.14	0	14.29	0	0
2000	50	40	33.33	20	30	40	20	30	20	10	0	6.67
2001	76.47	34.88	51.22	14.71	37.21	17.07	5.88	20.93	24.39	2.94	6.98	7.32
2002	33.33	59.18	64.29	21.43	22.45	16.67	40.48	14.29	19.05	4.76	4.08	0
2003	78.79	59.38	28.57	15.15	21.88	23.21	6.06	15.63	41.07	0	3.13	7.14
2004	57.89	60	37.14	10.53	20	22.86	10.53	20	37.14	21.05	0	2.86
2005	68.75	53.13	41.67	12.5	18.75	22.22	18.75	25	30.56	0	3.13	5.56
2006	30	58.33	16.67	30	8.33	41.67	30	33.33	33.33	10	0	8.33
2007	35.71	62.5	50	7.14	25	0	57.14	12.5	50	0	0	0
2008	66.67	37.5	50	27.78	25	31.25	5.56	37.5	18.75	0	0	0
2009	31.58	15.38	73.33	31.58	61.54	13.33	36.84	23.08	13.33	0	0	0
2010	52.17	21.74	33.33	39.13	52.17	45.83	8.70	26.09	20.83	0	0	0
2011	46.67	42.11	44.12	40	42.11	35.29	13.33	15.79	20.59	0	0	0
2012	66.67	42.11	63.16	20	31.58	21.05	13.33	26.32	15.79	0	0	0
Total	56.66	50.25	42.19	23.24	27.72	30.36	16.71	19.06	24.11	3.39	2.97	3.35

Source: Compilation based on WTO I-TIP database

Meanwhile, as shown in Table 6, high income countries are the most active as maintaining, concerned and supporting countries, with 56.66%, 50.25% and 42.19% of the participation from 1995 to 2012 respectively. These are followed by upper-middle income countries with 23.24%, 27.72% and 30.36%. Lower-middle income members' participation was 16.71%, 19.06% and 24.11%. Finally, low income countries made a very marginal contribution, representing 3.39%, 2.97% and 3.35% of the total participation. In this sense, it is important to note that participation on SPS Committees is necessary in order to raise (or support) any STC, and low income countries often don't have the necessary resources available to be able to develop a regular and active presence in such meetings.

In fact, considering the level of development of countries that 'confront' in SPS STCs, in 29% of the cases high income countries are both maintaining and concerned, in a 14% the maintaining country is high income and the concerned country is upper middle income, and just in 0.9% of the STCs a high income country is confronted by a low income country. On the other hand, in 10% of the cases a high income country is concerned about the SPS of an upper middle income country, in 6%, by a lower middle income country and in only 2.6% by a low income country.

As for the main topics regarding the SPS that were discussed on the Committee, there is a certain level of agreement between the different categories of countries, with animal health and food safety identified as the main issues.

3.3 SPS-related disputes

From 1995 to 2012, 40 disputes were presented to the WTO Dispute Settlement Body in which the SPS Agreement was cited by the complainant country among those violated by the respondent. Tables 7, 8 and 9 present figures relating to the members' participation in those disputes as complainant, respondent or third party. In this sense, the USA and Canada are the countries which have presented the most disputes, with 11 and 9 respectively, followed by the European Union with 4. On the other hand, the members most frequently acting as respondent to disputes have been the European Union and the USA, with 9 and 8 cases. Finally, participation as a third party is rather more disperse, with the European Union, Brazil and China leading.

Table 7 Participation as complainant in SPS disputes per country (1995–2012)

USA	11	Hungary	2	Mexico	1
Canada	9	China	1	New Zealand	1
European Union	4	Ecuador	1	Nicaragua	1
Argentina	3	India	1	Switzerland	1
Philippines	2	Indonesia	1	Thailand	1

Source: Compilation based on WTO Dispute Settlement Gateway

Comparatively more dramatic than notifications and STCs, are the important differences between the high income countries and the other three groups in terms of participation in SPS disputes as a complainant, and more so as a respondent. In this sense, high income countries have been the complainant in 65% of the SPS disputes presented from 1995 to 2012, and the respondent in 77.5% of the cases. Actually, the participation of high

income countries as complainant, and even more prominently as respondent, in SPS disputes was significantly higher than in disputes which did not invoke the SPS Agreement during the considered years.

Table 8 Participation as respondent in SPS disputes per country (1995–2012)

European Union	9
USA	8
Australia	6
Korea	5
India	3
Japan	2
Mexico	2
Turkey	2
Croatia	1
Egypt	1
Slovak Republic	1

Source: Compilation based on WTO Dispute Settlement Gateway

Table 9 Participation as third party in SPS disputes per country (1995–2012)

European Union	14	Canada	6	Uruguay	3
Brazil	13	Chile	6	Ecuador	2
China	13	Guatemala	6	Turkey	2
Australia	11	Japan	5	Dominican Republic	1
Chinese Taipei	10	Mexico	5	Hong Kong	1
USA	10	Peru	5	Hungary	1
New Zealand	9	Korea	5	Iceland	1
Norway	9	Thailand	5	Pakistan	1
Colombia	8	El Salvador	3	Philippines	1
India	8	Honduras	3	Viet Nam	1
Argentina	6	Paraguay	3	Zimbabwe	1

Source: Compilation based on WTO Dispute Settlement Gateway

Table 10 Annual participation in SPS disputes according to the members' income level (1995–2012)

	High income		*Upper-middle*		*Lower-middle*		*Low income*	
	Com.	*Res.*	*Com.*	*Res.*	*Com.*	*Res.*	*Com.*	*Res.*
1995	5	5	0	0	0	0	0	0
1996	3	3	0	0	0	0	0	0
1997	3	2	0	0	0	0	0	1
1998	4	5	0	0	0	0	1	0
1999	0	0	0	0	0	0	0	0

Table 10 Annual participation in SPS disputes according to the members' income level (1995–2012) (continued)

	High income		*Upper-middle*		*Lower-middle*		*Low income*	
	Com.	*Res.*	*Com.*	*Res.*	*Com.*	*Res.*	*Com.*	*Res.*
2000	1	0	0	1	1	1	0	0
2001	0	0	0	0	1	1	0	0
2002	2	3	2	0	2	1	0	1
2003	3	4	3	2	0	0	1	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	1	1	0	0	0	0	0	0
2008	1	2	1	0	0	0	0	0
2009	2	3	0	0	1	0	0	0
2010	0	1	0	0	1	0	0	0
2011	0	0	0	0	0	0	0	0
2012	1	2	2	0	0	1	0	0
Total	26	31	6	3	6	4	2	2

Source: Compilation based on WTO Dispute Settlement Gateway

In the meantime, upper-middle income members have participated just in 15% and 7.5% of the disputes, lower middle members in 15% and 10% and low income countries in 5% in both cases.

4 Concluding remarks

The general objective of this research was to constitute an approach that would examine the extent to which WTO members' level of development is a significant determinant of a country's participation in SPS mechanisms. In this sense, the results obtained evidence that participation patterns of WTO members in SPS notifications, Specific Trade Concerns, and especially disputes, have been strongly diverse according to the members' economic level; with high income countries much more active than those of middle income and, above all, low income. However, as this analysis has considered groups of countries, expectedly within them there are various exceptions. For instance, high income countries such as Japan, Switzerland, New Zealand or Norway, have a lower participation rate in SPS disputes and STCs than others such as Brazil, India or China.

This suggests that, it might be appropriate to estimate an econometric model where the dependent variable would be the level of participation of each country in the SPS WTO mechanisms and the explanatory variables would be a set of the members' characteristics. However, the low number of STCs and especially disputes compared with notifications, makes it difficult to apply that methodology. On the other hand, as also previously mentioned, for Specific Trade Concerns some authors suggest that it is important to differentiate between 'serious' and 'trivial' concerns, in accordance with (for instance) the number of meetings in which the subject is raised. This diversity has not been considered in the present paper, which accounts for all the STCs equally.

Finally, it is relevant to remark that the understanding of member participation in the SPS 'comitology' would eventually support the design of public policy corrective actions. In this case, given the importance of technical capabilities in order to support a measure and raise an STC or dispute in SPS, increasing the intensity of assistance seems the most appropriate measure. However, it is also necessary to take into account that some countries' lack of participation doesn't always necessarily derive from a lack of the capacity to do so, but from insufficient financial resources to regularly attend WTO SPS Committee meetings in Geneva or even from low interest in accordance with their commercial strategy.

References

Aisbett, E. and Pearson, L. (2012) *Environmental and Health Protections, or New Protectionism? Determinants of SPS Notifications by WTO Members*, Crawford School Research Paper No. 12–13, Crawford School of Public Policy, The Australian National University.

Alavi, A. (2007) 'African countries and the WTO's dispute settlement mechanism', *Development Policy Review*, Vol. 25, No. 1, pp.25–42.

Allee, T. (2008) 'Developing countries and the initiation of GATT/WTO disputes', Paper presented at the *1st Conference on the Political Economy of International Organizations*, 3–8 February, Monte Verità, Switzerland.

Beghin, J. and Melatos, M. (2012) 'The trade and welfare impacts of Australian quarantine policies: the case of pigmeat', *The World Economy*, Vol. 35, No. 8, pp.1006–1021.

Besedina, E. and Coupe, T. (2015) *Beggar Thy Neighbor? Application of SPS Measures by the Russian Federation. Case Study: The Impact of the Russian Import Ban on Ukrainian Confectionary Producers*, NUPI Working Paper No. 840, Norwegian Institute of International Affairs (NUPI), Oslo, Norway.

Besson, F. and Mehdi, R. (2004) 'Is WTO dispute settlement system biased against developing countries? An empirical analysis', Paper presented at the *Second International Conference on European and International Political and Economic Affairs*, 27–29 May, Athens, Greece.

Bohl, K. (2009) 'Problems of developing country access to WTO dispute settlement', *Chicago-Kent Journal of International and Comparative Law*, Vol. 9, pp.130–200.

Bown, C. (2004) 'Trade disputes and the implementation of protection under the GATT: an empirical assessment', *Journal of International Economics*, Vol. 62, No. 2, pp.263–294.

Bown, C. (2005) 'Participation in WTO dispute settlement: complainants, interested parties and free riders', *World Bank Economic Review*, Vol. 19, pp.287–310.

Bown, C. (2009) 'MFN and the third-party economic interests of developing countries in GATT/WTO dispute settlement', in Trachtman, J.P. and Thomas, C. (Eds): *Developing Countries in the WTO Legal System*, Oxford University Press, Oxford.

Busch, M., Reinhardt, E. and Shaffer, G. (2008) *Does Legal Capacity Matter? Explaining Dispute Initiation and Antidumping Actions in the WTO*, Issue Paper International Centre for Trade and Sustainable Development No. 4, ICTSD, Geneva, Switzerland.

Conti, J.A. (2010) 'Learning to dispute: repeat participation, expertise, and reputation at the World Trade Organization', *Law and Social Inquiry*, Vol. 35, No. 3, pp.625–662.

Crivelli, P. and Gröschl, J. (2012) *SPS Measures and Trade: Implementation Matters*, World Trade Organization Staff Working Paper No. ERSD-201 2-05, World Trade Organization (WTO), Economic Research and Statistics Division.

Da Almeida, F.M., Monteiro da Silva, O. and Da Lima, J.E. (2010) 'Determinantes das notificações aos acordos sobre medidas SPS e TBT emitidas pelo Brasil', in Monteiro da Silva, O. (Ed.): *Notificações aos Acordos de Barreiras Técnicas (TBT) e Sanitárias (SPS) da OMC: transparência comercial ou barreiras não tarifárias?*, Universidade Federal de Viçosa, Viçosa, Brasil, pp.155–180. [In Portuguese]

Davis, C. and Blodget, S. (2009) 'Who files? Developing country participation in GATT/WTO adjudication', *The Journal of Politics*, Vol. 71, No. 3, pp.1033–1049.

Disdier, A.C. and Fontagné, L. (2010) 'Trade impact of European measures on GMOs condemned by WTO panel', *Review of World Economics*, Vol. 146, No. 3, pp.495–514.

Disdier, A.C. and Marette, S. (2010) 'The combination of gravity and welfare approaches for evaluating non-tariff measures', *American Journal of Agricultural Economics*, Vol. 92, No. 3, pp.713–726.

Disdier, A.C., Fontagne, L. and Cadot, O. (2012) *North-South Standards Harmonization and International Trade*, CEPR Discussion Paper No. 8767, Oxford University Press, Oxford.

Disdier, A.C., Fontagne, L. and Mimouni, D. (2008) 'The impact of regulations on agricultural trade: evidence from SPS and TBT agreements', *American Journal of Agricultural Economics*, Vol. 90, No. 2, pp.336–350.

Drogué, S. and DeMaria, F. (2012) 'Pesticides residues and trade, the apple of discord?', *Food Policy*, Vol. 37, No. 6, pp.641–649.

Elsig, M. and Stucki, P. (2011) 'Low-income developing countries and WTO litigation: why wake up the sleeping dog?', *Review of International Political Economy*, Vol. 19, No. 2, pp.292–316.

Fadiga, M. and Fadiga-Stewart, L. (2005) 'The political and economic determinants of trade disputes under the WTO', Paper presented at the *American Agricultural Economics Association Annual Meeting Province*, 24–27 July, Rhode Island, NE, USA.

Ferro, E., Otsuki, T. and Wilson, J. (2015) 'The effect of product standards on agricultural exports', *Food Policy*, Vol. 50, pp.68–79.

Fontagné, L., Orefice, G., Piermartini, R. and Rocha, N. (2013) *Product Standards and Margins of Trade: Firm Level Evidence*, CESIFO Working Paper No. 4169, Center for Economic Studies and IFO Institute, München.

Ghodsi, M. (2014) *Technical Barriers to Trade: Determinants and Implications*, Unpublished PhD Thesis, Università Cattolica del Sacro Cuore, Italy.

Götz, C., Heckelei, T. and Rudloff, B. (2010) 'What makes countries initiate WTO disputes on food-related issues?', *Food Policy*, Vol. 35, pp.154–162.

Guzmán, A. and Simmons, B. (2005) *Power Plays and Capacity Constraints: The Selection of Defendants in WTO Disputes*, UC Berkeley Public Law Research Paper No. 660501, Berkeley, CA.

Hobbs, J.E. (2010) 'Public and private standards for food safety and quality: international trade implications', *Estey Centre Journal of International Law and Trade Policy*, Vol. 11, No. 1, pp.136–152.

Hoekman, B. and Nicita, A. (2008) *Trade Policy, Trade Costs, and Developing Country Trade*, World Bank Policy Research Working Paper No. 4797, World Bank, Washington, DC.

Holmes, P., Rollo, J. and Young, A. (2003) *Emerging Trends in WTO Dispute Settlement: Back to the GATT?*, World Bank Policy Research Working Paper No. 3133, World Bank, Washington, DC.

Horn, H., Mavroidis, P. and Wijkström, H. (1999) *Is the Use of the WTO Dispute Settlement System Biased?*, CEPR Discussion Paper No. 2340, Centre for Economy Policy Research, London.

Johns, L. and Pelc, K.J. (2012) *Overcrowding in WTO Dispute Settlement: Why Don't More Countries Join as Third Parties?* Available online at: https://www.princeton.edu/politics/about/filerepository/public/Leslie_Johns_Paper.pdf

Kalfagianni, A. (2015) 'Just food: the normative obligations of private agrifood governance', *Global Environmental Change*, Vol. 31, pp.174–186.

Kim, M. (2008) 'Costly procedures: divergent effects of legalization in the GATT/WTO dispute settlement procedures', *International Studies Quarterly*, Vol. 52, No. 3, pp.657–686.

Leitner, K. and Lester, S. (2013) 'WTO dispute settlement 1995–2012: a statistical analysis', *Journal of International Economic Law*, Vol. 16, No. 1, pp.257–267.

Maskus, K.E., Otsuki, T. and Wilson, J.S. (2005) *The Cost of Compliance with Product Standards for Firms in Developing Countries: An Econometric Study*, World Bank Policy Research Working Paper Series No. 3590, World Bank, Washington, DC.

Mosoti, V. (2006) 'Africa in the first decade of WTO dispute settlement', *Journal of International Economic Law*, Vol. 9, No. 2, pp.427–453.

Munasib, A. and Roy, D. (2013) 'Nontariff barriers as a bridge to cross', Paper presented at the *AAEA & CAES Joint Annual Meeting*, 4–6 August, Washington, DC, USA.

Murina, M. and Nicita, A. (2014) *Trading with Conditions: The Effect of Sanitary and Phytosanitary Measures on Lower Income Countries' Agricultural Exports*, UNCTAD Policy Issues in International Trade and Commodities Research Study Series No. 68, UNCTAD, Geneva.

Nicita, A. and Gourdon, J. (2013) *A Preliminary Analysis on Newly Collected Data on Non-Tariff Measures*, Policy Issues in International Trade and Commodities Study Series No. 53, UNCTAD, Geneva.

OECD (2005) *Review of Agricultural Policies – China*, OECD, Paris.

Olper, A., Curzi, D. and Pacca, L. (2014) 'Do food standards affect the quality of EU imports?', *Economics Letters*, Vol. 122, pp.233–237.

Penello, D. (2014) *Study of Average Effects of Non-Tariff Measures on Trade Imports*', UNCTAD Policy Issues in International Trade and Commodities Research Study Series No. 66, UNCTAD, Geneva.

Sattler, T. and Bernauer, T. (2011) 'Gravitation or discrimination? Determinants of litigation in the World Trade Organization', *European Journal of Political Research*, Vol. 50, No. 2, pp.143–167.

Sawyer, E., Hobbs, J. and Kerr, W. (2007) 'Is there a global market for organic beef? Harmonization and consumer preferences in international trade', *International Journal of Trade and Global Markets*, Vol. 1, No. 1, pp.89–106.

Song, H. and Chen, K. (2010) 'Trade effects and compliance costs of food safety regulations: the case of China', Paper presented at the *International Conference on Agricultural Risk and Food Security*, 10–12 June, Beijing, China.

van Tongeren, F., Beghin, J. and Marette, S. (2009) *A Cost-Benefit Framework for the Assessment of Non-Tariff Measures in Agro-Food Trade*, OECD Food Agriculture and Fisheries Working Papers No. 21, OECD, Paris.

Wilson, N. and Bray, V. (2010) 'It happened all at once: switching regressions, gravity models and food safety', Paper presented at the *AAEA, CAES, WAEA Joint Annual Meeting*, 25–27 July, Denver, CO, USA.

WTO (World Trade Organization) (2012) *World Trade Report 2012*, WTO, Geneva, Switzerland.

Public versus private investment in economic growth of Bangladesh: an econometric analysis

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Abstract: This paper analyses the roles of per capita real public and private investment growths in influencing per capita real GDP growth in Bangladesh spanning over 1972–2012. Autoregressive Distributed Lag (ARDL) procedure is applied for co-integration and Vector Error-Correction Model (VECM) is implemented for long-run and short-run dynamics. All three variables are found co-integrated. The findings from the estimates of VECM reveal long-run convergence with very slow speed of adjustment. The short-run dynamic interactive feedbacks among the variables are weak. Apparently, private investment plays a greater role than public investment in improving per capita real GDP growth in Bangladesh. The paper contributes to the existing body of literature in terms of applying improved econometric methodology and for a country (Bangladesh) for which no such rigorous study on this issue has yet been undertaken, to our knowledge.

Keywords: public and private investment; real GDP growth; co-integration; causality; convergence.

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1 Introduction

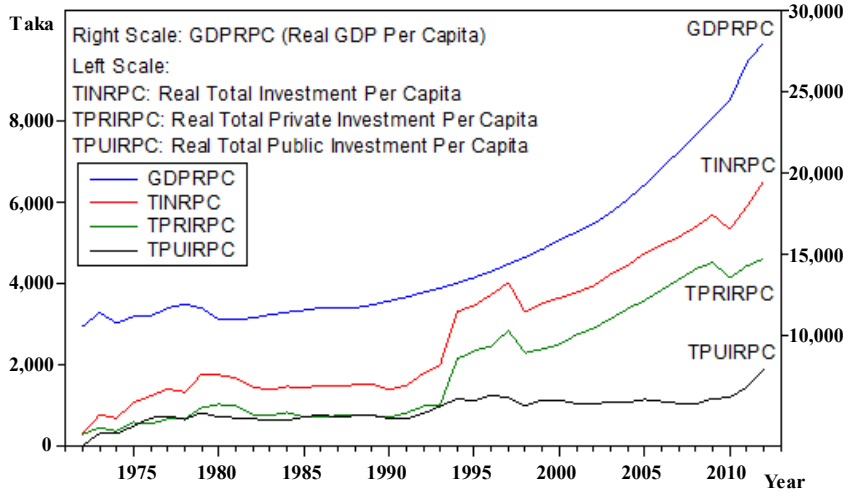
This paper analyses the dynamic effects of per capita real public and private investment growths on per capita real GDP growth in Bangladesh. Both variables play important roles in the growth process of developing Bangladesh. This issue of great importance continues to draw attention from both policymakers and academicians. The available empirical results on this issue remain in clouding controversies. This topic is being addressed from policy and theoretical perspectives due to differential effects of public and private investment on economic growth. This has been an unsettling issue particularly in macroeconomics and development economics.

The paper utilises a production function approach with public investment along with private investment as arguments in the analysis. This empirical study is in the spirit of Harrod–Domar model (Domar, 1946; Harrod, 1948) with Keynesian overtone emphasising the roles of private domestic savings and investment in enhancing economic growth rate to maintain full employment. The ARDL (Autoregressive Distributed Lag) approach for co-integration analysis (Pesaran et al., 2001) and the associated VECM methodology (Vector Error-Correction Model) are applied for examining the long-run and the short-run dynamics. The paper utilises annual time-series data from 1972 through 2012 involving a sample size of 41 observations. This study is of particular importance for Bangladesh making an important contribution to the existing body of related literature. The results of the study would be of significant interest to academicians, researchers, think-tank and policymakers in developing countries.

