Preferential trading agreements and the gravity model in presence of zero and missing trade flows:

Early results for China and India

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Abstract

The two most populous countries of the world have embarked upon an extensive array of preferential trading agreements in recent decades. This paper investigates the impacts on trade creation and trade diversion of China's and India's 11 major preferential trade agreements using an augmented gravity model that takes into account zero and missing trade flows in the data, employing a Zero Inflated Negative Binomial (ZINB) regression model as suggested in the recent literature by Burger et.al (2009) and Kohl (2012). By examining the impacts on exports and imports of preferential trading agreements with their respective trading partners over time, the paper reveals asymmetries, lessons and implications for ongoing efforts towards economic integration that have ramifications for the wider Asian continent and for world trading patterns.

Keywords: Trade creation; Trade diversion; Distance; Trade agreements

JEL Classification: F15; R12

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1. Introduction

With the continued stalemate in multilateral trade negotiations involving the WTO, countries around the world at different levels of development have been aggressively exploring the "second-best" option of bilateral/regional trade liberalization through Preferential Trade Agreements (PTAs), which are discriminatory by nature as they allow preferential treatment only between member countries whilst leaving member countries to follow their own trade policies against non-members. This trend has been particularly pronounced in Asia since the Asian financial crisis in 1997, which sparked off a bilateral PTA between Singapore and New Zealand in 2001. Since then, this trend has proliferated rapidly to include members of the ten-member Association of Southeast Asian Nations (ASEAN) grouping, as well as Australia, China, India, Japan and Korea[1], also known as the ASEAN+6 and is likely to be sustained and growing in the near future.

The above has been geared primarily with the objective of Asian economic integration, wherein PTAs can promote market-driven integration through a comprehensive coverage ranging from liberalization and facilitation of trade in goods, services, and investments. Policymakers in Asia believe that well designed and implemented FTAs have the potential to deepen trade and investment linkages both bilaterally and regionally among these economies. Several studies argue that the current proliferation of regionalism is driven by "competitive liberalization" and a tariff complementary effect", where country utilizes one PTA to reduce (or prevent) trade diversion from the other PTAs (Bagwell and Staiger , 1997; Baier et. al , 2011).

There exists a reasonable body of empirical literature attempting to analyze the impact of these PTAs in Asia-Pacific, but very few of them focus on ASEAN+6 economic grouping[2] that

[1] According to a latest study by Kawai and Wignaraja (2009), there were nearly 54 FTAs concluded within these countries, with 78 more in the stage of negotiations or discussions.

[2] ASEAN+6 refers to the 16 member regional grouping comprising of the ten-member Association of Southeast Asian Nations (ASEAN), China, India, Japan, Korea, Australia and New Zealand, which was formed in 2005, and is

includes both India and China, two of the major emerging economies in the world, who are also currently in negotiations towards creation of a Regional Comprehensive Economic Partnership (RCEP) in November 2012[3], thereby creating potentially the world's largest PTA yet. A majority of these studies have either used applied general equilibrium modelling or the gravity model of bilateral trade for this purpose, one of the most recent study being Sen, Srivastava and Pacheco (2013). However, most gravity models have been estimated without adequate attention to the model specification and the issue of including zero trade values as a dependant variable, which has the potential to create inconsistent results in the traditional log linear OLS approach (Burger, et.al 2009; Kohl, 2012).