Currently, the size of the Bangladesh economy is of around $120 billion or so in terms of annual GDP with total population of about 160 million. Since inception in 1971, the economy continues to progress much below its full potential amid occasional natural and political turmoils, weak institutions, opaque governance and rising corruption, to name a few. The continuing advance on the economic front is largely attributable to the surging private industrial sector resilience, vibrant agricultural sector and demographic dividend with over 60% of total population being in active age (15–64 years). However, this does not preclude the public sector role in the economy. Sectoral transformations are glaringly evidenced in agriculture and manufacturing. The share of agriculture to GDP stood at 50% in 1970s that gradually declined to below 20% in recent years while the share of industrial sector up trended from 8% in 1970s to 29%. Structural transformation in the economy is also revealed in spectacular growth in the services sector that is currently over 50% of GDP (Bangladesh Bureau of Statistics, 2013). At the same time, the foreign aid-dependent economy at early stages is now primarily propelled by exponentially growing exports of low-cost labour-intensive goods. Presumably, the open unemployment and underemployment rate combined together is over 40%. So, the labour supply is unconstrained.

On the investment front, recent total investment is 29% of GDP in which the share of private investment is 22% and that of public investment is 7%. To maintain the annual growth momentum in the range of 7–8%, the required total investment should be 5% higher over the current level, based on ad hoc capital-to-output ratio envelope calculation. Gross national savings is currently 30% of GDP (CPD, 2014). This projected savings-investment gap needs to be filled in by intensifying efforts to mobilise domestic savings and enticing long-term foreign direct investment. Figure 1 depicts historical movements of the key variables in this study:

Figure 1 Real GDP per capita, real total, real private and real public investments per capita (1972–2012) (see online version for colours)



In Figure 1, it is observed that per capita real public investment (TPUIRPC) remained almost flat from 1972 through early 1990s and started creeping since then. The same trend held for per capita real private investment (TPRIRPC) up to the mid-1990s. However, since mid-1990s, it started to grow much faster than per capita real public investment. As a result, the growth of the per capita real total investment (TINRPC) displays a similar pattern, as shown by the per capita real private investment. Per capita real GDP (GDPRPC) recorded impressive and steady uptrend since mid-1990s as well.

Controversies arise from concerns with regard to the efficiency of public investment versus private investment and their relative contributions to long-run economic growth in developing countries. There are two contradictory views on this issue: complementarity view versus substitution view. The first view is that public investment in infrastructures and capital goods industry complement private investment by raising marginal product of private capital and providing intermediate input for production in the private sector. Further, productive public investment in infrastructure and education for formation of human capital would help crowd-in private investment laying the foundation for private capital formation and stimulation. In addition, productive public investment may also play a countercyclical role in the economy giving rise to private sector investment by reducing the output demand and price volatility. Such complementarity is expected to be conducive to economic growth (Hatano, 2010). Other types of public investment may be substitutes and have a less positive or even negative effect on economic growth. Goods and services of public enterprises compete directly with those of the private sector. Further, wasteful public investment may also crowd-out private investment by raising cost of borrowing and tax burden on the private sector. These effects would tend to make public investment to act as a substitute for private investment (Balassa, 1988).

The rest of the paper is structured as follows: Section 2 briefly reviews the related literature. Section 3 outlines the empirical methodology. Section 4 reports empirical results. Finally, Section 5 offers conclusions with relevant policy implications.

2 Brief review of related literature

The existing volume of the literature on the relative roles and effectiveness of public and private investment in economic growth is vast and expansive focusing on their inter-linkages and contributions. Two major approaches are invoked to analyse the effects of public investment on economic growth by (Erden and Holcombe, 2005). According to them, the first approach is based on the neoclassical production function in which public capital enters as a separate input. Aschauer (1989a, 1989b) and Munnell (1990) find that public non-military investment spending, particularly on core infrastructure, has a substantial influence on output and the productivity of private capital. The analyses by Aschauer (1990) from the data on industrial countries and Cashin (1995) from cross-country data provide some support in favour of the above. However, studies such as Tatom (1991), Holtz-Eakin (1994), and Evans and Karras (1994) find that public investment has negligible impact on productivity. Khan and Reinhart (1990), and Khan and Kumar (1997) find that private investment has more influence on economic growth in developing countries, although public investment contributes to the productive performance of the economies. The empirical studies using the 'growth accounting' approach, find somewhat mixed evidence. They indicate that public investment in infrastructure contributes to economic productivity, although not as the major source of the economy-wide variations in productivity.

The second approach uses a model of private investment that incorporates public investment to capture its direct effect on private investment and also its indirect effect on private investment. Studies by Greene and Villanueva (1991) for a panel of developing countries, Ramirez (1994) for Mexico, Odedokun (1997) for 48 developing countries, and Ramirez (2000) for a panel of Latin American countries find that public investment stimulates private investment. Blejer and Khan (1984) for a panel of developing countries and Oshikoya (1994) for a panel of African countries present evidence that public investment in infrastructure has a positive impact on private investment, while non-infrastructure investment has a negative impact on private sector investment. In contrast, Wai and Wong (1982) for five developing countries and Nazmi and Ramirez (1997) for Mexico show that public investment crowds out private investment. The empirical literature suggests that public investment, indeed, affects private investment in developing economies. However, answers to the question of whether public investment stimulates or crowds out private investment remain ambiguous.

Several competing mechanisms through which public investment may influence private investment have been identified in the literature, for example, by Barth and Cordes (1980), Blejer and Khan (1984), Aschauer (1989a, 1989b), and Ramirez (1994). Potentially, the most significant mechanism and the most compelling argument supporting public investment is that public infrastructure investment would have substantial spill-over benefits for private investment. If public infrastructure investment is complementary to private investment, the rate of return to private investment will increase. This would entice private sector investors to undertake more capital investment. However, public investment may crowd out private investment if they compete for the same resources. Additionally, the crowding-out may be more significant if public investment is made in state enterprises that produce output that is in direct competition with the goods and services provided by private sector. Sound theoretical arguments point in both directions. So, whether public investment actually helps or hinders private investment is an issue open to further empirical inquiries.

The empirical findings on the relative effects of public and private investment on economic growth are evolving with no definitive conclusions. A number of studies conclude that private investment has a larger positive impact on economic growth than public investment (Khan and Reinhart, 1990; Coutinho and Gallo, 1991; Serven and Solimano, 1990). Since these studies have used relatively small samples of countries and limited time periods, how robust this conclusion is remains in disputes. Moreover, to answer the question, a number of other important issues related to differences in the two components of investment across developing countries in different income groups need to be investigated. As other determinants of economic growth, such as, human capital and macroeconomic stability, have received considerable attention in the recent literature. They need to be taken into account in conjunction when assessing the issue of the roles of public and private investments in economic growth process.

The basic neoclassical framework for examining the impacts of private and public investment on economic growth has been extended by Barro (1991) and Mankiw et al. (1992). They study issues related to convergence of per capita GDP growth across countries, and the role of human capital in determining the rate of convergence. According to Lucas (1988) and Romer (1989), technological progress affects the productivity of all other factors of production, or generates new products or ideas.

The positive assessment of public investment expenditures lack robustness in some empirical models that play a crucial role. The integration properties of the variables in the models can heavily influence the results, but have been largely ignored. If production functions are estimated with differenced data or if pooled regressions are carried out with fixed effects, crowding-in effects seem to diminish. Instead, negative marginal products of public investment can be detected (Perotti, 2007). Using country-specific VARs in first differences, Afonso and Aubyn (2009) find crowding-in effects of public investment for some countries, but crowding-out effects for others. In fact, an acceleration of private investment raises GDP and revenues to finance the public investment. Based on a panel VAR in first differences, Marattin and Sallotti (2011) conclude that positive shocks in fiscal spending exert positive effects on private consumption and investment in the euro-zone.

Even from a Keynesian perspective, crowding-out effects of private investment are expected. They will be reinforced in times of a crisis, since higher government debt can raise country-specific risk and interest rates. On the other hand, public investment may create more favourable conditions for private investment, for example, by providing better infrastructure. The existence of facilities, provided by the public sector, can increase productivity of private investment taking advantage of improved business conditions. For example, government investment in energy, telecommunications or other network industries may have stimulated private investment activities (Dethier and Moore, 2012).

Erden and Holcombe (2005) find evidence of a positive correlation between public and private investment for a sample of 19 developing countries over the period 1980–1997, and a negative correlation for a sample of developed economies for nearly the same period. Lora (2007) finds evidence of complementarities between public and private infrastructure investment for seven Latin American countries in the period of 1987–2001.

Another strand of papers has focused on the issue of the efficiency of public investment as well as on the role of good governance as a key determinant of the productivity of public investment projects. For example, Rajkumar and Swaroop (2008) study the effect of public health and education spending on outcomes (child mortality and educational failure rate). They find positive and significant effects only for countries with good governance. Keefer and Knack (2007) find that public investment is significantly higher in countries with weak institutions, which they argue is a reflection of the enhanced rent-seeking incentives of governments in environments where property rights are less secure. Mauro (1998) studies if predatory behaviour by corrupt politicians distorts the composition of government expenditure. In particular, he finds that education spending is adversely affected by corruption. De la Croix and Delavallade (2006) make Mauro's empirical model more consistent with theory, developing a model where the composition of public expenditures is tilted towards physical infrastructure and away from education and health, where the diversion of funds is more difficult. They also provide consistent empirical evidence for the model (Robinson and Torvik, 2005). The bottom line from this strand of the literature is that the determinants and also the consequences of public investment decisions are tied to the country's institutional factors relating to 'good governance'. Furthermore, the empirical evidence shows that high public investment ratios (as a share of total government expenditure as well as a percentage of GDP) are significantly associated with weak institutions. Empirical studies

on the issue of the role of public vis-à-vis private investment on economic growth in Bangladesh are very scant. As a result, this paper aims at filling an important gap in the literature, particularly for this country.

To add further, Nasiru (2012) examines the relationship between government expenditure (both capital and recurrent) and economic growth in Nigeria from 1961 to 2010. The results indicate that there is no long-run relationship between government expenditure and economic growth in Nigeria when real GDP is used only as the dependent variable. Also, the causality results show that government capital expenditure Granger causes economic growth. No causal relationship is observed between government recurrent expenditure and economic growth. Thus, the policy implication of this result is that any decrease in capital expenditure would have negative effects on economic growth in Nigeria.

Nenbee and Medee (2011) employ the arcane approach of vector autoregression and error correction model and discover that the response of GDP to standard improvements in federal government expenditure (FGE) in Nigeria is negative in the short run. This means that FGE has no effect on GDP in the long-run. Taiwo and Abayomi (2011) empirically investigate the trends and impact of government spending on growth rates of real GDP in Nigeria from 1970 to 2008 using the Ordinary Least Square (OLS) technique. The results illustrate that there is a direct relationship between real GDP, recurrent and capital expenditure of government. They suggest that government should encourage efficient distribution of development resources by stressing on private sector participation as well as commercialisation of privatisation.

Ghazali (2010) identifies the causal relationship between private domestic investment and economic growth (GDP) in Pakistan over the period of 1981 to 2008. This study discovers that there is bi-directional causality between private domestic investment and economic growth. The co-integration results from this study show that there is a long-run relationship between private domestic investment and economic growth. From the result, it is obvious that private domestic investment in Pakistan spurs economic growth.

Tan and Tang (2011) investigate the dynamic relationship between private domestic investment (PDI), the user cost of capital, and economic growth in Malaysia over the period of 1970 to 2009. The result shows that PDI, the user cost of capital, and economic growth are co-integrated in Malaysia. The Granger causality test shows that there is unidirectional causality running from PDI to economic growth and from PDI to the user cost of capital in the long run.

Cookey (2011) confirms that official corruption and fiscal irresponsibility by government officials have consumed what could have been the economic dividends of government expenditure. Also, this corroborates with the study carried out by Okwu et al. (2012), Nasiru (2012) and Nenbee and Medee (2011) that government expenditure has not positively and significantly influenced economic growth in Nigeria.

Warner (2014) examines the empirical record whether big infrastructure and public capital drives have succeeded in accelerating economic growth in low-income countries. On average, the evidence shows only a weak positive association between investment spending and growth and only in the same year, as lagged impacts are not significant. Furthermore, there is little evidence of long-term positive impacts. Some individual countries may be exception to this general result.

Corong et al. (2012) investigate the role of public infrastructure investment on economic growth and poverty reduction in the Philippines. Using a dynamic general equilibrium-microsimulation model that explicitly models public capital as a production

input, they find that the positive supply side effects of higher public investment expenditure manifest over time, through higher capital accumulation and improved productivity. The findings reveal that higher public infrastructure investment not only positively impacts real GDP, but also reduces poverty and inequality in the short and long run. In this context, the Philippine government needs to become more proactive in finding ways to finance higher public investment expenditures. This is especially relevant with respect to international financing, given the narrow tax base in the country. The simulation results confirm that international financing is better alternatives than tax financing when considered in terms of its ability to improve the economy's physical infrastructure in order to create job opportunities, improve productivity and complement its social protection measures.

Ilegbinosa et al. (2015) examine the impact of domestic investment on economic growth in Nigeria for 1970–2013. Their results reveal that (i) increase in government productive capital expenditure positively affects economic growth but it is statistically insignificant; (ii) increase in government protective expenditure reduces economic growth, but this is not statistically significant; (iii) government expenditure on administration, economic services, and social services crowdes in private investment, though only government expenditure on economic services proves significant at 5% level of significance. Conversely, government expenditure on transfers crowds out private investment, though this is not statistically significant. Bozkurt et al. (2015) identify the factors influencing the economic growth of 28 oil-producing countries. In the mix of six causal factors in their study, they find that public expenditure on education contributes positively to economic growth.

3 Empirical methodology

Bangladesh is a labour-surplus country with over 60% of the active age population struggling with around 40% open unemployment and underemployment rates. So, it is reasonable to assume that Bangladesh is capital constrained with surplus labour. Moreover, expression of real GDP, real public investment and real private investment in per capita terms presents the production function in intensive form since actual labour force participation rate and employment data are not reliably available at this time. Thus,

$$Y = F(G,K); F_g > 0, F_{gg} < 0, F_k > 0, F_{kk} < 0, F_{gk} \gtrless 0 \tag{1}$$

where, Y = real GDP per capita, G = real public investment per capita, and K = real private investment per capita. $F_g > 0$ and $F_k > 0$ (first order derivatives) mean increase in public investment and that in private investment spur real GDP per capita, respectively. The respective second order derivatives $F_{gg} < 0$ and $F_{kk} < 0$ show diminishing marginal productivities of public and private investment, respectively. The cross-partial derivatives, $F_{gk} > 0$ means complementarity between these two types of investment, while $F_{gk} < 0$ shows their substitutability.

For estimation purpose, Cobb-Douglas production function in intensive form in the spirit of Harrod–Domar growth model is taken into consideration as follows:

$$Y_t = AGt^{\alpha} Kt^{\beta} \tag{2}$$

Additionally, A measures total factor productivity or technological progress (Solow's residual as in Solow, 1956), α = output elasticity of public investment and β = output elasticity of private investment. In logarithmic term, the above model as an estimating base equation is specified as follows:

$$\ln Y_t = A + \alpha \ln G_t + \beta \ln K_t + \ln e_t \tag{3}$$

Here, ln is natural logarithm, e = residual term and t = time subscript. The notations used subsequently in this paper for the above are $\ln Y_t = LGDPRPC_t$, $\ln G_t = LTPUIRPC_t$ and $\ln K_t = LTPRIRPC_t$.

There are several methods available to test for the existence of long-run equilibrium relationship among time-series variables. The most widely used methods include Engle and Granger (1987) test, maximum likelihood test following Johansen (1988, 1991) and Johansen and Juselius (1990) tests. These methods require that the variables in the system are integrated of order one, i.e. $I(1)$. In addition, these methods suffer from low power and do not have good small sample properties. Owing to these problems, a newly developed autoregressive distributed lag (ARDL) approach to co-integration has become popular in recent years.

This study employs ARDL approach to co-integration following the methodology proposed by Pesaran et al. (2001). This methodology is preferred to classical co-integration procedures as it has certain advantages over them. For example, it can be applied regardless of the stationarity properties of the variables in the sample. Secondly, it allows for inferences on long-run estimates which are not possible under classical co-integration procedures. Furthermore, ARDL model can accommodate greater number of variables in comparison to Vector Autoregressive (VAR) models.

To begin with, data have to be tested for unit root. This testing is necessary to avoid the possibility of spurious regression as bounds test is based on the assumption that the variables are $I(0)$ or $I(1)$. If data are found $I(0)$ or $I(1)$, the ARDL approach to co-integration is applied which consists of three steps. First, the existence of a long-run relationship between or among the variables is established by testing for the significance of lagged variables in an error-correction mechanism regression. Then, the first lags of all variables in level are added to the equation to create the error-correction mechanism equation for performing additional test by computing the joint F-test on the significance of all the lagged variables. Second, the ARDL form of equation is estimated where the optimal lag-length is selected by Akaike (1969) Information criterion (AIC). Subsequently, the restricted version of the equation is solved for the long-run solution.

An ARDL representation of equation (3) is specified as equation (4) below:

$$\begin{aligned}\Delta LGDPRPC_t = {} & \beta_0 + \sum_{i=1}^{p} \beta_i \Delta LGPRPC_{t-i} + \sum_{i=1}^{p} \lambda_i \Delta LTPUIRPC_{t-i} \\ & + \sum_{i=1}^{p} \alpha_i \Delta LTPRIRPC_{t-i} + \psi LGPRPC_{t-1} + \gamma LTPUIRPC_{t-1} \\ & + \theta LTPRIRPC_{t-1} + \mu_t\end{aligned} \tag{4}$$

For null hypothesis (H_0) of no co-integration,

$$\psi = \gamma = \theta = 0 \tag{5}$$

For alternative hypothesis (H_A) of co-integration,

$$\psi \neq \gamma \neq \theta \neq 0 \tag{6}$$

Third, vector error-correction model using the first-differences of the variables is estimated for the lagged long-run solution, and to determine the speed of adjustment towards long-run equilibrium. A general vector error-correction model following Engle and Granger (1987) is specified below:

$$\begin{aligned}\Delta LGDPRPC_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta LGPRPC_{t-i} + \sum_{i=1}^{p} \lambda_i \Delta LTPUIRPC_{t-i} \\ + \sum_{i=1}^{p} \alpha_i \Delta LTPRIRPC_{t-i} + \pi EC_{t-1} + \mu_t'\end{aligned} \tag{7}$$

The estimated coefficient (π) of the error-correction tern (EC_{t-1}) is expected to be negative for long-run convergence and causal flows. If λ_i's and α_i's are non-zeros, lagged changes in public and private investment lead the current change in per capita real GDP growth in the short-run. Their relative numerical magnitudes indicate relative influence of the relevant explanatory variable on the dependent variable. The sum of the coefficients of each lagged independent variable shows its net interactive feedback effect with other variables.

Finally, stability of short-run and long-run coefficients is examined by employing cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests. The CUSUM and SUSUMSQ statistics are updated recursively and plotted against the ±2 S.E. band. If the plots of CUSUM and CUSUMSQ statistics stay within the critical bounds of 5% level of significance, the null hypothesis of stable coefficients in the given regression cannot be rejected.

To restate, annual time-series data for Bangladesh are utilised covering time period from 1972 to 2012 with a total sample of 41 observations as limited by data availability on yearly basis. The relevant data are obtained from the Bangladesh Bureau of Statistics.

4 Empirical results

To examine the nature of data distribution for each variable, the standard descriptors are reported in Table 1.

Table 1 Descriptive statistics

	LGDPRPC	*LTPUIRPC*	*LTPRIRPC*
Mean	14908.39	894.3842	1927.164
Median	12664.00	829.7543	1017.617
Maximum	28037.00	1908.613	4617.069
Minimum	10573.00	10.80833	301.1782
Std. Dev.	4751.241	334.3292	1428.741
Skewness	1.304414	0.141610	0.589023
Kurtosis	3.643081	4.333624	1.857134
Jarque-Bera	12.33337	3.175395	4.602143
Probability	0.002098	0.204396	0.100151
Sum	611244.0	36669.75	79013.72
Sum Sq. Dev.	9.03E+08	4471040	81651994
Observations	41	41	41

For normal distribution of each time series variable, mean equals median, skewness equals zero, kurtosis equals 3, and probability of Jarque–Bera statistic equals zero. None of the above is evidenced in Table 1 suggesting a lack of normality in the data distribution of each variable, although the sample set is fairly large with 41 observations. Furthermore, the standard deviation of each variable is exorbitantly high.

Next, the Spearman's pair-wise correlation coefficients are reported in Table 2.

Table 2 Correlation coefficients

Variables	*LGDPRPC*	*LTPUIRPC*	*LTPRIRPC*
LGDPRPC	1.000000		
LTPUIRPC	0.422881	1.000000	
	(2.799961)*		
LTPRIRPC	0.276759	–0.243816	1.000000
	(1.728052)*	(–1.508416)*	

Note: *Associated *t*-values are reported within parentheses.

As observed above, both public and private investments have low-to-moderate positive correlation with per capita real GDP. Both types of investment reveal low negative correlation indicating their moderate substitutability.

The ADF and PP tests for non-stationarity and their counterpart (the KPSS) test for stationarity are implemented to examine the time series property of each variable. The computed test statistics are reported in Table 3.

A cursory inspection of the results in Table 3 infer that both ADF and PP tests reject the null hypothesis of non-stationarity for LGDPRPC at 5% level of significance while the KPSS test rejects the null hypothesis of stationarity at 1% level of significance. Both ADF and PP tests also confirm non-stationarity for LPUIRPC and LPRIPC at the above levels of significance but KPSS test reveals otherwise for LPRIPC. Thus, the findings are mixed. To add further, ADF test is inefficient and less reliable due to its super-sensitivity to the selection of lag-structure than KPSS test. However, KPSS test also suffers from sample size distortions. The mixture of $I(0)$ and $I(1)$ variables justify implementation of the ARDL procedure for co-integration. This procedure can skip unit root testing and determination of the order of integration of time series variables.

Table 3 Results of three alternative unit root tests

A. Augmented Dickey–Fuller Test: Null of Unit Root ($\Delta y_t = a + b_0 y_{t-1} + \sum_{j=1}^{k} b_j \Delta y_{t-j} + e_{tk}$)

Variables	*Lags*	*Level*	*First Difference*	*Result (Level)*
LGDPRPC	9	4.42(C)	–9.05***(C,T)	Non-stationary
LPUIRPC	8	–3.66**(C,T)		Stationary
LPRIRPC	9	–2.33 (C,T)	–6.91***(N)	Non-stationary

B. Phillips–Perron Test: Null of Unit Root ($\Delta y_t = \mu_0 + \mu_1 y_{t-1} + \sum_{j=1}^{k} \mu_j \Delta y_{t-j} + \beta D + \dot{e}_{tk}$ with D dummy)

Variables	*Lags*	*Level*	*First Difference*	*Result (Level)*
LGDPRPC	9	6.68 (C)	–11.84***(C,T)	Non-stationary
LPUIRPC	8	–17.51*** (C,T)		Stationary
LPRIRPC	9	–2.55 (C,T)*	–6.83***(N)	Non-stationary

Table 3 Results of three alternative unit root tests (continued)

C. KPSS (Kwiatkowski–Phillips–Schmidt–Shin) Test: Null of No Unit Root (Stationarity)				
Variables	*Lags*	*Level*	*First Difference*	*Result (Level)*
LGDPRPC	9	0.20**(C,T)	0.14 (C,T)	Non-stationary
LPUIRPC	8	0.13* (C,T)	0.33 (C)	Non-stationary
LPRIRPC	9	0.08 (C,T)		Stationary

Notes: (1) The McKinnon critical values for ADF and PP Tests: (with both intercept and trend) are: (a) 1% = –4.07; (b) 5% = –3.46; and (c) 10% = –3.16 respectively; (with only intercept) are: (a) 1% = –3.48; (b) 5% = –2.88; and (c) 10% = –2.58; (without intercept and trend) are: (a) 1% = –2.59; (b) 5% = –1.94; and (c) 10% = –1.62 respectively.

(2) Critical values for KPSS Test: (with both intercept and trend: (a) 1% = 0.22; (b) 5%=0.15; and (c) 10% = 0.12; respectively; (with intercept only): (a) 1%=0.74; (b) 5%=0.46; and (c) 10% = 0.35 respectively; (without intercept and trend) (a) 1%=0.73; (b) 5% = 0.46; and (c) 10% = 0.35 respectively.

(3) (a) *** = significant at 1% level; (b) ** = significant at 5% level; and (c) * = significant at 10% level.

(4) Letters in parentheses after the coefficients represent the following characteristic included during the unit root tests and in determining the critical values as appropriate: C = Intercept; T = Trend; and N = None (No Intercept ; No Trend).

(5) SIC was used to determine optimal lag length

Second, the unrestricted VAR in first-difference as in equation (4) is estimated and results are reported in Table 4 to test the null hypothesis (H_0) for no co-integration ($\psi = \gamma = \theta = 0$) with its alternative ($H_A$) for co-integration ($\psi \neq \gamma \neq \theta \neq 0$).

Table 4 Estimates of the unrestricted ARDL model (equation (4))

$$\begin{aligned}\Delta LGDRPC_t = {} & 0.2439 + 0.4653\Delta LGDPRPC_{t-1} - 0.2095\ \Delta LGDPRPC_{t-2} \\ & (0.6644) \qquad (2.5895) \qquad (-1.2270) \\ & + 0.0433\Delta LTPUIRPC_{t-1} + 0.07154\,\Delta LTPUIRPC_{t-2} - 0.0125\Delta LTPUIRPC_{t-3} \\ & \qquad (1.5412) \qquad (3.4003) \qquad (-1.5174) \\ & - 0.0463\,\Delta LTPRIRPC_{t-1} - 0.0131 LGDPRPC_{t-1} - 0.0614 LTPUIRPC_{t-1} \\ & \qquad (-2.5219) \qquad (-0.3758) \qquad (-1.7982) \\ & + 0.0431\Delta LTPRIRPC_{t-1} \\ & \qquad (2.4843)\end{aligned}$$

Notes: $\bar{R}^2$ = 0.6533; AIC = –5.4009; Fcal = 8.5391.

F-statistic (Lower Bound) at 5% level of significance = 2.365

F-statistic (Upper Bound) at 5% level of significance = 3.553

Respective *t*-value of each coefficient is reported in parenthesis.

As observed in Table 4, $\bar{R}^2$ at 0.6533 is reasonably high explaining around 65% of the variation in the dependent variable due to explanatory variables. For the Pesaran et al. (2001) co-integration test, the lower bound and the upper bound critical values of F-statistic at 5% level of significance are 2.365 and 3.553, respectively. The calculated F-statistic at 8.5391 is higher than the upper-bound critical value. Thus, the null hypothesis of no co-integration is clearly rejected.

To ensure that the estimated model is statistically sound, some of diagnostic checks are conducted as shown in Table 5. The autocorrelation test is performed to ensure that the residuals from this estimated model are free of serial correlation. The Portmanteau test for autocorrelation leads to acceptance of the null of no autocorrelation.

Table 5 Portmanteau test for serial correlation

Lags	*Q-Stat*	*Prob.*	*Adj. Q-Stat*	*Prob.*	*df*
1	0.158464	NA*	0.162865	NA*	NA*
2	1.340149	NA*	1.412075	NA*	NA*
3	3.312289	0.1909	3.558228	0.1688	2
e4	3.314705	0.3456	3.560937	0.3129	3
5	3.491094	0.4792	3.764886	0.4388	4
6	3.492095	0.6246	3.766082	0.5836	5
7	3.551737	0.7371	3.839639	0.6984	6
8	4.457505	0.7258	4.995275	0.6605	7
9	6.304700	0.6131	7.436211	0.4904	8
10	9.187397	0.4202	11.38657	0.2501	9
11	9.360093	0.4983	11.63233	0.3104	10
12	12.20685	0.3483	15.84553	0.1470	11

Notes: *The test is valid only for lags larger than the VAR lag order. df is degrees of freedom for (approximate) chi-square distribution.*df and Prob. may not be valid for models with exogenous variables.

Additionally, the recursive residuals from this model are displayed in Figure 2 indicating their well behaviour with no trend or structural breaks. Figure 2, thus, clearly reveals random movements of the recursive residuals.

Figure 2 Stability test: recursive residuals (see online version for colours)

Stability of the coefficients of the unrestricted VAR in response to given shocks by ±2 S.E. are shown in Figure 3. The estimated coefficients are stable as they mostly fall within the 5% significant lines.

Figure 3 Stability tests: recursive coefficients (see online version for colours)

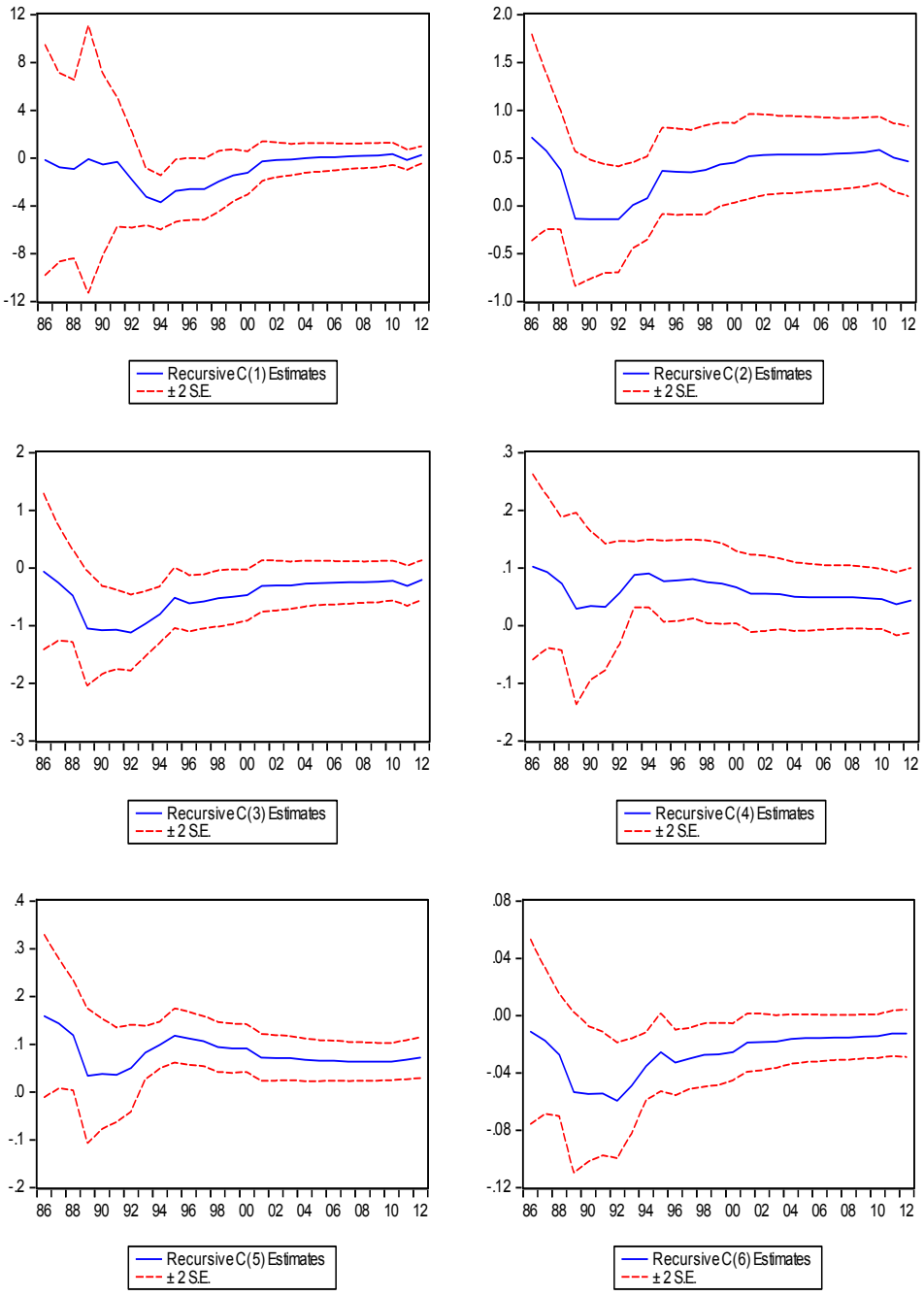
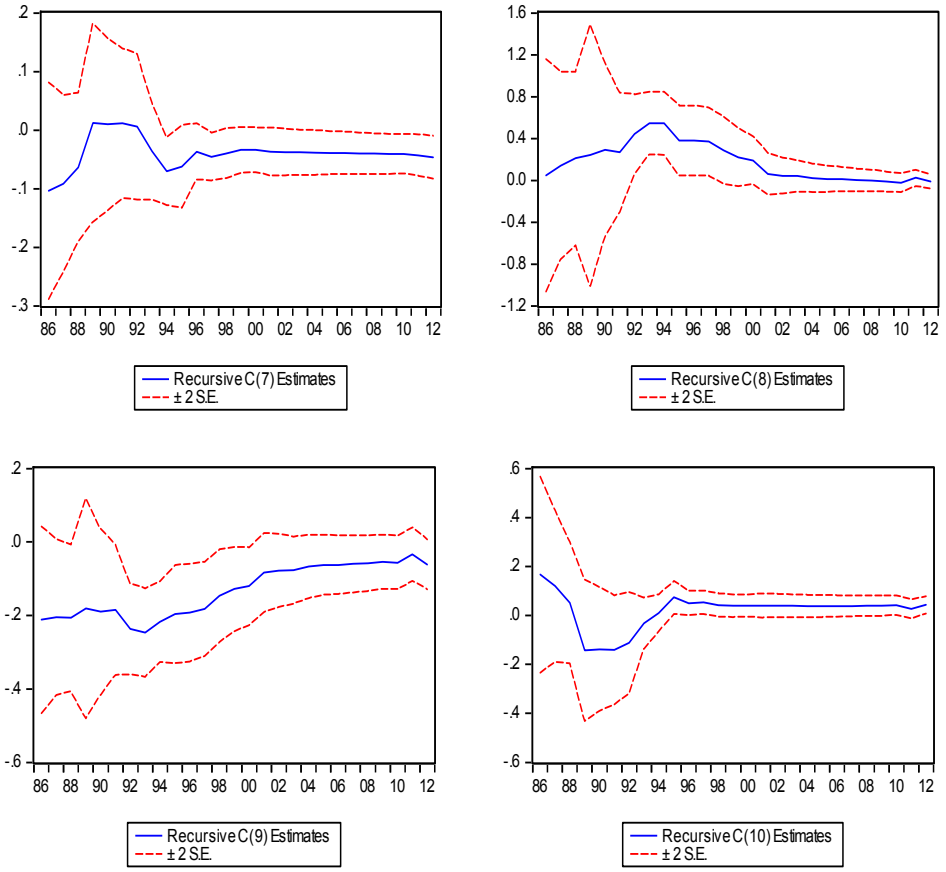


Figure 3 Stability tests: recursive coefficients (see online version for colours) (continued)



Finally, on the evidence of co-integrating relationship, the vector error-correction model (VECM) as specified in equation (7) for long-run convergence and short-run dynamics is estimated by OLS. The estimates are reported in Table 6.

In Table 6, $\bar{R}^2$ at 0.6802 shows that 68% of the current positive change in per capita real GDP is due to its own two lagged changes along with the 4-year lagged changes in per capita real public and private investment in the long run as well as in the short run. The F-statistic at 7.7694 reveals overall statistical significance of the estimated VECM. The DW-statistic at 2.1447 confirms existence of negligible negative serial correlation. In addition, the Portmanteau test for serial correlation also shows absence of serial correlation in the residuals. The AIC criterion is taken into cognizance to determine optimum lag-structure to overcome the problem of over-parameterisation of the model and resulting bias as well as inefficiency in the estimated parameters.

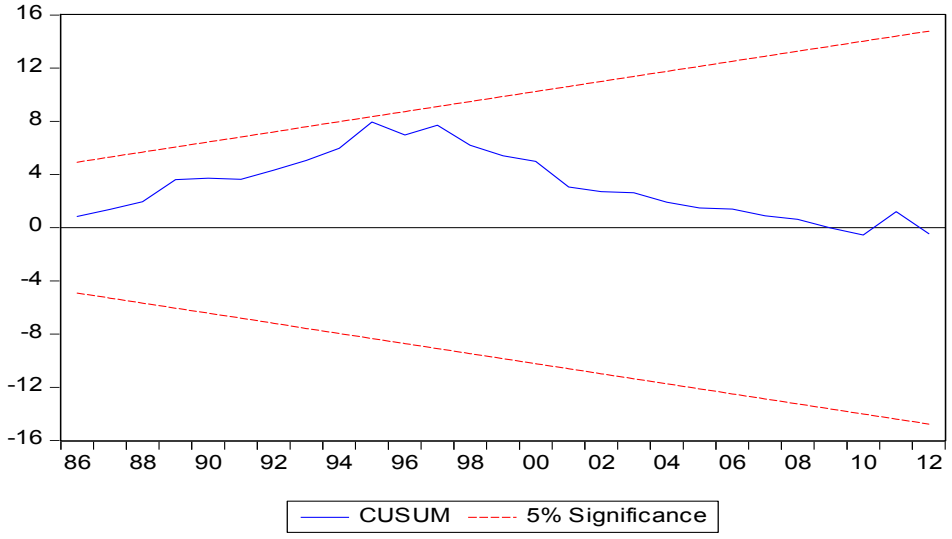
Table 6 Vector error-correction model (VECM) estimates (Dependent variables: DLGDPRPC)

Variable	*Coefficient*	*Std. Error*	*t-statistic*	*Prob.*
C	0.162485	0.072831	2.230972	0.0353
DLGDPRPC (–1)	0.693366	0.203288	3.410757	0.0023
DLGDPRPC (–2)	–0.190189	0.173611	–1.095490	0.2842
DLTPUIRPC (–1)	–0.038352	0.046026	–0.833267	0.4129
DLTPUIRPC (–2)	0.065883	0.025561	2.577442	0.0165
DLTPUIRPC (–3)	–0.074490	0.031552	–2.360856	0.0267
DLTPUIRPC (–4)	0.012002	0.008258	1.453396	0.1591
DLTPRIRPC (–1)	–0.017032	0.022628	–0.752409	0.4590
DLTPRIRPC (–2)	0.008663	0.019148	0.452409	0.6550
DLTPRIRPC (–3)	0.022921	0.019534	1.173359	0.2522
DLTPRIRPC (–4)	0.029325	0.017654	–1.661101	0.1097
EC_{t-1}	–0.008628	0.004004	–2.155022	0.0414
Adjusted R^2	0.6802			
F-Statistic	7.7769			
DW-Statistic	2.1447			
AIC	–5.4397			

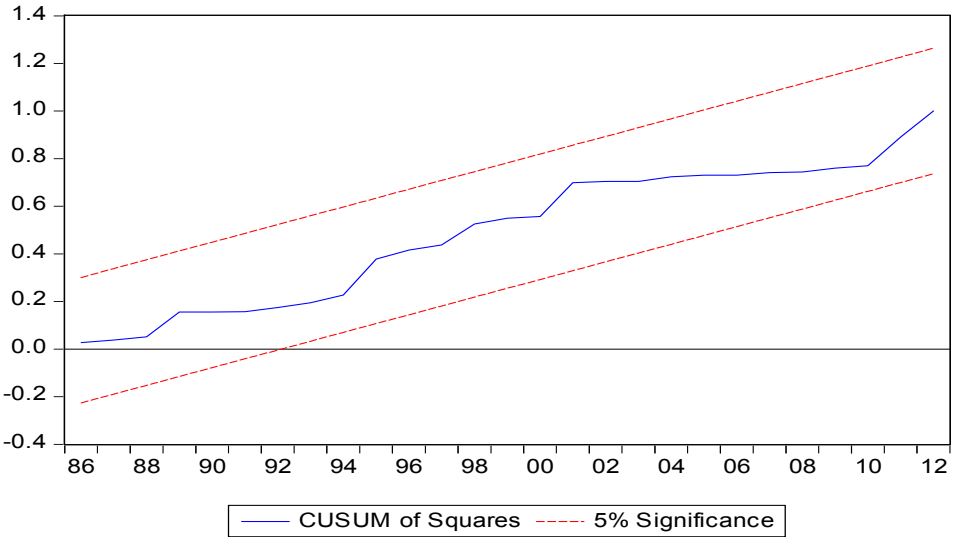
The coefficient of the error-correction term, EC_{t-1}, has expected negative sign. It is far less than unity but quite significant in terms of the associated t-value for long-run convergence. The estimated coefficient of the error-correction term, thus, clearly confirms convergence towards a long-run equilibrium. However, the speed of adjustment for convergence is very slow, in view of very low magnitude of the coefficient of the error-correction term. Slow long-run causal flow from changes in per capita real public and private investment growths to current change in per capita real GDP growth over initial 4-year lags for both variables is, perhaps, due to unduly prolonged gestation gap in public projects, regulatory hurdles for private investment, slow and untimely disbursements of public funds, and unexpected long delay in implementation of public projects. The sum of the short-run coefficients of lagged changes in per capita real public investment growth over the 4-year lagged period is marginally negative indicating subdued net negative effect on the current change in per capita real GDP growth. In contrast, the sum of the coefficients of lagged changes in per capita real private investment over the same four-lagged periods is positive implying net positive short-run effect on the current change in per capita real GDP growth. However, some of the individual short-run coefficients for both public and private investment growths are statistically insignificant in terms of the associated *t*-values. To add further, the coefficients of the lagged changes in public investment and private investment growths are non-zeros. Thus, these two variables are likely to jointly lead the current change in per capita real GDP growth in the short run.

Finally, the stability of the coefficients of the estimated model is ascertained by invoking CUSUM and CUSUM squared tests, as shown in Figure 4.

Figure 4 CUSUM and CUSUM-squared residual stability tests (see online version for colours)



(a) CUSUM test



(b) CUSUM squared test

The coefficients of the estimated model in terms of both CUSUM and CUSUM Squared tests are stable as they stay within the 5% significant straight lines. So, the model parameters are stable in the short run as well as in the long run.

5 Conclusions and policy implications

To recapitulate, the variables are found to be non-stationary and co-integrated. The vector error-correction model shows convergence in the long run with very slow speed of adjustment. The net short-run effects of public and private investment are very weak. However, these do not preclude their long-term roles in lifting per capita real GDP growth in Bangladesh. Relatively, private investment is more effective than public investment in overall sense.

In light of the above findings, the development policy of Bangladesh should put added emphasis on promoting private investment to enhance real economic growth. This would require adequate funding, timely disbursements of public funds, timely implementation of public infrastructure projects, and further easing of regulatory burden on the private investors. Furthermore, reducing public sector corruption and graft, streamlining bureaucracy, improving overall governance, and ensuring political stability would further accelerate private investment by mitigating crowding-out effects. These reform efforts are expected to entice FDI. As of now, its magnitude has remained disappointingly low in Bangladesh. Larger FDI inflows are likely to improve private sector productivity through advanced technology, improved managerial and marketing skills, and foreign marketing networks as positive spillovers.

Inclosing, productive public investment in infrastructure, energy sector, water supply, education and health sector to aid private sector directly and indirectly will accelerate per capita real economic growth in Bangladesh.

References

Afonso, A. and Aubyn, M. (2009) 'Macroeconomic rates of return of public and private investment: crowding-in and crowding-out effects', *The Manchester School*, Vol. 77, pp.21–39.

Akaike, H. (1969) 'Fitting autoregression for prediction', *Annals of the Institute of Statistical Mathematics*, Vol. 21, pp.243–247.

Aschauer, D.A. (1989a) 'Is public expenditure productive?', *Journal of Monetary Economics*, Vol. 23, pp.177–200.

Aschauer, D.A. (1989b) 'Public investment and productivity growth in the group of seven', *Economic Perspectives*, Vol. 13, pp.17–25.

Aschauer, D.A. (1990) 'Why is infrastructure important?', in Munnell, A. (Ed.): *Is There a Shortfall in Public Capital Investment?*, Conference Series of Federal Reserve Bank of Boston, Boston, MA.

Balassa, B. (1988) 'Outward orientation', in Chenery, H. and Srinivasan, T.N. (Eds): *Handbook of Development Economics*, Vol. 2, North-Holland, Amsterdam.

Bangladesh Bureau of Statistics (2013) *Bangladesh Economic Review*, Bangladesh Bureau of Statistics, Dhaka.

Barro, R.J. (1991) 'Economic growth in cross-section of countries', *Quarterly Journal of Economics*, Vol. 106, pp.407–443.

Barth, J.R. and Joseph, J.C. (1980) 'Substitutability, complementarity, and the impact of government spending on economic activity', *Journal of Economics and Business*, Vol. 32, No. 3, pp.235–242.

Blejer, M.I. and Khan, M.S. (1984) 'Government policy and private investment in developing countries', *IMF Staff Papers*, Vol. 31, No. 2, pp.379–403.

Bozkurt, A., Erdem, C. and EroAYIu, A. (2015) 'Identifying the factors affecting the economic growth of oil-producing countries', *International Journal of Trade and Global markets*, Vol. 8, pp.97–111.

Cashin, P. (1995) 'Government spending, taxes, and economic growth', *IMF Staff Papers*, Vol. 42, No. 2, pp.237–269.

Cookey, A.E. (2011) *Does Government Expenditure Yield Greater Dividends in Democracies? A Comparative Analysis of Military and Civilian Regimes*. Available online at: www.iiste.org

Corong, E., Dacuycuy, L., Reyes, R. and Taningco, A. (2012) *The Growth and Distributive Impacts of Public Infrastructures Investment in the Philippines*, Partnership for Economic Policy (PEP) Working Paper No. 2012-15, Shanghai, China.

Coutinho, R. and Gallo, G. (1991) *Do Public and Private Investments Stand in Each Other's Way?*, WDR Background Paper, World Bank, Washington, DC.

CPD (Centre for Policy Dialogue) (2014) *State of the Bangladesh Economy*, Centre for Policy Dialogue, Dhaka.

De la Croix, D. and Delavallade, C. (2006) *Growth, Public Investment and Corruption with Failing Institutions*, CORE Discussion Paper (2006/101). Available online at: http://ssrn.com/abstract=970305

Dethier, J.J. and Moore, A. (2012) *Infrastructure in Developing Countries: An Overview of Some Economic Issues*, ZEF-Discussion Papers on Development Policy No. 165, University of Bonn, Bonn, Germany.

Domar, E. (1946) 'Capital expansion, rate of growth and employment', *Econometrica*, Vol. 14, pp.137–147.

Engle, R.F. and Granger, C.W.J. (1987) 'Cointegration and error-correction representation, estimation and testing', *Econometrica*, Vol. 55, pp.251–276.

Erden, L. and Holcombe, R.G. (2005) 'The effects of public investment on private investment in developing economies', *Public Finance Review*, Vol. 33, No. 5, pp.575–602.

Evans, P. and Karras, G. (1994) 'Are government activities productive? Evidence from a panel of U.S. states', *Review of Economics and Statistics*, Vol. 76, No. 1, pp.1–11.

Ghazali, A. (2010) 'Analyzing the relationship between foreign direct investment, domestic investment and economic growth for Pakistan', *International Research Journal of Finance and Economics*, Vol. 47, pp.123–131.

Greene, J. and Villanueva, D. (1991) 'Private investment in developing countries: an empirical analysis', *IMF Staff Paper*, Vol. 38, No. 1, pp.33–58.

Harrod, R.F. (1948) *Towards a Dynamic Economics: Some Recent Developments of Economic Theory and their Application to Policy*, Macmillan, London.

Hatano, T. (2010) 'Crowding-in effect of public investment on private investment', *Japan Public Policy Review*, Vol. 6, No. 1, pp.105–119.

Holtz-Eakin, D. (1994) 'Public-sector capital and productivity puzzle', *Review of Economics and Statistics*, Vol. 76, No. 1, pp.12–21.

Ilegbinosa, I.A., Micheal, A. and Watson, S.I. (2015) 'Domestic investment and economic growth in Nigeria from 1970–2013: an econometric analysis', *Canadian Social Science*, Vol. 11, pp.70–79.

Johansen, S. (1988) 'Statistical analysis of cointegration vectors', *Journal of Economic Dynamics and Control*, Vol. 12, pp.231–254.

Johansen, S. (1991) 'Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models', *Econometrica*, Vol. 59, No. 6, pp.1551–1580.

Johansen, S. and Juselius, K. (1990) 'Maximum likelihood estimation and inference on cointegration with application to the demand of money', *Oxford Bulletin of Economics and Statistics*, Vol. 52, pp.169–210.

Keefer, P. and Knack, S. (2007) 'Boondoggles, rent-seeking and political checks and balances: public investment under unaccountable government', *Review of Economics and Statistics*, Vol. 89, No. 3, pp.566–572.

Khan, M. and Kumar, M.S. (1997) 'Public and private investment and the growth process in developing countries', *Oxford Bulletin of Economics and Statistics*, Vol. 59, pp.69–88.

Khan, M. and Reinhart, C.M. (1990) 'Private investment and economic growth in developing countries, *World Development*, Vol. 18, No. 1, pp.19–27.

Lora, E. (2007) *Public Investment in Infrastructure in Latin America: Is Debt the Culprit?* Research Department Working Paper 595, Inter-American Development Bank, Washington, DC.

Lucas Jr., R.E. (1988) 'On the mechanics of economic development', *Journal of Monetary Economics*, Vol. 22, No. 1, pp.3–42.

Mankiw, N.A., Romer, D. and Weil, D.N. (1992) 'A contribution to the empirics of economic growth, *Quarterly Journal of Economics*, Vol. 107, pp.407–437.

Marattin, L. and Sallotti, S. (2011) 'On the usefulness of government spending in the euro area', *Journal of Socio-Economics*, Vol. 40, pp.780–795.

Mauro, P. (1998) 'Corruption and the composition of government expenditure', *Journal of Public Economics*, Vol. 69, No. 2, pp.263–279.

Munnell, A.H. (1990) 'Why has productivity declined? Productivity and public investment', *New England Economic Review*, Vol. 30, pp.3–22.

Nasiru, I. (2012) 'Government expenditure and economic growth in Nigeria: cointegration analysis and causality testing', *Academic Research International*, Vol. 2, No. 3, pp.718–723.

Nazmi, N. and Ramirez, M.D. (1997) 'Public and private investment and economic growth in Mexico', *Contemporary Economics Policy*, Vol. 15, No. 1, pp.65–75.

Nenbee, G.S. and Medee, P.N. (2011) 'Econometric analysis of the impact of fiscal policy on Nigeria's economic growth, 1960–2010', *International Journal of Economic Development Research and Investment*, Vol. 2, No. 1.

Odedokun, M.O. (1997) 'Relative effects of public versus private investment spending on economic efficiency and growth in developing countries', *Applied Economics*, Vol. 29, pp.1325–1336.

Okwu, A.T., Desmond, N.I., Obiwuru, T.C. and Odiche, L.N. (2012) 'Effects of public expenditure on economic growth in Nigeria: a disaggregated time series analysis', *International Journal of Management Sciences and Business Research*, Vol. 1, No. 7, pp.1–15.

Oshikoya, T.W. (1994) 'Macroeconomic determinants of domestic private investment in Africa: an empirical analysis', *Economic Development and Cultural Change*, Vol. 42, pp.573–596.

Perotti, R. (2007) *In Search of the Transmission Mechanism of Fiscal Policy*, NBER Working Paper 13143, National Bureau of Economic Research, Cambridge.

Pesaran, H.M., Shin, Y. and Smith, R.J. (2001) 'Bounds testing approaches to the analysis of level relationships', *Journal of Applied Econometrics*, Vol. 16, No. 3, pp.289–326.

Rajkumar, A.S. and Swaroop, V. (2008) 'Public spending and outcomes: does governance matter?', *Journal of Development Economics*, Vol. 86, pp.96–111.

Ramirez, M.D. (1994) 'Public and private investment in Mexico, 1950-90: an empirical analysis', *Southern Economic Journal*, Vol. 61, pp.1–17.

Ramirez, M.D (2000) 'The impact of public investment on private investment spending in Latin America: 1980-95', *Atlantic Economic Journal*, Vol. 28, pp.210–225.

Robinson, J. and Torvik, R. (2005) 'White elephants', *Journal of Public Economics*, Vol. 89, pp.197–210.

Romer, P.M. (1989) *Human Capital and Growth: Theory and Evidence*, NBER Working Paper 3171, National Bureau of Economic Research, Cambridge.

Serven, L. and Solimano, A. (1990) *Private Investment and Macroeconomic Adjustment: Theory, Country Experience, and Policy Implications*, Unpublished, Macroeconomic Adjustment and Growth Division, World Bank, Washington, DC.

Solow, R. (1956) 'A contribution to the theory of economic growth', *Quarterly Journal of Economics*, Vol. 70, pp.65–94.

Taiwo, M. and Abayomi, T. (2011) 'Governments expenditure and economic development: empirical evidences from Nigeria', *International Journal of Business and Management*, Vol. 6, No. 3.

Tan, B.W. and Tang, C.F. (2011) *The Dynamic Relationship between Private Domestic Investment, the User Cost of Capital and Economic Growth in Malaysia*, MPRA Paper no. 27964. Available online at: http://mpra.ub.uni-muenchen.de/27964/ (accessed on 8 January 2011).

Tatom, J.A. (1991) 'Public capital and private sector performance', *Federal Reserve Bank of St. Louis Review*, Vol. 73, No. 3, pp.3–15.

Wai, U.T. and Wong, C. (1982) 'Determinants of private investment in developing countries', *Journal of Development Studies*, Vol. 19, pp.19–36.

Warner, A.M. (2014) *Public Investment as an Engine of Growth*, IMF Working Paper WP/14/148, International Monetary Fund, Washington, DC.

The determinants of parts and components trade: the role of trust and commitment

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Abstract: We draw on the knowledge from the fields of international economics and international marketing to improve our insights on the determinants of bilateral trade, in particular trade in Parts and Components (P&C). While trade economists have confirmed the importance of trade agreements, infrastructure and institutional quality among others, as important determinants of trade, international marketers have pointed to the critical role of trust and commitment among partners as antecedents to cross border relationships. In this paper, we introduce macro level variables to represent the antecedents of trust and commitment between dyads in a trade gravity model. We base our findings on 17,030 bilateral relationships involving 291 SITC 5 digit products that we classify as P&C. Our findings confirm the importance of cultural distance, business ethics and transaction specific investments in a bilateral trade relationship. In particular, we find that trust and commitment among partners are more important in P&C trade.

Keywords: parts and components trade; trust; commitment; trade relationship; gravity models.

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1 Introduction

Trade in parts and components (P&C) contribute such a substantial part of international trade, particularly in East Asia, that its evaluation and analysis has attracted the attention of a number of trade economists (Arndt, Jones, Kierzkowski, Athukorala, Menon, Kimura, Obashi, Yamashita, among others). In addition to the volume of trade that involves P&C, the inability of traditional trade theories to fully explain the phenomenon justifies the interest among these researchers. Previous researchers have focused their efforts in explaining the trends in P&C trade (Athukorala, 2005; Athukorala, 2012; Athukorala and Menon, 2010; Caporale et al., 2015), its determinants (Athukorala and Yamashita, 2006; Yamashita, 2011), location (Ando, 2006; Arndt and Kierzkowski, 2001) and theoretical reasoning behind such trade (Jones et al., 2005; Kimura and Obashi, 2011). However, interest in P&C trade is not limited only to international trade economists. Concurrent with the developments in the international economics area, researchers in the field of international industrial marketing have also been involved in discovering the driving force behind the relationship between importers and exporters. In particular, B2B relationships between dyads across borders also include P&C trade. One area that has been the focus of many international marketers is trust across borders among partners in a trading relationship (Zaheer and Zaheer, 2006; Katsikeas et al., 2009; Dyer and Chu, 2003). Although some aspects of trust have been considered by trade economists by including cultural distance in empirical models (Child et al., 2009; Linders et al., 2005), importer-exporter relationship has largely been ignored. Thus, in addition to updating the works of Athukorala, Menon, and Yamashita, the objective of this paper is to draw on the knowledge derived from both the fields of international economics and international marketing so as to enrich our understanding of the antecedents/determinants of P&C trade. This paper is an effort to directly answer the call made by Kimura and Obashi (2011) for more inter-disciplinary research on P&C trade. In particular, we empirically test the importance of importer-exporter relationship as an antecedent of P&C bilateral trade. More specifically, we attempt to show that the degree of trust and commitment between the dyads in an international relationship contributes significantly to bilateral trade. We also question whether or not such a relationship is more prominent in P&C trade, when compared with non P&C manufacturing trade.

In the next section we highlight some key attributes of P&C trade which provides a context for explaining the determinants of bilateral trade in such products. Section 3 reviews literature from the international economics and marketing fields to identify the main variables that influence P&C trade. We explain the sources of data and methodology in Section 4, followed by a discussion of our findings. In Section 6 we conclude our paper.

2 Parts and components trade patterns

When compared to the general bilateral trade analysis, the analysis of trade flows of intermediate goods and particularly of parts and components has been considered to be still in its infancy and requires further development. It was not until recently that this area has started to gain momentum (Córcoles et al., 2014). Three important factors have contributed towards the explosion of P&C trade worldwide. First, the introduction of production technology that allowed for the fragmentation of production stages. In the Information Technology (IT) sector, this technology is attributed to the IBM PC with its modular product architecture which allowed fixed and publicly known components to be produced by firms (Langlois and Robertson, 1995). Component producers could now work independently based on their core capabilities and take advantage of location and ownership advantages (Bonham et al., 2007). The standardisation of components reduced the barriers to entry and lowered prices in a highly competitive environment. Potential reduction in production costs motivated PC producers to search for cheaper locations to set up subsidiaries or establish links with suppliers (Athukorala and Yamashita, 2008). A similar rationale applied for other machineries including the automobile industry (Athukorala, 2005). Second, the reduction of trade barriers (particularly import tariffs) worldwide stemming from the various GATT/WTO rounds of negotiations allowed for easier movement of goods (and later, services) across international borders. The Kennedy Round focused on the reduction of tariffs on manufactured goods and since the completion of that round, trade policy which previously was biased against manufactured goods had been reversed (Bridgman, 2012). Third is the rise of the East Asian economies (including China) as factories for the world (Kimura and Obashi, 2011). The share of East Asia (excluding Japan) in total world exports of P&C increased from 20.2% in 1992/93 to 34.1% in 2006/7 (Athukorala, 2001). The governments of the East Asian nations (Singapore, Chinese Taipei, Hong Kong SAR, South Korea, Malaysia, Thailand and China in particular) have been proactive in promoting their respective locational advantages to attract FDI from Japanese, US and European multinationals, More recently, intra-regional FDI has also been courted with (Taguchi et al., 2014). In addition to reducing trade barriers, East Asian governments have vied with each other to develop their infrastructures and human resources so that international production networks include firms from their respective countries.

The trends and patterns of P&C trade has been explained extensively by others (Athukorala, 2005; Athukorala and Menon, 2010). We highlight below two important features of trade in P&C that may not have been emphasised in previous papers that dealt with the subject (Athukorala and Yamashita, 2006; Athukorala and Yamashita, 2008; Kimura and Obashi, 2011; Athukorala, 2001; Yamashita, 2011). The first feature concerns the specific intermediate goods that dominate trade in P&C. Table 1 extracts the top 20 of the 291 5-digit SITC product categories included in our analysis. The trade values are averaged for the 2008–2009 and 2012–2013 periods. These 20 top categories make up 51% of total imports of P&C and about 49% of total exports during both periods. The following 20 product categories (21–40) make up an additional 18% of total trade while the last 100 product categories add about 25% of total imports. Among the top 20 product categories, automobile related P&C make up 17.32% of imports (4 items), while 24.5% of total imports are related to electronic and electrical P&C (10 items). Not

surprisingly, analysis of P&C trade in the automobile and electronic industries is popular among trade economist (Abdul Aziz et al., 2013; Ernst, 2004). There are a few items which can be considered lumpy products like P&C for airplanes and helicopters (SITC 79295), turbojets and turbo-propellers (SITC 71491) and civil engineering machinery (SITC 72399). However, it should be noted that the top 2 product categories (SITC 75997 Parts of automatic data processing machines and units thereof, magnetic or optical readers and machines for transcribing and processing data n.e.s. and SITC 78439 Parts and accessories n.e.s. for tractors, motor cars and other motor vehicles, trucks, public transport vehicles and road vehicles, n.e.s) seem to be a potpourri of various parts and accessories. In 2012/13, these two items make up 5.87% and 8.08% of total imports respectively, and may include items that do not fit perfectly into other SITC categories. These two product categories are also the top two export items.

Table 1 Top 20 parts and components product categories, 2008/09 and 2012/13

SITC	*Average 2008–09*				*Average 2012–13*			
	Imports (%)	*Cumulated imports (%)*	*Exports (%)*	*Cumulated exports (%)*	*Imports (%)*	*Cumulated imports (%)*	*Exports (%)*	*Cumulated exports (%)*
78439	7.62	7.62	8.22	8.22	8.08	8.08	8.82	8.82
75997	8.00	15.62	7.40	15.62	5.87	13.95	5.61	14.43
76493	4.42	20.03	3.63	19.25	3.70	17.66	2.96	17.39
78432	2.94	22.97	2.70	21.95	3.34	20.99	3.01	20.41
79295	3.20	26.17	2.91	24.86	3.06	24.05	2.64	23.05
78434	2.19	28.35	2.08	26.94	2.84	26.89	2.76	25.81
77637	2.40	30.75	2.23	29.17	2.57	29.46	2.32	28.13
71491	2.22	32.97	1.92	31.10	2.36	31.83	1.62	29.75
77261	1.51	34.48	1.59	32.68	2.06	33.89	2.08	31.83
77259	1.83	36.31	1.85	34.54	1.90	35.79	1.82	33.66
71322	1.47	37.78	1.46	36.00	1.63	37.43	1.58	35.23
89319	1.64	39.43	1.59	37.58	1.63	39.06	1.67	36.91
71392	1.58	41.01	1.69	39.27	1.61	40.66	1.75	38.66
71391	1.57	42.57	1.38	40.65	1.59	42.26	1.53	40.19
77313	1.27	43.84	1.22	41.87	1.59	43.85	1.48	41.67
71323	1.46	45.30	1.64	43.52	1.57	45.42	1.63	43.29
77812	1.52	46.82	1.54	45.06	1.51	46.93	1.59	44.88
77689	1.85	48.67	1.05	46.10	1.51	48.44	0.87	45.75
71441	1.24	49.91	1.20	47.31	1.44	49.88	1.34	47.10
77282	1.35	51.26	1.34	48.65	1.42	51.29	1.56	48.65

Source: UN Comtrade

The second interesting feature concerns those bilateral trade relationships that dominate the P&C trade. Table 2 extracts out the top 50 bilateral relationships in the P&C trade. As can be seen in the last row of the table, these 50 trade relationships make up 40.63% and 36.94% of import and export of global P&C trade respectively. Among these top 50 trade

relationships, there are 22 distinct countries, 14 of which are involved in both import and export relationships. All the usual suspects are in the list. On the import side, Germany and the USA dominate with 6.94% and 6.4% respectively. Asian economies like Hong Kong SAR, Singapore, South Korea and Japan are also major importers of P&C. On the export side, three main countries dominate: the USA, China and Germany comprising a total of 23.52% of total P&C exports. Among the bilateral relationships, the imports of USA from China, Canada from the USA, Hong Kong from China, and USA from Mexico are among the leading ones. On the export side, China's exports to Hong Kong, Canada to the USA, and Mexico to the USA are the three leading ones.

A cursory look at these 50 bilateral relationships provides us with some indications as to the determinants of P&C trade. First, distance between trading partners is obvious as the main trade relationships seems to take place more among neighbours (Hong Kong-China; USA-Canada; Japan-China; Germany-France, etc.). Second, trade between developed and developing economies is also quite prominent. Nearly every relationship in Table 2 that involves a developing country on one side has a developed country on the other side. At the same time, trade relationships among developed countries are also significant (USA-Canada; Japan-USA, etc.). It should also be noted that the developing countries listed in Table 2 are mainly middle and upper middle income countries. Third, there is an obvious absence of countries from the African and South American continents. While distance can be attributed to this, lack of proper infrastructure and other transaction costs involved in dealing with such countries may be additional reasons. These three reasons and other determinants are the focus of our paper in the following sections.

Table 2 Main bilateral relationships in P&C trade

Importer	*Exporter*	*Import (%)*	*Cumulative imports (%)*	*Exports (%)*	*Cumulative exports (%)*
USA	China	2.23	2.23	0.47	0.47
Canada	USA	2.15	4.38	1.62	2.09
Hong Kong SAR	China	2.13	6.51	2.73	4.82
USA	Mexico	2.09	8.60	1.84	6.67
China	Japan	1.98	10.58	1.00	7.66
Mexico	USA	1.55	12.13	2.35	10.01
USA	Canada	1.52	13.65	2.49	12.50
USA	Japan	1.48	15.13	0.50	13.00
France	Germany	1.28	16.41	0.92	13.92
Japan	China	1.16	17.57	1.65	15.57
USA	Germany	0.95	18.52	0.51	16.08
Singapore	USA	0.88	19.40	0.34	16.42
Germany	France	0.80	20.20	1.26	17.68
Germany	China	0.76	20.96	0.66	18.34
UK	Germany	0.76	21.72	0.46	18.80

Table 2 Main bilateral relationships in P&C trade (continued)

Importer	*Exporter*	*Import (%)*	*Cumulative imports (%)*	*Exports (%)*	*Cumulative exports (%)*
China	Germany	0.76	22.48	0.56	19.36
Spain	Germany	0.72	23.20	0.33	19.69
UK	USA	0.71	23.90	0.59	20.28
Germany	Czech Republic	0.67	24.57	0.52	20.80
France	USA	0.66	25.23	0.43	21.23
Austria	Germany	0.65	25.88	0.64	21.87
Italy	Germany	0.64	26.53	0.55	22.42
Germany	UK	0.64	27.17	0.71	23.13
Japan	USA	0.63	27.81	1.47	24.60
Hong Kong SAR	Japan	0.63	28.43	0.21	24.81
Germany	Austria	0.60	29.04	0.58	25.39
Germany	USA	0.60	29.64	0.96	26.35
Spain	France	0.58	30.22	0.39	26.74
USA	France	0.58	30.80	0.41	27.15
Korea, Rep	Japan	0.55	31.35	0.17	27.32
Korea, Rep	China	0.55	31.90	1.16	28.48
Netherlands	Germany	0.54	32.44	0.40	28.88
Czech Republic	Germany	0.52	32.97	0.77	29.64
Germany	Italy	0.52	33.48	0.58	30.23
Thailand	Japan	0.51	34.00	0.22	30.45
Mexico	China	0.50	34.50	0.01	30.46
USA	UK	0.50	35.00	0.58	31.04
China	USA	0.50	35.50	1.63	32.67
Germany	Hungary	0.48	35.98	0.37	33.04
Belgium	Germany	0.48	36.46	0.28	33.32
Germany	Poland	0.46	36.93	0.53	33.84
France	Italy	0.46	37.39	0.27	34.11
Malaysia	USA	0.45	37.84	0.30	34.41
Poland	Germany	0.44	38.28	0.53	34.94
Hungary	Germany	0.43	38.71	0.57	35.51
Germany	Japan	0.40	39.10	0.16	35.66
Switzerland	Germany	0.39	39.49	0.32	35.98
Singapore	Malaysia	0.39	39.88	0.45	36.43
UK	France	0.37	40.23	0.19	36.62
Singapore	China	0.37	40.63	0.32	36.94

Source: UN Comtrade

3 Literature review

Differences that exist between countries motivate trade, just as differences among individuals force specialisation and exchange. Early international trade theories tend to explain the sources of differences – whether due to differences in factor productivity (David Ricardo) or in factor endowments (Hecksher-Ohlin). Newer trade theories however emphasise similarities between countries to explain the nature of trade. In particular, economies of scales advantages and the desire for greater choices are reasons given for greater intra-industry trade (Helpman and Krugman, 1985; Krugman, 1980). Intra-industry trade is likely to be larger among countries of similar size and factor proportions, as evidenced by trade among Western European countries (Greenaway and Milner, 1986).

3.1 General determinants of bilateral trade

The use of gravity equations has dominated empirical research in international trade. It has been used extensively to estimate various factors affecting bilateral trade – from currency unions (Rose, 2000) to the Dalai Lama effect (Fuchs and Klann, 2013). The general gravity framework theorises that 'the volume of trade between two countries is proportional to the product of an index of their economic size, and the factor of proportionality depends on measures of "trade resistance" between them' (Helpman et al., 2008, p.442). While geographical distance between the two countries is used to capture all kinds of resistance, the tradition of identifying commonalities among countries to explain bilateral trade has been a focus of attention in recent years. The underlying logic behind the reason why countries that are more similar tend to trade more with each other is transaction costs. Bae and Salomon (2010) suggests that various distances among countries – political, regulatory, economic, cultural or cognitive – are manifested in the 'liability of foreignness' (Hymer, 1960) which results in an increase in various costs including coordination, knowledge transfer, labour and legal costs for the trading firm. To minimise this liability, international exchange tends to take place among firms from more similar countries. Thus, countries that share a common border, a common language, a common history (e.g. colonial master), a common currency and a common political system tend to trade more with each other (Frankel et al., 1998). It can be argued however, that these commonalities stem from the similarities in values, behaviour and attitudes (or in a general sense, culture) of the people in the two countries.

Thus, the GDPs and GDP per capita of both partners and the geographic distance between them are the most common determinants of bilateral trade. Other 'trade resistance' factors are added based on the specific focus of various scholars.

3.2 Specific determinants of international trade in parts and components

When examining the specific determinants of trade in P&C, one should expect some overlaps with the general determinants. Based on the theory of trade under imperfect competition, countries would trade more with partners with a larger GDP because of the scale effect (Jones et al., 2005). In addition, GDP per capita also acts as a proxy for the economic depth of countries, which is conducive for international production networks (Grossman and Helpman, 2005; Athukorala and Yamashita, 2006). GDP per capita has also been used as a proxy for the quality of infrastructure in countries – another important

determinant of P&C trade (Egger and Egger, 2005). Geographical distances between countries also represent transportation and time costs, an important variable in vertical trade. Related factors like sharing a common border, language and polity may also be significant as transaction costs can be reduced if partners are able to understand each other more easily (Athukorala and Yamashita, 2006). Thus, the geographic proximity of Japan to China for example, might explain a lower coordination cost for firms from these countries, compared to those incurred by American firms intending to offshore some of their production blocks in China (Dean et al., 2009).

The theory of comparative advantage provides a good basis for locational advantages that a nation may have over another. Relative labour cost is an important determinant of vertical specialisation (Jones, 2000). More specifically, unit labour cost (ULC) which takes into account both wage rates and productivity has been found to be a significant determinant of P&C trade (Yamashita, 2011). The shifting of labour intensive production blocks within the PC industry to East Asian countries in the 1980s for instance, was motivated by an abundant supply of low-wage labour and reasonably priced high skilled engineers (Bonham et al., 2007). Since goods may cross multiple borders in P&C trade, import tariffs influences the extent of trade. Bridgman (2012) proved that falling tariffs are in fact more important in explaining greater P&C trade than falling transportation costs. As such, membership of partners in a common regional trading bloc provides a seamless movement of these goods resulting in trade creation among member countries (Ramasamy, 2011; Yang and Martinez-Zarzoso, 2014). The proposal of an Asian Economic Community which encompasses several key economies in East Asia (ASEAN, Japan, China and South Korea) for instance, would facilitate smoother back and forth trade in P&C. Yamashita (2011) found that the quality of infrastructure (proxied by time involved in trade facilitation) and institutions (proxied by an index of governance) are also significant determinants of P&C trade for the USA and Japan.

As a large portion of P&C trade is among subsidiaries of multinationals, the stock of FDI of one country in another is a good measure of the extent of MNC activity. Görg (2000) for instance found that US FDI in the EU was strongly related to US imports of P&C. Similarly, East Asian exports of PC parts and components have also been influenced by the inward FDI they have received, particularly from Japan, USA and the EU countries (Bonham et al., 2007). Exchange rates movements over time can also reflect cost competitiveness (Soloaga and Winters, 2001) of the exporting country. Ceteris paribus, a depreciating currency reduces the cost of production and promotes more exports of P&C (Yamashita, 2011). However, when evaluating the exports of P&C of East Asian countries, Jongwanich (2010) found the exchange rates to be an insignificant predictor of P&C trade. Since P&C trade may involve more than two countries, the real effective exchange rates (REER) of one country may have to be combined with the REER of other supplier countries to obtain the exact role of exchange rates (Thorbecke, 2011).

In sum, the purpose of an international production network is to reduce costs of production by taking advantage of locational factors that a country provides. Thus, the determinants that act specifically for P&C trade are those that reduce the direct and indirect costs related to the production and movements of P&C across borders.

3.3 Importer–exporter relationship quality

The industrial marketing literature is rich in conceptual and empirical work on a wide range of issues that pertain to buyer-seller relationships (Morgan and Hunt, 1994). The ideas developed at a domestic dyad level have been also extended to importer-exporter relationships by international marketing scholars (Skarmeas and Robson, 2008; Bianchi and Saleh, 2010; Saleh et al., 2013). A common finding that has emerged from these studies is that trust and commitment are essential for a positive outcome in exporter and importer relationship (Samiee and Walters, 2003; Hewett et al., 2002; Walter et al., 2003; Dwyer et al., 1987; Saleh et al., 2013). Trust is widely recognised as a basis for all types of human interactions. In the context of inter-firm relationships, trust is defined as the willingness to rely on an exchange partner in whom one has confidence (Moorman et al., 1993). Trust is created when one party has confidence in the reliability and integrity of their exchange partner (Morgan and Hunt, 1994). Trust influences the success of dyad relationship because it reduces transaction costs, facilitates the investment by the seller in relation-specific assets and motivates the seller to share more information with buyers (Dyer and Chu, 2000; Xie et al., 2010). There are several antecedents of trust with the main ones being opportunism (Morgan and Hunt, 1994; Katsikeas et al., 2009) and cultural distance (Amelung, 1994).

Opportunism is defined as self-interest seeking with guile (Williamson, 1985) and occurs when suppliers withhold critical information, misrepresent facts, apply trickery or take advantage of trading partners (Wathne and Heide, 2000; Williamson, 1985). The opposite of opportunistic behaviour is benevolence. In an importer-exporter relationship, 'an importer's benevolence towards its exporters is the importer's voluntary helping behaviour beyond the call of duty designed to enhance the wellbeing of its exporting partners' (Lee et al., 2008, p.10). The reason for benevolent behaviour could be either altruistic or for mutual gains. Nevertheless, such behaviours are reciprocated by the exchange partner (Lee et al., 2008; Merrilees and Miller, 1999). Thus, an opportunistic (benevolent) importer would engender a lesser (greater) degree of trust from the exporter. National culture has a powerful influence on trust levels among partners (Doney et al., 1998; Zaheer and Zaheer, 2006; Aliyu and Bawa, 2015). Cultural distance, as in the case of international trade literature, negatively affects several aspects of communications between the dyad including information content, frequency and modality (Lee et al., 2008; Dow, 2000). In other words, the liability of foreignness increases with cultural distance and negatively affects that dyad relationship.

Commitment, on the other hand, shows a desire by one party to continue a relationship with its exchange partner (Richey and Myers, 2001), by helping each other out to meet common goals (Lee et al., 2008). Grayson and Ambler (1999) found that the higher the perceived quality of buyer-seller interactions and the greater the supplier's involvement in the buyer's marketing process, the greater the commitment by the buyer to the relationship. Antecedents of commitment include opportunism (Joshi and Arnold, 1997; Skarmeas et al., 2002) as well as transaction specific investment (Skarmeas et al., 2002). Transaction specific investment is similar to asset specificity in the transaction cost theory (Williamson, 1981) in that when one partner invest in assets that are highly specialised such as purchasing equipment for the sole purpose of producing for the partner (Heide and John, 1992), the level of commitment between both parties increases (Skarmeas and Robson, 2008). This is particularly true in the case of international

production networks where firms incur substantial sunk costs in 'identifying location advantages and the strength of business partners, as well as building up reliable links' (Kimura and Obashi, 2011, p.15).

Thus, the three common antecedents to importer-exporter relationship quality that is considered in this paper are opportunism, cultural distance and transaction specific investments.

4 Data and model

In order to estimate the effects of trust and commitment on bilateral P&C trade and non-P&C manufacturing trade, we employed a version of the standard gravity model specified by Gassebner et al. (2010) modified from Rose (2004) to fit the following equation:

$$\begin{aligned}\ln(\text{Trade}_{ei}) &= c + \beta_1 \ln(\text{GDP}_{\text{exporter}}) + \beta_2 \ln(\text{GDP}_{\text{importer}}) + \beta_3 \ln(\text{GDPC}_{\text{exporter}}) \\ &+ \beta_4 \ln(\text{GDPC}_{\text{exporter}}) + \beta_5 \ln(\text{DIST}) + \beta_6 \ln(\text{IF}_{\text{exporter}}) + \beta_6 \ln(\text{IF}_{\text{importer}}) \\ &+ \beta_7 \ln(\text{IQ}) + \gamma'' \text{X}_{ei} + \lambda_1 CD + \lambda_2 \ln(\text{ETH}_{\text{exporter}}) + \lambda_3 \ln(\text{ETH}_{\text{importer}}) \\ &+ \lambda_4 \ln(\text{TSI}_{\text{exporter}}) + \lambda_5 (\text{TSI}_{\text{importer}}) + \text{error}_{ei}\end{aligned} \tag{1}$$

with $\text{error}_{ei} = x_e + m_i + v_{ei}$.

where:

- Trade_{ei} represents the real exports or imports of different trade categories (P&C or non-P&C manufacturing goods) from country e (exporting country) to country i (importing country), deflated by the US GDP deflator;
- $\text{GDP}_{\text{exporter}}$ and $\text{GDP}_{\text{importer}}$ are the two trading countries' real GDP ;
- $\text{GDPC}_{\text{exporter}}$ and $\text{GDPC}_{\text{importer}}$ are the two trading countries' real GDP per capita;
- DIST_{ei} is the geographical distance between the two trading countries' most populated cities;
- $\text{IF}_{\text{exporter}}$ is the exporting country's infrastructure, proxied by the days taken for the exporting country to complete exports procedures.
- $\text{IF}_{\text{importer}}$ is the importing country's infrastructure, proxied by the days taken for the importing country to complete imports procedures;
- CD_{ei} is the cultural distance between the two trading countries;
- $\text{ETH}_{\text{exporter}}$ and $\text{ETH}_{\text{importer}}$ are the two trading countries' business ethics;
- $\text{TSI}_{\text{exporter}}$ and $\text{TSI}_{\text{importer}}$ are the two trading countries' transaction-specific investments;
- X_{ei} is a set of controlling variables comprising the following: a dummy variable taking a value of one if the two trading countries share the same official language (LANG_{ei}); a dummy variable taking a value of one if the two trading countries were in a colonial relationship (COLONY_{ei}); a dummy variable for a common coloniser

after 1945 ($COMCOL_{ei}$); a dummy variable taking a value of one if the two trading countries have an regional trade agreement in force (RTA_{ei}); $CONTIG_{ei}$ is a dummy variable indicating whether the two trading countries share a common border; IQ_{ei} is similarity/dissimilarity in institutional quality between trading countries; and e_{ei} is the error term with x_e representing the export-specific effects, m_i representing the importer-specific effect and v_{ei} representing the remaining errors.

We chose this specification because the core variables of the model have been proven to be very successful in fitting bilateral trade data of different countries across different trade classifications. For instance, Aidt and Gassebner (2010) and Gassebner et al. (2010) use the same specification to analyse general bilateral trade data of 130 and 170 countries, respectively. It proves to be very reliable and does a good job of predicting trade flows in both cross section and time series (McCleery and DePaolis, 2014) In order to ensure that the data collection period for all our variables matched, we averaged the 2008–2009 data. Time-varying variables in equation (1) are the average units of the same period (2008–2009) measured at 2005 constant dollar. Table 3 lists the data sources for each variable. Data was collected for 131 countries with 17,030 possible bilateral relationships. This is a cross-sectional application.

Table 3 Description of variables and data sources

Variables	*Description*	*Source*
$Export\_PC_{ei}$	The average (2008–2009) of total value of P&C exports from the exporting country *e* to the importing country *i* measured at constant (2005) US dollars.	Comtrade
$Import\_PC_{ei}$	The average (2008–2009) of total value of P&C imports from the exporting country *e* to the importing country *i* measured at constant (2005) US dollars.	Comtrade
$Export\_ME_{ei}$	The average (2008–2009) of the total value of manufacturing exports excluding $Export\_PC_{ei}$ from the exporting country *e* to the importing country *i* measured at constant (2005) US dollars.	Comtrade
$Import\_ME_{ei}$	The average (2008–2009) of the total value of manufacturing imports excluding $Import\_PC_{ei}$ from the exporting country *e* to the importing country *i* measured at constant (2005) US dollars.	Comtrade
$GDP_{exporter}$ $GDP_{importer}$	The GDP (average value of 2008–2009) of the exporter and importer measured at constant (2005) US dollars, respectively.	WDI
$GDPC_{exporter}$ $GDPC_{importer}$	The product of the average real GDP per capita (2008–2009) of country *e* and country *i* measured at constant (2005) US dollars, respectively (removed from the fitted equation given the needs for correcting multicolinearity)	WDI
CONTIG	1 = the trading countries share a common border; 0 = otherwise	CEPII
DIST	The geographical distance between the trading countries	CEPII
LANG	1 = the trading countries share a common language; 0 = otherwise	CEPII
COLONY	1 = the trading countries were once in a colonial relationship; 0 = otherwise	CEPII
COMCOL	1 = the trading countries had a common colonizer after 1945; 0 = otherwise	CEPII

Table 3 Description of variables and data sources (continued)

Variables	*Description*	*Source*
RTA	1 = the trading countries have regional trade agreement in force; 0 = otherwise	WTO
IQ	The similarity/dissimilarity in institutional quality between trading countries	WGC
CD	The similarity/dissimilarity in nation culture between trading countries	
$ETH_{exporter}$ $ETH_{importer}$	National ethics of the *exporting country* and importing country , respectively	GCR
$TSI_{exporter}$ $TSI_{importer}$	Transaction-specific investments of *exporting country* and importing country , respectively	GCR

The construction of some important variables is described below.

4.1 Specification of P&C

The values of exports and imports of P&C were calculated using the approach suggested by Yamashita (2011). The approach classifies 291 items at the 5-digit SITC level as P&C items for our analysis. Exports and imports from country *e* to/from country *i* of the selected items were downloaded from UN COMTRADE. The averages values of 2008 and 2009 were named $Exports\_PC_{ei}$ and $Imports\_PC_{ei}$. We also calculated the values of exports and imports of non-P&C manufacturing goods, namely $Exports\_ME_{ei}$ and $Imports\_ME_{ei}$ by subtracting $Exports\_PC_{ei}$ and $Imports\_PC_{ei}$ from the sum of exports and the sum of imports of all goods under SITC 7 and 8, respectively.

4.2 Cultural distance (CD)

We use Kogut and Singh's (1988) index, based on Hofstede's (1980) data on national cultures to measure the cultural distance (CD_{ei}) between an exporter (*e*) and importer (*i*). A large CD_{ei} implies that the national culture of country *e* is very different from the national cultural of country *i*. Kogut and Singh's aggregation has been widely used as a measure of cultural distance and has become the proxy of choice of national cultural differences (Xu and Shenkar, 2002).

4.3 Institutional quality

Institutional quality (IQ_{ei}) is measured by World Bank's Worldwide Governance Indicators (*WGI*). It consists of six broad dimensions of governance: voice and accountability, political stability and absence of violence/terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption. The data captures the views and experiences of survey respondents and experts in both the public and private sectors as well as NGOs. The unobserved components model is used to rescale the variables from –2.5 to 2.5, with higher values indicating better outcomes (see Kaufmann, 2010 for the detailed methodology). We used the average of the six indicators (*IQ*) to proxy the overall institutional quality of the countries included in the analysis and

$(IQ_e\text{-}IQ_i)^2$ to measure the similarity/dissimilarly in the institutional quality between the exporting country *e* and the importing country *i*. In this case, higher values indicate higher dissimilarly in the institutional quality between the trading countries.

4.4 Business ethics (ETH)

We use the average of two question items from the Global Competitiveness Report 2010–2011 (GCR) of the World Economic Forum to construct the measure of business ethics at a national level (*ETH*). The first question compares firms' corporate ethics with emphasis on their ethical behaviour against those of other countries. The second question focuses specifically on the comparison of firms' strength of auditing and reporting standards. While *ethical behaviour of firms* and *auditing and reporting standards* or *the ethics of financial reporting* are closely associated (Enderle, 2004; Sreejesh et al., 2014; Kalbers, 2009; Karaibrahimoglu and Cangarli, 2015), they are both regarded as critical dimensions of corporate governance (NCFFR, 1987; Rockness and Rockness (2006). More importantly, corporate governance and business ethics are intertwined (Tricker and Tricker, 2013). In here, we are using the quality of corporate governance to proxy the ethics of business of a country. The selected question instruments are listed below:

1.16 How would you compare the corporate ethics (ethical behaviour in interactions with public officials, politicians, and other enterprises) of firms in your country with those of other countries in the world? (1 = among the worst in the world; 7 = among the best in the world)
1.17. In your country, how would you assess financial auditing and reporting standards regarding company financial performance? (1 = extremely weak; 7= extremely strong)

ETH_e and ETH_i denote the business ethics of the exporting (*e*) and importing county (*i*), respectively. The measure shows that New Zealand, Sweden, Finland, Singapore, and Denmark are the top five most ethical countries. The 2010–11 report of *GCR* is based on face-to-face interviews (63%) and online surveys (27%) of a total of 12,614 business executives across 133 participating countries carried out during the 2008–2009 period.

4.5 Transaction-specific investments (TSI)

We use the average of four question items from *GCR* to construct the measure of transaction-specific investment (*TSI*) at the country level. The selected question instruments are listed below.

11.02. How would you assess the quality of local suppliers in your country? (1 = very poor; 7 = very good)
11.05. In your country, do you exporting companies have a narrow or broad presence in the value chain? (1 = narrow – primarily involved in individual steps of the value chain (e.g., resource extraction or production); 7 = broad – present across the entire value chain (i.e., do not only produce but also perform product design, marketing sales, logistics, and after-sales services)))

11.07. In your country, how sophisticated are production processes? (1 = not at all – labour-intensive methods or previous generations of process technology prevail; 7 = highly –the world's best and most efficient process technology prevails)
12.01. In your country, how do companies obtain technology? (1 = exclusively from licensing or imitating foreign companies; 7 = by conducting formal research and pioneering their own new products and processes)

Countries that scored high in these areas are likely to be perceived as ideal partners in terms of lower risk owing to greater reliability and are more willing to invest in specific relationships, signalling commitment to existing and potential partners. Countries that topped the list were Germany, Japan, Switzerland, Sweden, and Finland.

Gravity models in similar specifications have been commonly used in the past to identify the determinants of bilateral trade. The model has an excellent empirical fit and is based on robust theoretical foundations (Anderson and van Wincoop, 2003). Nevertheless, it should be noted that the parameters in equation (1) could be estimated by a range of estimators. Egger (2005) evaluated the appropriateness of various estimators for equations with specifications similar to equation (1) and discovered that the OLS is likely to be a biased estimator. It is likely to overestimate the importance of exporter GDP or GDP per capita and underestimate the importance of importer GDP or GDP per capita or vice versa. The fixed effects estimator ignores the parameters of variables that vary only in a single dimension (e.g. exporter GDP or infrastructure in the cross-sectional data). Although the random effects estimator does not yield these shortcomings but it is still a biased estimator when not all unobserved effects are uncorrelated with the regressors. Egger's comparisons concluded that the OLS, fixed and random effects estimators are all unsuitable for cross-sectional gravity applications. The Hausman and Taylor (1981) estimator is recommended for estimating equation (1) as it overcomes the above-mentioned limitations. Egger (2005) has shown that the Hausman–Taylor estimator (HTM) is consistent or at least equivalent to the random and fixed effects estimators. To test the appropriateness of the HTM for our models, the Hausman–Taylor over-identification test is applied to the FEM and HTM specifications. The test statistics for base models (Column A and E of Tables 4 and 5) were all less than the critical chi-squared value at 1% significance. Thus, the null hypothesis that the unobserved effects are correlated with other regressors is not rejected. We conclude that the HTM is a more efficient estimator.

The fitted models with all the r.h.s. variables were checked for the presence of (a) multicolinearity (VIF>5), (b) heteroskedasticity (rejecting the null in the White test) and (c) normality of the error term (by examining the histogram of the error term). Both (a) and (b) were detected but were remedied by removing the GDP per capita variable and by applying White's heteroskedasticity-consistent estimator, respectively. The presence of multicollinearity also forced us to enter CD_{ei}, *ETH* and *TSI* in separate equations. The final fitted models provided very neat specifications after the above remedies. Collectively, the goodness-of-fit for all fitted models were satisfactory, with adjusted R^2 ranging from 48.8% to 52.1%, quite similar to the results in other studies (Athukorala and Menon, 2010; Athukorala and Yamashita, 2008).

5 Results and discussion

Tables 4 and 5 show the results of our estimations. Both the beta and standardised beta coefficients are reported. Column A in Table 4 shows the results of the base model for P&C trade which includes some of the main determinants used by previous authors including GDP of the importer and the exporter, distance, shared features like language, common coloniser, etc. We have also included a dummy for membership in an RTA, a proxy for infrastructure as well as the institutional quality distance between partners. The same determinants have also been used in a separate model using non P&C products (SITC 7 plus 8 minus the 291 SITC 5 digits P&C) as the dependent variable (see Table 5, Column E). Our results for the base model are consistent with the results of previous studies (Gassebner et al., 2010; Nitsch, 2007; Rose, 2000). Briefly, bilateral trade in both P&C and non P&C manufacturing trade are greater when the economic size of the exporter and importer is larger (GDP) and when trading partners are nearer to each other ($DIST_{ei}$ and $CONTIG_{ei}$). Bilateral trade is also influenced by commonalities like a similar language ($LANG_{ei}$) and colonial history ($COLONY_{ei}$ and $COMCOL_{ei}$). The quality of infrastructure is important for both P&C as well as non P&C trade. This is not surprising as both types of trade require efficient movements of goods between locations. Our results show that IF is significantly negative (the lesser the number of days required for trade procedures, the greater the amount of trade). Our results also tend to suggest that the infrastructure of the exporting country is marginally more important for P&C trade.

The institutional quality distance (IQ_{ei}) has a significant negative co-efficient for both types of trade, implying that countries that are more similar in their institutional quality tend to trade more. This determinant seems more important for P&C trade. Finally, membership in a trading bloc also contributes to greater bilateral trade. There is no significant difference between P&C and non P&C goods in this regard.

We now turn to the main antecedents of trust and commitment. Owing to multicollinearity issues, cultural distance, business ethics and transaction specific investments are included in separate models (Columns B-D and F-H). Cultural distance represented by the Kogut and Singh index (CD_{ei}) has a negative co-efficient implying that cultures that are more similar tend to trade more (Columns B and F). In fact, our cultural distance variable is relatively more important than other culture variables like LANG and COMCOL as shown by the standardised betas. In other words, cultural similarity is more important than cultural familiarity in explaining bilateral trade (Linders et al., 2005). As explained earlier, a wider cultural distance increases the liability of foreignness which may lead to difficulties in communication and coordination, not only among subsidiaries of an MNC (Bae and Salomon, 2010) but also between importers and foreign third party suppliers. This may lead to a lower level of trust and commitment between the dyads and adversely affect trade flows.

In our study, the level of business ethics in a country is used as an antecedent of opportunism. Traders with a higher level of ethics can be trusted as they are more likely to be benevolent and/or are less likely to take advantage of the shortcomings of partners. We find that our proxy to be positive and significant indicating that a higher level of business ethics in both the exporting and importing country contribute to greater bilateral trade.

Table 4 Determinants of P&C exports

	Dependent Variable: P&C exports											
	Column A			*Column B*			*Column C*			*Column D*		
	Base Model			*Cultural Distance*			*Ethics*			*TSI*		
Variable	*Beta*	*Std. Beta*	*p-value*	*Beta*	*Std. Beta*	*p-value*	*Beta*	*Std. Beta*	*p-value*	*Beta*	*Std. Beta*	*p-value*
C	–26.078	–0.560	0.000	–29.884	–0.506	0.000	–32.611	–0.561	0.000	–30.750	–0.555	0.000
$GDP_{exporter}$	1.130	0.592	0.000	1.064	0.470	0.000	1.123	0.569	0.000	1.098	0.562	0.000
$GDP_{importer}$	1.163	0.476	0.000	1.282	0.525	0.000	1.145	0.469	0.000	0.934	0.382	0.000
DIST	–1.585	–0.306	0.000	–1.351	–0.260	0.000	–1.601	–0.309	0.000	–1.512	–0.292	0.000
COLONY	0.730	0.021	0.000	0.561	0.016	0.003	0.740	0.021	0.000	0.729	0.021	0.000
COMCOL	0.807	0.051	0.000	0.237	0.015	0.139	0.765	0.049	0.000	0.759	0.048	0.000
LANG	0.993	0.075	0.000	0.887	0.067	0.000	0.961	0.073	0.000	1.129	0.085	0.000
CONTIG	1.510	0.053	0.000	1.270	0.045	0.000	1.514	0.053	0.000	1.572	0.055	0.000
$IF_{exporter}$	–0.930	–0.121	0.007	–0.908	–0.156	0.011	–0.584	–0.079	0.138	–0.514	–0.081	0.196
$IF_{importer}$	–0.817	–0.119	0.000	–0.351	–0.051	0.000	–0.526	–0.076	0.000	–0.130	–0.019	0.027
IQ	–0.092	–0.040	0.000	–0.004	–0.002	0.829	–0.100	–0.044	0.000	–0.096	–0.042	0.000
RTA	0.519	0.039	0.000	0.504	0.038	0.000	0.507	0.038	0.000	0.506	0.038	0.000
CD				–0.239	–0.134	0.000						
$ETH_{exporter}$							2.055	0.083	0.148			
$ETH_{importer}$							1.630	0.063	0.000			
$TSI_{importer}$										2.394	0.108	0.121
$TSI_{exporter}$										3.186	0.163	0.000
N		10208			5997			10208			10208	
Adjusted R^2		0.488			0.509			0.494			0.519	

Table 5 Determinants of non P&C exports

Dependent Variable: Manufacturing exports (P&C exports excluded)												
	Column A			*Column B*			*Column C*			*Column D*		
	Base Model			*Cultural Distance*			*Ethics*			*TSI*		
Variable	*Beta*	*Std. Beta*	*p-value*	*Beta*	*Std. Beta*	*p-value*	*Beta*	*Std. Beta*	*p-value*	*Beta*	*Std. Beta*	*p-value*
C	–21.352	–0.603	0.000	–24.704	–0.575	0.000	–26.416	–0.604	0.000	–26.054	–0.597	0.000
$GDP_{exporter}$	1.023	0.628	0.000	1.013	0.515	0.000	1.056	0.609	0.000	1.031	0.622	0.000
$GDP_{importer}$	1.095	0.497	0.000	1.169	0.531	0.000	1.078	0.489	0.000	0.868	0.394	0.000
$DIST$	–1.442	–0.308	0.000	–1.274	–0.272	0.000	–1.458	–0.312	0.000	–1.371	–0.293	0.000
$COLONY$	0.633	0.020	0.000	0.516	0.016	0.001	0.643	0.020	0.000	0.634	0.020	0.000
$COMCOL$	0.778	0.055	0.000	0.337	0.024	0.015	0.740	0.052	0.000	0.729	0.051	0.000
$LANG$	0.955	0.080	0.000	0.793	0.067	0.000	0.926	0.078	0.000	1.091	0.091	0.000
$CONTIG$	1.363	0.053	0.000	1.115	0.044	0.000	1.367	0.053	0.000	1.423	0.056	0.000
$IF_{exporter}$	–0.821	–0.098	0.019	–0.857	–0.155	0.013	–0.615	–0.083	0.127	–0.458	–0.085	0.264
$IF_{importer}$	–0.912	–0.147	0.000	–0.539	–0.087	0.000	–0.630	–0.101	0.000	–0.234	–0.038	0.000
IQ	–0.052	–0.025	0.000	0.027	0.013	0.063	–0.059	–0.028	0.000	–0.054	–0.026	0.000
RTA	0.417	0.034	0.000	0.433	0.036	0.000	0.406	0.034	0.000	0.403	0.033	0.000
CD				–0.193	–0.119	0.000						
$ETH_{exporter}$							0.730	0.039	0.615			
$ETH_{importer}$							1.573	0.068	0.000			
$TSI_{importer}$										1.839	0.063	0.247
$TSI_{exporter}$										3.127	0.178	0.000
N	9947			5908			9947			9947		
Adjusted R^2	0.496			0.516			0.499			0.521		

Two important points can be seen from our results. First, the level of ethics among importers is generally more important than the levels of their counterparts. In both types of trade, P&C and non P&C, the ethics of the importer is significant at the 1% level. The ethics of the exporter is not significant. Based on our standardised betas, the ethics of the importer is more important than several of the traditional variables used in the past including membership in a common RTA or institutional quality distance. Second, the importance of ethics as a determinant of bilateral trade is equally important in both P&C and non P&C exports.

Among the three antecedents of trust and commitment, transaction specific investment (TSI) is the most important determinant of exports (columns D and H). The inclusion of *TSI* provides the highest incremental adjusted R^2 when compared to the inclusion of *CD* or *ETH*. Standardised beta coefficients show that TSI is more important than all other variables, other than the GDP of the dyads. The TSI of the exporter is clearly more important to trade than his/her importer counterpart. In fact, our results show that none of the importer's TSI variable is significant. This is true for both types of trade. The quality of local suppliers, the sophistication of production processes within the country and the capacity for innovation among domestic businesses adds up to the ability of suppliers to meet the demands of buyers. It shows commitment by the supplier to the business relationship. Thus, it is not surprising that TSI plays a critical role in P&C trade.

6 Conclusion

In this paper, we have drawn on the knowledge from both international economics and international marketing fields to improve our understanding on the determinants of exports, in particular exports of P&C. While international trade economists have been focusing on macro-level variables to assist in policy development, international marketing researchers have been pre-occupied with strategies to improve the relationship between the exporter and importer. Using gravity models, trade economists have confirmed the importance of trade agreements, infrastructure and institutional quality as important determinants of trade (Ramakrishnan and Varma, 2014; Espinosa-Ramírez, 2015). On the other hand, by analysing data at the firm-level, international marketers point to the critical role of trust and commitment among partners as antecedents to a cross border relationship. Indeed, in the present study, both conduits are found to be equally important in enhancing trade relationships. In modelling the export function, we have introduced macro level variables to represent the antecedents of trust and commitment between dyads in a gravity model. Our findings confirm the importance of cultural distance, business ethics and transaction specific investments in a bilateral trade relationship. We find that trust and commitment among partners are equally important in P&C and non P&C trade.

Our findings have important policy implications. First, the crucial role that transaction-specific investments play in bilateral trade, and more specifically in P&C trade, points to the need for policy-makers to invest more in raising the quality of local suppliers so that they would be capable of expanding the breadth of the value chain by increasing the sophistication of the production processes and innovation. This could be supported through tax incentives, investing in human capital development, setting up a quality supplier directory and encouraging capital inflows. This is particularly true for exporters. Although such policies are not new, our findings provide additional support

for such efforts. P&C production and trade is projected to continue to grow over the next two decades (Athukorala, 2001), and it would be futile for policy makers to use restrictive trade policies to interfere with its trajectory. Rather, improving the capacity of local suppliers in terms of capabilities and competitiveness would ensure that more gains are accrued. Second, our findings highlight the importance of business ethics of importers. Thus, improving the level of business ethics among importers can no longer be seen exclusively at a firm level. Efforts at a national level to raise the general standards of ethics become equally important. While eradicating corruption in the public sector has been emphasised in the past, efforts at reducing malpractices, cheating and breaking of contracts among businesses are equally important. To uphold the rule of law would be useful, but educating the business community on its importance by encouraging industry level code of conducts, protecting whistleblowers and the like would also contribute towards a more ethical business community.

The current study is the first of its kind to include trust and commitment of international businesses into an empirical trade model. No doubt, there are limitations. These include the proxies used to represent the new variables. Other important variables like exchange rates and cost of labour have also been excluded from our current model. Moreover, a sufficient length of time series of the main variables of interest is not available to conduct a longitudinal analysis. Future work could address these shortcomings. Our study demonstrates the needs for developing an economic-marketing interdisciplinary approach to revisit our existing puzzles and to move away from the current analytic practices of separation between economic and marketing variables. In the same way, researchers must also pay attention to the development of analytical and modelling approaches of other disciplines.

References

Abdul Aziz, S.N., Allanson, P. and Petrie, D. (2013) 'International production networks: the automobile industry in East Asia', *International Journal of Trade and Global Markets*, Vol. 6, No. 4, pp.356–373.

Aliyu, S.U.R. and Bawa, S. (2015) 'Gravity model by panel data approach: empirical evidence from Nigeria', *International Journal of Trade and Global Markets*, Vol. 8, pp.42–57.

Amelung, T. (1994) 'The impact of transaction costs on trade flows in the Asia-Pacific', in Garnaut, R. and Drysdale, P. (Eds): *Asia-Pacific Regionalism – Readings in International Economic Relations*, Harper Collins, Sydney.

Anderson, J.E. and van Wincoop, E. (2003) 'Gravity with gravitas: a solution to the border puzzle', *American Economic Review*, Vol. 93, pp.170–192.

Ando, M. (2006) 'Fragmentation and vertical intra-industry trade in East Asia', *North American Journal of Economics and Finance*, Vol. 17, pp.257–281.

Arndt, S.W. and Kierzkowski, H. (2001) *Fragmentation: New Production Patterns in the World Economy*, Oxford University Press, Oxford.

Athukorala, P. (2001) *Crisis and Recovery in Malaysia: The Role of Capital Controls*, Edward Elgar Publishing, Cheltenham, England.

Athukorala, P. (2005) 'Product fragmentation and trade patterns in East Asia', *Asian Economic Papers*, Vol. 4, pp.1–27.

Athukorala, P. (2012) 'Asian trade flows: trends, patterns and prospects', *Japan and the World Economy*, Vol. 24, pp.150–162.

Athukorala, P. and Menon, J. (2010) *Global Production Sharing, Trade Patterns, and Determinants of Trade Flows in East Asia*, ADB Working Paper Series on Regional Economic Integration, Asian Development Bank, Manila, pp.1–66.

Athukorala, P. and Yamashita, N. (2006) 'Production fragmentation and trade integration: East Asia in a global context', *North American Journal of Economics and Finance*, Vol. 17, pp.233–256.

Athukorala, P. and Yamashita, N. (2008) 'Patterns and determinants of production fragmentation in world manufacturing trade', in Mauro, F., McKibbin, W. and Dees, S. (Eds): *Globalization, Regionalism and Economic Interdependence*, Cambridge University Press, Cambridge, pp.23–45.

Bae, J.H. and Salomon, R. (2010) 'Institutional distance in international business research', in Pedersen, T.M., Tihanyi, T. and Devinney, L. (Eds): *Advances in International Management: The Past, Present and the Future of International Business and Management*, Emerald, New York, pp.328–349.

Bianchi, C. and Saleh, A. (2010) 'On importer trust and commitment: a comparative study of two developing countries', *International Marketing Review*, Vol. 27, pp.55–86.

Bonham, C.S., Gangnes, B. and Van Assche, A. (2007) 'Fragmentation and East Asia's information technology trade', *Applied Economics*, Vol. 39, pp.215–228.

Bridgman, B. (2012) 'The rise of vertical specialization trade', *Journal of International Economics*, Vol. 86, pp.133–140.

Caporale, G.M., Sova, A. and Sova, R. (2015) 'Trade flows and trade specialisation: the case of China', *China Economic Review*, Vol. 34, pp.261–273.

Child, L., Sapienza, P. and Zingales, L. (2009) 'Cultural biases in economic exchange', *The Quarterly Journal of Economics*, Vol. 124, pp.1095–1131.

Córcoles, D., Díaz-Mora, C. and Gandoy, R. (2014) 'Product sophistication: a tie that binds partners in international trade', *Economic Modelling*, Vol. 44, pp.S33–S41.

Dean, J.M., Lovely, M.E. and Mora, J. (2009) 'Decomposing China–Japan–U.S. trade: vertical specialization, ownership, and organizational form', *Journal of Asian Economics*, Vol. 20, pp.596–610.

Doney, P.M., Cannon, J.P. and Mullen, M.R. (1998) 'Understanding the influence of national culture on the development of trust', *The Academy of Management Review*, Vol. 23, pp.601–620.

Dow, D. (2000) 'A note on psychological distance and export market selection', *Journal of International Marketing*, Vol. 8, pp.51–64.

Dwyer, R.F., Schurr, P.H. and Oh, S. (1987) 'Developing buyer–seller relationships', *Journal of Marketing*, Vol. 51, pp.11–27.

Dyer, J.H. and Chu, W. (2000) 'The determinants of trust in supplier–automaker relationships in the U.S., Japan and Korea', *Journal of International Business Studies*, Vol. 31, pp.259–285.

Dyer, J.H. and Chu, W. (2003) 'The role of trustworthiness in reducing transaction costs and improving performance: empirical evidence from the United States, Japan, and Korea', *Organization Science*, Vol. 14, pp.57–68.

Egger, P. (2005) 'Alternative techniques for estimation of cross-section gravity models', *Review of International Economics*, Vol. 13, No. 5, pp.881–891.

Egger, H. and Egger, P. (2005) 'The determinants of EU processing trade', *World Economy*, Vol. 28, pp.147–168.

Enderle, G. (2004) 'The ethics of financial reporting, the global reporting initiative, and the balanced concept of the firm', in Brenkert, G. (Ed.): *Corporate Integrity & Accountability*, Sage Publications, Inc, Thousand Oaks, CA, pp.87–100.

Ernst, D. (2004) 'Global production networks in East Asia's electronics industry and upgrading prospects in Malaysia', in Yusuf, S., Altaf, M.A. and Nabeshima, K. (Eds): *Global Production Networking and Technological Change in East Asia*, Vol. 476, Work Bank, Washington, DC, pp.89–157.

Espinosa-Ramírez, R.S. (2015) 'Corruption, trade and institutional reforms', *International Journal of Trade and Global Markets*, Vol. 8, pp.127–141.

Frankel, J.A., Stein, E. and Wei, S-J. (1998) *Continental Trading Blocs: Are They Natural or Supernatural? BT – The Regionalization of the World Economy*. Available online at: http://www.nber.org/chapters/c7821.pdf\npapers2://publication/uuid/6361859D-6D65-43E9-9D96-F6F55805BFB8

Fuchs, A. and Klann, N.H. (2013) 'Paying a visit: the Dalai Lama effect on international trade', *Journal of International Economics*, Vol. 91, pp.164–177.

Gassebner, M., Keck, A. and Teh, R. (2010) 'Shaken, not stirred: the impact of disasters on international trade', *Review of International Economics*, Vol. 18, pp.351–368.

Görg, H. (2000) 'Fragmentation and trade: US inward processing trade in the EU', *Weltwirtschaftliches Archiv*, Vol. 136, pp.403–422.

Grayson, K. and Ambler, T. (1999) 'The dark side of long-term relationships in marketing services', *Journal of Marketing Research*, Vol. 36, pp.132–141.

Greenaway, D. and Milner, C. (1986) *The Economics of Intra Industry Trade*, Basil Blackwell, Oxford.

Grossman, G. and Helpman, E. (2005) 'Outsourcing in a global economy', *Review of Economic Studies*, Vol. 72, pp.135–159.

Hausman, J. and Taylor, W. (1981) 'Panel data and unobservable individual effects', *Journal of Econometrics*, Vol. 16, p.155.

Heide, J.B. and John, G. (1992) 'Do norms matter in marketing relationships?', *Journal of Marketing*, Vol. 56, pp.32–44. Available online at: http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=9208310665&site=ehost-live

Helpman, H. and Krugman, P. (1985) *Market Structure and Foreign Trade*, MIT Press, Cambridge, MA.

Helpman, E., Melitz, M. and Rubinstein, Y. (2008) 'Estimating trade flows: trading partners and trading volumes', *The Quarterly Journal of Economics*, Vol. 123, No. 2, pp.441–487.

Hewett, K., Money, R.B. and Sharma, S. (2002) 'An exploration of the moderating role of buyer corporate culture in industrial buyer–seller relationships', *Journal of the Academy of Marketing Science*, Vol. 30, pp.229–239.

Hofstede, G. (1980) *Culture's Consequences: International Differences in Work-Related Values*, Sage, Beverly Hills, CA.

Hymer, S. (1960) *The International Operations of National Firms*, MIT Press, Cambridge, MA.

Jones, R.W. (2000) *Globalization and the Theory of Input Trade*, MIT Press, Cambridge, MA.

Jones, R., Kierzkowski, H. and Lurong, C. (2005) 'What does evidence tell us about fragmentation and outsourcing?', *International Review of Economics and Finance*, Vol. 14, pp.305–316.

Jongwanich, J. (2010) 'Determinants of export performance in East and Southeast Asia', *The World Economy*, Vol. 33, No. 1, pp.20–41.

Joshi, A.W. and Arnold, S.J. (1997) 'The impact of buyer dependence on buyer opportunism in buyer–supplier relationships : the moderating role of relational norms', *Psychology & Marketing*, Vol. 14, pp.823–845.

Kalbers, P. (2009) 'Fraudulent financial reporting, corporate governance and ethics: 1987–2007', *Review of Accounting and Finance*, Vol. 8, pp.187–209.

Karaibrahimoglu, Y.Z. and Cangarli, B.G. (2015) 'Do auditing and reporting standards affect firms' ethical behaviours? The moderating role of national culture', *Journal of Business Ethics*, Vol. 50, pp.13–31.

Katsikeas, C.S., Skarmeas, D. and Bello, D.C. (2009) 'Developing successful trust-based international exchange relationships', *Journal of International Business Studies*, Vol. 40, pp.132–155.

Kaufmann, D., Kraay, A. and Mastruzzi, M. (2010) *The Worldwide Governance Indicators: Methodology and Analytical Issues*, World Bank Policy Research Working Paper No. 5430, World Bank, Washington, DC.

Kimura, F. and Obashi, A. (2011) *Production Networks in East Asia: What We Know So Far*, Tokyo. Available online at: http://www.adbi.org/working-paper/2011/11/11/4792.production.networks.east.asia/

Kogut, B. and Singh, H. (1988) 'The effect of national culture on the choice of entry mode', *Journal of International Business Studies*, Vol. 19, pp.411–432.

Krugman, P. (1980) 'Scale economies, product differentiation, and the pattern of trade', *American Economic Review*, Vol. 70, pp.950–959.

Langlois, R.N. and Robertson, P.L. (1995) *Firms, Markets, and Economic Change: A Dynamic Theory of Business Institutions*, Routledge, London.

Lee, D.J., Jeong, I., Lee, H.T. and Sung, H.J. (2008) 'Developing a model of reciprocity in the importer–exporter relationship: the relative efficacy of economic versus social factors', *Industrial Marketing Management*, Vol. 37, pp.9–22.

Linders, G., Slangen, A.H.L., De Groot, H.L.F. and Beugelsdijk, S. (2005) *Cultural and Institutional Determinants of Bilateral Trade Flows*, Tinbergen Institute Discussion Paper No. 05-074/3, Tinbergen Institute, Amsterdam.

McCleery, R. and DePaolis, F. (2014) 'So you want to build a trade model? Available resources and critical choices', *Economic Modelling*, Vol. 40, pp.199–207.

Merrilees, B. and Miller, D. (1999) 'Direct selling in the west and east: the relative roles of product and relationship (guanxi) drivers', *Journal of Business Research*, Vol. 45, pp.267–273.

Moorman, C., Deshpandé, R. and Zaltman, G. (1993) 'Factors affecting trust in market research relationships', *Journal of Marketing*, Vol. 57, pp.81–101. Available online at: http://www.jstor.org/stable/1252059

Morgan, R.M. and Hunt, S.D. (1994) 'The commitment-trust theory of relationship marketing', *Journal of Marketing*, Vol. 58, pp.20–38. Available online at: http://web.a.ebscohost.com/ehost/detail?sid=9cfad4f2-6aa3-4be8-9411-1dc38f4663cb%40sessionmgr4002&vid=1&hid=4109&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=buh&AN=9408160246

NCFFR (1987) *Report of the National Commission on Fraudulent Financial Reporting*, Committee of Sponsoring Organizations of the Treadway, National Commission on Fraudulent Financial Reporting, Washington, DC.

Nitsch, V. (2007) 'State visits and international trade', *World Economy*, Vol. 30, No. 12, pp.1797–1816.

Ramakrishnan, A. and Varma, P. (2014) 'Do free trade agreements promote intra-industry trade? The case of India and its FTAs', *International Journal of Trade and Global Markets*, Vol. 7, pp.129–144.

Ramasamy, B. (2011) 'Trade liberalization and international production networks: the automotive industry in China', *Fighting Irrelevance: The Role of Regional Trade Agreements in International Production Networks in Asia*, United Nations ESCAP, Bangkok.

Richey, R.G. and Myers, M.B. (2001) 'An investigation of market information use in export channel decisions – antecedents and outcomes', *International Journal of Physical Distribution & Logistics Management*, Vol. 31, pp.334–353.

Rockness, H. and Rockness, J. (2005) 'Legislated ethics: from Enron to Sarbanes-Oxley, the impact on corporate America', *Journal of Business Ethics*, Vol. 57, pp.31–54.

Rose, A.K. (2000) 'One money, one market : estimating the effect of common currencies on trade', *Economic Policy*, Vol. 15, pp.7–46.

Rose, A.K. (2004) 'Do we really know that the WTO increases trade?', *American Economic Review*, Vol. 94, pp.98–114.

Saleh, M.A., Ali, M.Y. and Quazi, A. (2013) 'A comparative study of consumer and B2B goods importers' trust and commitment: evidence from an Asian developing country', *Australasian Marketing Journal (AMJ)*, Vol. 21, No. 2, pp.126–136.

Samiee, S. and Walters, P.G.P. (2003) 'Relationship marketing in an international context: a literature review', *International Business Review*, Vol. 12, pp.193–214.

Skarmeas, D., Katsikeas, C.S. and Schlegelmilch, B.B. (2002) 'Drivers of commitment and its impact on performance in cross-cultural buyer–seller relationships: the importer's perspective', *Journal of International Business Studies*, Vol. 33, pp.757–783.

Skarmeas, D. and Robson, M.J. (2008) 'Determinants of relationship quality in importer–exporter relationships', *British Journal of Management*, Vol. 19, pp.171–184.

Soloaga, I. and Winters, L.A. (2001) 'Regionalism in the nineties: what effect on trade?', *North American Journal of Economics and Finance*, Vol. 12, pp.1–29.

Sreejesh, S., Mohapatra, S. and Anusree, M.R. (2014) *Business Research Methods: An Applied Orientation*, Springer International Publishing, Berlin.

Taguchi, H., Matsushima, D. and Hayakawa, K. (2014) 'The emerging production network in Mekong region', *International Journal of Trade and Global Markets*, Vol. 7, No. 1, pp.18–35.

Thorbecke, W. (2011) 'Investigating the effect of exchange rate changes on china's processed exports', *Journal of the Japanese and International Economies*, Vol. 25, pp.33–46.

Tricker, B. and Tricker, G. (2013) *Business Ethics: A Stakeholder, Governance and Risk Approach*, Routledge, Abingdon.

Walter, A., Müllerb, T.A., Helfertc, G. and Ritterd, T. (2003) 'Functions of industrial supplier relationships and their impact on relationship quality', *Industrial Marketing Management*, Vol. 32, pp.159–169.

Wathne, K.H. and Heide, J.B. (2000) 'Opportunism in interfirm relationships: forms, outcomes, and solutions', *Journal of Marketing*, Vol. 64, pp.36–51.

Williamson, O.E. (1981) 'The economics of organization: the transaction cost approach', *American Journal of Sociology*, Vol. 87, pp.548–577.

Williamson, O.E. (1985) *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting*, The Free Press, New York.

Xie, E., Li, Y., Su, Z. and Teo, H.H. (2010) 'The determinants of local suppliers' trust towards foreign buyers', *Management International Review*, Vol. 50, pp.585–611.

Xu, D. and Shenkar, O. (2002) 'Institutional distance and the multinational enterprise', *Academy of Management Review*, Vol. 27, pp.608–618.

Yamashita, N. (2011) 'Production sharing and trade flows: a comparative analysis of Japan and the US', *Journal of Asian Economics*, Vol. 22, pp.383–397.

Yang, S. and Martinez-Zarzoso, I. (2014) 'A panel data analysis of trade creation and trade diversion effects: the case of ASEAN–China free trade area', *China Economic Review*, Vol. 29, pp.138–151.

Zaheer, S. and Zaheer, A. (2006) 'Trust across borders', *Journal of International Business Studies*, Vol. 37, pp.21–29.

An empirical exploration of Chinese imports and the US steel industry

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Abstract: The paper identifies four key issues concerning the relationship between Chinese imports and the US steel industry: currency manipulation, state-owned enterprises, subsidisation, and environmental regulations. Given these issues, we run a regression to empirically explore the relationship between Chinese imports and US steel prices. We found that Chinese imports have two conflicting effects: one is to lower US steel prices while the other is to increase the prices via China's increasing market share. The overall impact is that Chinese imports increase US steel prices, as the effect due to market share is larger than the demand effect. With these findings, we suggest that, of the four effects considered, Chinese subsidisation is the most crucial.

Keywords: steel industry; international trade; imports.

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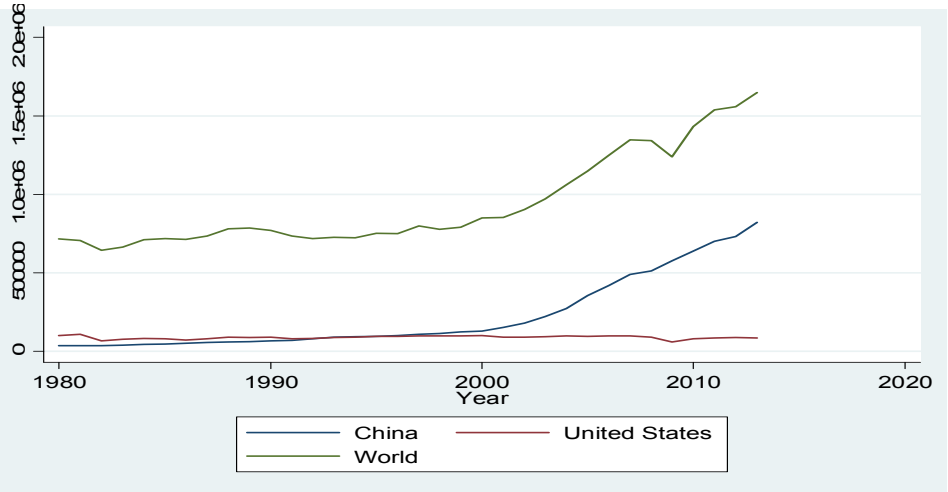
1 Introduction

In this paper, we study the US and Chinese steel industries; it is a relationship that evokes many interesting economic questions. Both empirical and explanatory content will be employed to analyse the relationship between the quantity of Chinese steel imports and domestic US steel prices. An econometric model will be used in an effort to both ascertain the relationship between Chinese steel imports and price levels in the US domestic steel market and to emphasise the importance and relevance of understanding the structure and operation of the Chinese steel industry. The actions and policies of the Chinese steel industry and the Chinese government have significant implications for both the US and international steelmaking communities. Therefore, an understanding of these dynamics is essential for steel manufacturers and policy makers alike.

Figure 1 Crude steel production (1000 tons) (see online version for colours)



Note: Graph drawn from the crude steel production, 1980–2013, at World Steel Association website (http://www.worldsteel.org/dms/internetDocumentList/statistics-archive/production-archive/steel-archive/steel-annually/steel-annually-1980-2013/document/steel%20annually%201980-2013.pdf).

As shown in Figure 1, China is by far the world's largest steel producing country with 779 million metric tons (mmt) of steel produced in 2013 alone, an increase of 7.5% over 2012. By comparison, the USA produced a mere 87 mmt in 2013. The recent global recession did not impact the Chinese economy as severely as it affected the economies of many other industrialised nations. Consequently, the Chinese steel industry suffered less and has recovered more quickly than the steel industries of other industrialised nations. This has created an interesting set of market dynamics. One of the most important of these are concerns regarding chronic oversupply and overcapacity in the Chinese steel industry which has led to controversy over dumping and unfair trade practices. The Chinese crude steel overcapacity problem became acute in 2006, with excess capacity in the amount of 160 mmt (Tang, 2010). This excess capacity has led to much consternation in its destination markets.

This paper is organised into four additional sections. Section 2 reviews the current literature regarding the Chinese steel industry and its implications for international trade. Section 2 will be organised into four subsections dealing with currency manipulation, state-owned enterprises, steel industry subsidisation and environmental concerns, respectively. Section 3 will explain the data and econometric model used in this study. Section 4 will discuss the empirical results of the regression analysis. Section 5 concludes the paper and makes several policy recommendations.

2 Literature review

Owing to the relevance of this issue, a great deal of research has been performed on the Chinese steel industry. In almost every way – structure, organisation, operations, etc. – the Chinese steel industry differs from the steel industries of other countries such as the USA These differences have enormous implications for both steelmaking competitors and purchasers of downstream steel products. This section will analyse the aspects of the Chinese steel industry that impact international trade most significantly while giving a general overview of the research already performed.

Perhaps the most controversial aspect of the Chinese steel industry is the allegation of currency manipulation on the part of the Chinese government. Between 1995 and 2005, the Chinese currency, the RMB or 'Yuan', was pegged to the value of the US dollar at an exchange rate of 8.28 RMB per US dollar. This means that the People's Bank of China (PBOC), the Chinese central bank, would readily buy and sell RMB in exchange for foreign currency at this rate. Price and Nance (2009b) explain, 'By offering holders of foreign exchange an artificially high rate in RMB for [US] dollars, the PBOC provides them with a strong incentive to sell their dollars to the PBOC, rather than using them to purchase goods and services from the U.S. and other countries' (p.7). This fixed exchange rate system worked in tandem with a policy of heavily restricted net capital outflows. The result of these policies was the accumulation of enormous amounts of foreign currency reserves, which facilitated greater control over the RMB's value. In fact, China had accumulated foreign currency reserves in excess of $2.85 trillion by the end of 2010 (Lifei and Yanping, 2011).

In 2005, China announced a significant shift in monetary policy by stating its intention to move towards a floating exchange rate system. Beginning in July 2005, the Chinese allowed the RMB to trade within a broader range, resulting in a rapid 20% appreciation. Many economists and analysts believe, however, that the RMB remains

significantly undervalued. According to the US Department of the Treasury (2009), the RMB has appreciated a cumulative total of 21.2% against the dollar since the 2005 policy shift. Furthermore, despite China's stated intent to implement a floating exchange rate regime, evidence suggests that this is simply not the case in practice. The US Department of the Treasury (2011) has arrived at the following conclusion:

> "China's continued rapid pace of foreign reserve accumulation and the huge flow of capital from the Chinese public to advanced countries that it implies [sic], the essentially unchanged level of China's real effective exchange rate especially given rapid productivity growth in the traded goods sector, and widening of current account surpluses, all indicate that the renminbi remains substantially undervalued." (p.16)

Although the Chinese officially operate a 'managed floating exchange rate regime based on market supply with reference to a basket of currencies', the RMB is actually allowed to float only within a band of values determined by the PBOC (US Department of the Treasury, 2009, p.13). This policy holds vast implications for international trade in all industries, including steel. China seems committed to moving towards a floating exchange rate system only so far as such a policy benefits its own financial interests. Such a system of interventionist economics benefits the Chinese industry by encouraging exports and bolstering domestic production and employment in the wake of fewer imports, but only at the expense of its trading partners.

Another important topic relevant to the Chinese steel industry is the state ownership and control of key businesses and infrastructure. Although precise estimates fluctuate, Price and Nance (2009b) state that the degree of state ownership of the Chinese economy ranges between 35% and 80%, with the Chinese government holding an extraordinary degree of control over the economy by any measure. The Chinese government has a 'controlling interest in the four largest banks, as well as the largest insurance company' in addition to outright ownership of individual companies (Price and Nance, 2009b, p.5). The government uses its ownership rights and influence to direct resources such as investment and credit, which are of particular importance in the steel industry, to preferred businesses and sectors of the economy.

Part of the 2005 reform efforts included the release of an official iron and steel industry development policy by the Chinese government. This policy directs that foreign investors in iron and steel production use domestic suppliers and technology whenever possible, without regard to price considerations (Office of the US Trade Representative, 2011). In 2009, China's State Council issued a new set of industry revitalisation plans, which provided a blueprint for key industries, including iron and steel, considered vital to the overall health of the Chinese economy. The goals of the Steel Industry Revitalisation Plan (Steel Plan) included the modernisation of steel production via technical upgrades and innovation, the control of output and elimination of obsolete production capacity, improved industry structure, and encouraging international expansion while simultaneously maintaining domestic market stability (Tang, 2010). The Steel Plan went so far as to direct actions such as acquisitions and mergers among steelmakers and even the geographic location and relocation of Chinese steel mills. It is difficult to imagine such a system in the USA, where companies are not obligated to submit every detail of their operations to governmental direction and control.

One of the most concerning threats to US steel producers is the persistent overproduction of steel and steel products by Chinese manufacturers, which creates a great incentive for Chinese producers to dump excess product in overseas markets.

China's Steel Plan recognises this problem and consequently includes measures to reduce production to more appropriate levels and eliminate obsolete capacity, stating an intention to reduce steel output to 460 million tons in 2009 (an 8% reduction from 2008) and to incrementally increase production to 500 million tons in 2011. However, China produced over 567 million tons in 2009.This exceeded planned output for 2009 by 23% and was above even the 2011 targets by 13% (Tang, 2010). Such discrepancies between the stated intentions of the Chinese government and the actual outcomes create doubt about the credibility of the Chinese government's stated intentions and/or its ability to meet its own objectives. The Office of the US Trade Representative (2008) explains why China's Steel Plan is of such concern to US steel producers and manufacturers of downstream products:

> "[China's policy] is troubling because it attempts to dictate industry outcomes and involves the government in making decisions that should be made by the marketplace. It prescribes the number and size of steel producers in China, where they will be located, the types of products that will and will not be produced, and the technology that will be used … it represents another significant example of China reverting to a reliance on government management of market outcomes instead of moving toward a reliance on market mechanisms." (p.81)

Many of these Chinese policies appear even more concerning in the light of the commitments made in its Protocol of Accession to the WTO. In this Protocol, the Chinese officials agreed that their government would not influence, directly or indirectly, commercial decisions on the part of state-owned or state-invested enterprises (Office of the US Trade Representative, 2011).

Some state owned enterprise (SOE) reforms have been instituted in recent times and it is true that increasing amounts of control over vital business decisions have been transferred to civilian business managers (Islam and Chowdhury, 1997). However, Islam and Chowdhury (1997, p.277) state that despite movement 'towards a market system, by any measure – productivity, profitability, returns on assets – the state sector remains vastly inferior to the non-state firms'. Why then does the Chinese government retain such tight control over Chinese industry? One must consider the fact that Chinese SOEs are 'an integral part of the social welfare system as roughly a quarter of the population depends on the health and housing benefits derived from SOE employment' (Islam and Chowdhury, 1997, p.278). Chinese industrial firms are chronically overstaffed, and privatisation of these companies would likely have serious ramifications in the form of large-scale bankruptcies and unemployment (Islam and Chowdhury, 1997). So, not only does the Chinese government benefit financially from its ownership of industrial enterprises, but it also uses them as an integral component of the social welfare system, the collapse of which could have catastrophic consequences for a huge number of the country's workers.

Chinese citizens realise this too, as Matthews (2009) reports that efforts to close inefficient steel mills and consolidate excess production capacity led both local and regional governments and Chinese workers to protest the expected loss of jobs and tax revenue. In a nation such as the USA, inefficient firms would simply be driven out of business by natural market forces, but the Chinese government continues to intervene in these situations, essentially propping-up inefficient industries through various forms of government aid and intervention which are unavailable, even unthinkable, to businesses in free market countries.

A third major concern relating to the Chinese steel industry is the provision of various forms of subsidies to favoured industries and companies by the Chinese government. Price and Nance (2009b, p.9) relate that the Chinese government regularly directs state owned banks to 'lend funds to favoured enterprises at interest rates well below market rates, even when the borrower may not be creditworthy'. This sort of intervention in the lending sector extends as far as outright write-offs of non-performing loans and debt forgiveness, tax rebates to government owned steel manufacturers for investment purposes, and direct infusions of funds (Taube and Schmidkonz, 2009). To give just one example, Taube and Schmidkonz (2009) relate:

> By 1998, many companies had become unable to service their loans. As a consequence, on the one hand, the Chinese government encouraged larger state-owned enterprises to cut back their workforce in order to improve efficiency levels and avoid bankruptcy. On the other hand, authorities appointed 46 steel companies to be regrouped or merged while another 18 steelmakers were chosen to go bankrupt. In the context of this policy initiative, *a write off of non-performing loans amounting to 2.6 billion Yuan RMB became necessary* [emphasis added] (p.79).

In another striking example, the Chinese government *guaranteed* that the price of Shanghai Baosteel's stock would not dip below 4.53 RMB, thus creating the incentive for investors to buy the government-backed shares (Taube and Schmidkonz, 2009). Largely because of political desires to maintain solid employment levels, the Chinese government often provides state-owned companies with financing that keeps them from going bankrupt. This financing is usually administered in the form of new equity infusions in return for more shares in a company, and the conversion of loans by state-owned banks and investment companies into equity (Price and Nance, 2009b). It is also common to observe the Chinese government directing mergers or acquisitions in which the acquiring company is not made to pay, or is made to pay very little, for the assets it receives (Price and Nance, 2009b).

The Chinese government additionally provides assistance with land and production inputs. Price and Nance (2009b) explain that the Chinese government essentially owns and controls all land in the country, and may distribute it however it desires. Taube and Schmidkonz (2009, p.85) relate, 'Many Chinese steel mills never had to pay any real prices for the land they are operating their facilities on'. This land was simply distributed to them by the government under the central planning regime. Furthermore, the government controls water and electricity supplies in the country, and gives Chinese steel producers priority access to these vital inputs at greatly reduced rates (Taube and Schmidkonz, 2009). Hence, Chinese steel producers have a decisive cost advantage over foreign competitors in these areas.

The Chinese government also provides favourable tax incentives for its domestic steel producers including 'preferential income tax rates, discounts on corporate income tax, tax privileges for operations in central and western China, tax benefits for technology development, tax benefits for using 'waste resources", and tax exemptions' (Price and Nance, 2009b, p.13). In an effort to discourage the exportation of certain vital products and natural resources, China denies VAT rebates for selected products. Price and Nance (2009a) explain that the denial of VAT rebates for certain products of particular importance to Chinese domestic industry is a less obvious way to tax exports:

> "By denying VAT reimbursement, as China has done for various raw materials, it is less advantageous to export a product as compared to selling it domestically … by denying VAT reimbursement for exports of coke, for example, China encourages its use to produce steel products in China, which may be eligible for a VAT rebate when they are exported." (p.7)

A final type of subsidy provided by the Chinese government relates to the provision of critical raw material inputs like coke and other rare earth metals that are necessary components of the steel production process. Nearly 91% of the crude steel produced in China comes from integrated mills, which use iron ore as their primary charge. This means that Chinese steel production is extremely dependent on the supply of key earth elements, especially iron ore. Because Chinese production of iron ore is not sufficient to meet domestic demand, the difference (more than 50%) must be imported (Tang, 2010). This situation is further complicated by the fact that domestic Chinese iron ore deposits consist largely of 'low-grade hematite ores with high impurities and relatively low iron content between 30% and 35%. Iron ore from Brazilian or Australian mines, by comparison, offers average iron content between 55% and 65%' (Tang, 2010, pp.9–10).

As could be expected, China has taken a very aggressive attitude towards the acquisition of steelmaking raw materials worldwide, including both iron ore and other rare earth elements essential to the steelmaking process (Tang, 2010). This has great implications for integrated steel producers worldwide as China continues to tighten the global supply of these key production inputs. Integrated producers in the USA should be especially concerned. While the USA was once able to keep pace with domestic demand using domestically produced rare earth elements, it is now heavily dependent on imports, more than 90% of which are supplied by China (Tang, 2010). China has been steadily increasing export taxes and tightening export quotas for rare earth elements since 2005. July 2010 brought news that China would reduce these export quotas by 72% in the second half of the year, worsening the situation for global producers (Tang, 2010).

China restricts exports of products such as 'antimony, bauxite, coke, fluorspar, indium, magnesium carbonate, molybdenum, rare earths, silicon, talc, tin, tungsten, yellow phosphorus and zinc, all of which are of key interest to US producers of downstream products' (Office of the US Trade Representative, 2011, p.69). China has official quotas for many of them (Price and Nance, 2009a). For example, China imposes a 10% export tax on steel scrap and a 40% export tax on coke, both products being key inputs in the steel production process (Price et al., 2008). These export taxes are specifically designed to 'encourage exports and … Subsidize domestic downstream industries' (Price et al., 2008, p.11). By limiting exports of these products through various means, China artificially deflates the domestic prices of these materials and gives a competitive advantage to Chinese producers. This situation distorts trade and this distortion is further aggravated by the fact that China is the world's leading producer of most of these rare earths (Office of the US Trade Representative, 2011). This of course makes obtaining these materials more costly for competing foreign steel producers that require these inputs.

This situation is compounded by the Chinese government's willingness to help domestic steel producers acquire overseas assets and access to foreign raw material supplies. Price and Nance (2009b) give examples of Chinese state owned enterprises buying significant foreign deposits of rare earth metals used as inputs in the steel production process, particularly in Australia. The government has publicly committed itself to assisting state owned companies to purchase foreign resource assets (Price and

Nance, 2009b). When one considers that the goal of Chinese policymakers is and has always been to benefit Chinese industry irrespective of the costs to other countries in terms of international trade implications, it becomes clear that China will continue to make it both difficult and expensive for foreign competitors to obtain these resources.

Another critical issue is the Chinese environmental policy and enforcement. One of the most expensive aspects of steel manufacturing in developed countries like the USA is environmental compliance, and the conspicuous absence of comparable Chinese regulation gives Chinese steel producers an enormous cost advantage over foreign competitors (Price and Nance, 2009b). Environmental laws are in force in China, however they are generally far more lax and weakly enforced, if they are enforced at all (Price and Nance, 2009b). Again, steel output demands and the maintenance of the social welfare role of even grossly polluting steel companies often provide a strong disincentive to environmental responsibility. According to the Alliance for American Manufacturing (2009, p.45), 'For existing facilities, the current US [environmental] standard is more than six times as stringent as the Chinese standard, and more than 14 times as stringent in the case of new facilities'. Measurements of the actual emissions of Chinese steel producers reveal pollution levels several times above maximum allowable levels in the USA, and, in one case, reached as much as 'eight times the U.S. limit for existing sources and twenty-five times the U.S. limit for new sources' (Alliance for American Manufacturing, 2009, p.45).

Chinese steel producers simply have no incentive to bring their emissions levels into compliance with existing domestic regulations, let alone meet the relatively stringent environmental standards of developed foreign countries. If China does not change its environmental stance, then Chinese companies will continue to operate without the burden of environmental compliance costs. This obviously creates a formidable advantage for Chinese producers. Price and Nance (2009b, p.21) explain that US steel manufacturers have been estimated to 'spend twice as much per ton of steel on environmental protection as their Chinese counterparts do'. Without the burden of environmental compliance costs, Chinese steel manufacturers are able to leverage an even greater advantage over their international competitors.

The balance of the relevant literature on the subject indicates that Chinese steel producers do benefit from an artificially depreciated currency value, state-owned enterprises and resources, government subsidies, and weak environmental laws. These issues are of critical interest to US steel manufacturers, as it means that they are competing not only with their Chinese steel producing counterparts, but also with the vast resources of the Chinese government itself. Such competitive dynamics can hardly be considered fair trade. On the contrary, they stand in opposition to principles of international trade based upon comparative advantage and thereby reduce total gains from trade. Much of the literature suggests that many of these issues could be resolved if the Chinese government would simply adhere to its own promises, as well as to its binding World Trade Organization (WTO) obligations. With no substantial compliance efforts being observed on the part of the Chinese government, other industrialised steel producing nations need to pay particular attention to enforcing existing national and international trade laws.

3 Model and data

The objective of the model is to evaluate the relationship between the quantity of Chinese steel imports and US domestic steel prices in an effort to determine to what extent domestic prices are influenced by Chinese competition. This will have implications for the overall US steel industry because domestic steel producers will be affected as domestic prices fluctuate in response to Chinese imports. US prices may also affect Chinese exporters who will respond to changing prices by increasing or decreasing their flow of goods into the USA. If Chinese steel imports play a significant role in US markets, then US producers have reason to be concerned about the nature and operation of their Chinese counterparts, and the issues discussed in Section 2 will therefore become even more relevant. The following model will be employed to examine the relationship between imports of Chinese steel products and the price of comparable domestically-produced steel products in US markets.

$$\begin{aligned} Steel\ Price_t = {} & \beta_0 + \beta_1 IM\ China_t + \beta_2 \left(IM\ China / IM\ World \right)_t \\ & + \beta_3 Scrap_t + \beta_4 Coal_t + \beta_5 Zinc_t + \beta_6 TWI_t + \varepsilon_t \end{aligned} \tag{1}$$

where:

- *Steel Price* is the real iron and steel mills price index,
- *IM China* is the quantity (in kilograms) of Chinese steel imports, HTS classification 7227,
- (*IM China/IM World*) is the ratio of the quantity of Chinese steel imports, HTS classification 7227, to the total quantity of imports from the world, HTS classification 7227,
- *Scrap* is the is the real carbon steel scrap price index,
- *Coal* is the real price of metallurgical (coking) coal,
- *Zinc* is the real price of zinc,
- *TWI* is the trade weighted exchange index for the US dollar,
- β is a vector of coefficients, and
- ε represents the omitted influences on the gross and is assumed to be well behaved.

The steel price index (*Steel Price*) was obtained from U.S. Bureau of Labour Statistics. The quantities of both Chinese and world steel imports into the USA (*IM China* and *IM World*) were obtained from the U.S. International Trade Commission's *DataWeb* service. Given that the increased import quantities shift the domestic supply curve outward causing equilibrium price to fall, it is expected that *IM China* would have an inverse (negative) relationship with the dependent variable, US steel price index. We have included (*IM China/IM World*), the ratio of Chinese imports to world imports (HTS classification 7227) in order to ascertain the dynamics that reflects the market share or market power of the Chinese imports in the US steel market. As the market power of the

Chinese imports strengthens with the ratio *IM China/IM World*, we expect that there would be a positive relationship between the ratio and the US steel prices, *ceteris paribus*.

The price of metallurgical (coking) coal (*Coal*) was obtained from Energy Information Administration (EIA) of the U.S. Department of Energy while the scrap price index (*Scrap*) was obtained from U.S. Bureau of Labour Statistics. Zinc price (*Zinc*) was obtained from Index Mundi. They were selected because each is a key input in the steelmaking process. Scrap is the ferrous base material used to charge electric-arc furnaces. Coal is a key energy input in the production process. Zinc is a key metal input used in the production process and can be considered representative of other similar inputs such as manganese, chromium, aluminium, etc. Fluctuations in any of these variable prices are expected to have a positive relationship with the dependent variable.

Finally, the trade weighted exchange index (*TWI*) was obtained from the Federal Reserve Bank of St. Louis' website (Federal Reserve Economic Data, FRED). *TWI*, a weighted average of the foreign exchange value of the US dollar against a subset of the broad index currencies including the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia and Sweden, reflects import dynamics in steel imports more applicably.

All price data, i.e. *Steel Price, Scrap, Coal, Zinc*, are deflated by CPI, and all data sets are covered between January 1996 and June 2014.

4 Empirical results

The estimates of the multiple linear regression model using the ordinary least squares (OLS) method on the data set are shown in Table 1. Consistent with expectations, β_1, the coefficient of the variable of particular interest (*IM China*), is shown to have a negative and statistically significant effect (at the 1% level) on the dependent variable. Thus, an increase in the imports of Chinese steel of HTS classification 7227 decreases the US domestic price of the steel product. It shows that every million tons of Chinese steel imported into the USA has lowered the US steel price index, on average since 1996, directly by 0.256. However, its *direct* impact on the US steel price index has been offset by the growing market power of the Chinese imports proxied by (*IM China/IM World*). The coefficient of (*IM China/IM World*), β_2, which has a statistically significant (at the 1% level) effect on domestic price, shows that the US steel price index increases by 0.247 as the Chinese import share increases by 1%.

Given these opposing effects on the US steel price index, we calculate the quantity elasticity of the US steel price as below to capture the *overall* impact of the Chinese imports:

$$\begin{aligned}\frac{\partial \ln\left(Steel\ Price_t\right)}{\partial \ln\left(IM\ China_t\right)} &= \left(\frac{\partial\, Steel\ Price_t}{\partial\, IM\ China_t}\right)\left(\frac{IM\ China_t}{Steel\ Price_t}\right) \\ &= \left(\hat{\beta}_1 + \frac{\hat{\beta}_2}{IM\ World_t}\right)\left(\frac{IM\ China_t}{Steel\ Price_t}\right)\end{aligned} \tag{2}$$

Table 1 Regression result

Variables	*Coefficient*
Import China	–2.56E-09*** (6.48E-10)
Import China/import world	0.247*** (0.056)
Scrap	0.093*** (0.012)
Coal	0.081** (0.037)
Zinc	0.008*** (0.001)
TWI	–0.001 (0.001)
Constant	–0.551*** (0.078)
Observation	222
R^2	0.818

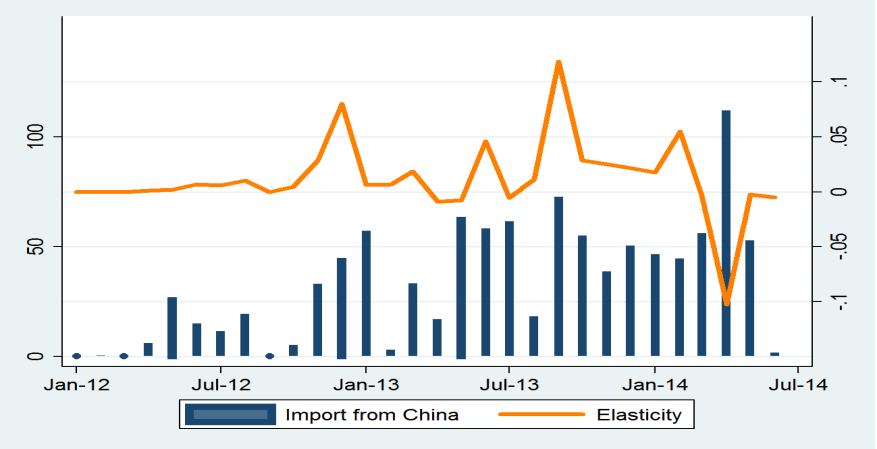
Notes: Standard errors in parenthesis.

*** denote statistically significant at level of 10%, 5% and 1%, respectively.

Figure 2 shows the recent trend of the imports from China and its *overall* impact on the US steel price index. From the figure, we compile two findings. First, contrary to conventional wisdom that increased Chinese imports would lower the US steel price, the overall impact of Chinese imports on the US steel prices shows the opposite – during most of the period from 2012 to 2014, US steel prices increase with increases in Chinese imports. The results indicate that the impact from the growing market share of the Chinese imports has been slightly larger than the *direct* impact from Chinese imports, resulting in the increase in US steel prices. We consider this finding plausible in that, given the productive capacity of the US steel industry, an increase in the demand has been met by Chinese imports. This has increased the market power of the Chinese steel industry. Second, although the overall impact of the Chinese imports was positive most of time, the magnitude is small, ranging from 0.12 to –0.1. This indicates that an increase in Chinese imports of 1% has limited influence on the US steel prices (a small 0.12% increase or 0.1% decrease). This implies that the US steel market is still competitive, allowing the Chinese imports to be substituted by other competitors, i.e. Korea or Japan.

Consistent with expectations that steel prices increase as input prices increase, the price of scrap (β_3) and the price of zinc (β_5) have a positive and statistically significant effect (at the 1% level) on the domestic price of steel. An increase in coal price (β_4) also increases the US steel price index, but its impact is not statistically significant. Although the exchange rate is not statistically significant, an increase in the nominal exchange rate between the USA and other major trading partners plays a role in lowering US steel prices as the US price of imported products drops.

Figure 2 US steel price responses to import from China (see online version for colours)



5 Conclusion

This paper analyses the structure, composition and effects of the Chinese steel industry in the international marketplace. Particular attention is paid to the implications of these issues for international trade in general and the international steelmaking community in particular. The hypothesis that the actions and policies of the Chinese steel industry do significantly affect the USA and the international steel industry was tested empirically. It therefore follows that an understanding of these dynamics is essential for steel manufacturers and governments alike.

Using OLS regression analysis, we compile two main findings. The first finding is that Chinese imports have two conflicting effects on the US steel prices: one is to directly lower the price of the US steel while the other is to increase the price of the US steel price via the larger Chinese market share. The overall impact of Chinese imports on the US steel price has been positive as the impact of increased market power is larger than the demand effect of the direct importation of cheap Chinese steel. The second finding is that the overall impact of the Chinese imports is small and limited as the US steel market remains largely competitive.

Based on the findings of this study, we draw some policy implications. First, as evidenced by the impact of market share, the over-capacity of the Chinese steel industry has a serious impact on the US steel market. China's over-capacity not only drives out her competitors, but also strengthens the market power of the Chinese steel industry. Thus, it is important not only to maintain the competitiveness in the imports of steel products to the USA, but also to delve into the issues that were addressed in the introduction, i.e. environmental regulations in China as well as the subsidies to the Chinese steel industry. Second, as evidenced by our regression results, the nominal exchange rate itself may not be crucial to the US steel industry although the issue is crucial to more general trade problems between the USA and China. Thus, for its own sake, the US steel industry may have to focus more on the subsidies as the subsidy issue

is the one of main causes of Chinese over-capacity in steel production. While it may have been domestic Chinese issues that motivated the subsidies, the results have serious consequences for the global steel market.

References

Alliance for American Manufacturing (2009) *An Assessment of Environmental Regulation of the Steel Industry in China*, Taube Report, Washington, DC.

Islam, I. and Chowdhury, A. (1997) *Asia-Pacific Economies: A Survey*, Routledge, London, UK.

Lifei, Z. and Yanping, L. (2011) 'China's currency reserves rise to record, domestic lending exceeds target', *Bloomberg News*, p.1. Available online at: www.bloomberg.com/news/2011-01-11 (accessed on 6 April 2011).

Matthews, R. (2009) 'China takes a hard look at its steel industry', *The Wall Street Journal*, 13 October, p.B1.

Office of the US Trade Representative (2008) *2008 National Trade Estimate Report on Foreign Trade Barriers*, Office of the US Trade Representative, Washington, DC.

Office of the US Trade Representative (2011) *2011 National Trade Estimate Report on Foreign Trade Barriers*, Office of the US Trade Representative, Washington, DC.

Price, A.H., Brightbill, T.C., Weld, C.B., Capito, C.L. and Morgan, R.E. (2008) *Raw Deal: How Governmental Trade Barriers and Subsidies Are Distorting Global Trade in Raw Materials*, Wiley, Washington, DC.

Price, A. and Nance, D. (2009a) *Export Barriers and Global Trade in Raw Materials: The Steel Industry Experience*, Wiley, Washington, DC.

Price, A. and Nance, D. (2009b) *Rebalancing the U.S.–China Economic Relationship: A Steel Industry Perspective*, Wiley, Washington, DC.

Tang, R. (2010) *China's Steel Industry and Its Impact on the Unites States: Issues for Congress*, Congressional Research Service Report, Washington, DC.

Taube, M. and Schmidkonz, C. (2009) *The State-Business Nexus in China's Steel Industry: Chinese Market Distortions in Domestic and International Perspective*, Think! Desk China Research and Consulting, Munchen, Germany.

US Department of the Treasury, Office of International Affairs (2009) *Report to Congress on International Economic and Exchange Rate Policies*, Washington, DC.

US Department of the Treasury, Office of International Affairs (2011) *Report to Congress on International Economic and Exchange Rate Policies*, Washington, DC.

Appendix 1 Descriptive Statistics

Variable	*Obs*	*Mean*	*Std. Dev*	*Min*	*Max*
Steel Price Index	222	142.745	37.08826	94.1	237.6
$Import_{China}$ (thousand ton)	222	5,697	16,200	0	112,0
$Import_{World}$ (thousand ton)	222	24,300	6,072	6,414	60,300
$Import_{China}/Import_{World}$	222	0.1945216	0.5405444	0	2.89304
Scrap	222	305.0509	164.4161	106.1	743.1
Coal	222	85.14595	45.74805	37.7	201.6
Zinc	222	1,610.249	780.6001	748.81	4,381.45
TWI	222	86.575	11.79901	69.0236	112.1958