This paper estimates an augmented gravity model by adding dummy variables separately for PTA-specific country pairs that are either part of a regional bloc, or outside of it involving all trading partners of India and China among the ASEAN+6 countries over 1984-2009. This paper contributes to the existing literature on Asian Economic Integration and application of the gravity model in a number of ways. First, this paper attempts to model economic integration by considering all trading partners of India and China including those with zero or missing trade flows which has been rarely attempted before in the empirical literature, with most empirical studies attempting to only include trading partners with positive trade flows such as Baier and Bergstrand (2007), Vicard (2011) and Sen et.al (2013). Magee (2008) considers zero trade flows in his study of trade creation and trade diversion of PTAs but restricts them to WTO members only over 1980-1998. Second, this paper incorporates the Poisson Pseudo Maximum Likelihood (PPML) and the negative binomial (NB) methods to estimate the zero trade flows in the data, including the Zero-inflated negative binomial (ZINB) version hitherto not attempted by empirical studies specifically in the India-China context, or broader context of Asian Economic Integration. Apart from Kohl (2012) who applied NB and ZINB methods to revisit the role of WTO in creating trade post Rose (2004), Magee (2008) is the only other study so far that estimates the trade creation and trade diversion effects of regional trade agreements on bilateral trade flows controlling for country pair, importer-year, and exporter-year fixed effects incorporating a PPML estimation. Finally, the paper attempts to analyse the intra-bloc and extra-bloc effects of 11 individual PTAs, including 7

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presently attempting to create one of the world's largest PTA by starting negotiations towards creation of a Regional Comprehensive Economic Partnership (RCEP) in November 2012.

[3] See *http://www.asiaone.com/News/AsiaOne%2BNews/Asia/Story/A1Story20121022-378928.html*

regional ones on China and India's bilateral exports and imports respectively, which has also never been attempted before in the existing literature. In particular, the inclusion of the Asia-Pacific Trade Agreement (APTA) PTA dummy is an important contribution of this study as this is the only regional PTA in Asia that currently includes membership of both India and China, with the RCEP still under negotiation.

The remainder of this paper is organized as follows. Section 2 reviews the trends in PTA proliferation among these countries over the period under study. Section 3 reviews the empirical literature on the use of the gravity model for measuring the trade creating and trade diverting effects of PTAs. Section 4 describes the econometric approach and the data. Results and policy implications are discussed in Section 5, followed by conclusions in Section 6.

2. Trends in PTA proliferation among ASEAN+6 members

Table 1 presents a list of PTAs involving ASEAN+6 members enforced over the 1975-2009 period. It can be observed that out of 38 such PTAs, 30 were purely bilateral. The oldest one among the regional agreements was the Asia-Pacific Trade Agreement (APTA) which has been in force since 1976 and is a PTA on selected goods[4]. Although China acceded to APTA in 2001, India and Korea were founding members.

(Table 1 about here)

Among the bilateral PTAs, the Australia-New Zealand Closer Economic Relations (CER) is the earliest one having been in force since 1983. There has been a proliferation of bilateral PTAs since 2001 beginning with the bilateral PTA involving New Zealand and Singapore, a trend that has intensified in its pace over the past decade. Some countries have two or more PTAs with the same trading partner, one being bilateral and the other being regional in scope. Most bilateral PTAs of ASEAN+6 came into force post-2003, and they are still evolving in terms of their impact on stimulating bilateral trade and investment linkages since the coverage of some of them are being extended from goods only to include services and investment flows.

[4] See http://www.unescap.org/tid/apta.asp for more details on the APTA agreement.

Lee and Park (2005) observe in the East Asian context that this rapid rise of new regionalism, besides aiming to enhance market-driven integration, is a reaction to the creation of other regional blocs, viz. NAFTA and the EU, due to a "domino effect" of the fear of being left out (Baldwin, 1993). As a regional bloc, ASEAN has been an attractive PTA partner, with China, Korea, Japan, and more recently India, Australia and New Zealand enforcing their regional PTAs with the ten-member Southeast Asian countries. On a bilateral basis, while Singapore has been the leader in entering into PTAs, other members of ASEAN+6 are catching up fast. It is also observed that cross-regional PTAs are increasing in number, with members of other regional blocs (e.g. NAFTA) entering into bilateral PTAs with ASEAN+6 members, viz. the US-Singapore FTA and more recently, the attempts to expand the Trans-Pacific Partnership (TPP) agreement to 9 members including the United States[5]. While the EU did not have a bilateral or regional PTA partner in the ASEAN+6 countries until 2006, has since embraced PTAs fairly rapidly, and currently has a working FTA with Korea, and Singapore, and is in the process of negotiations with India among other ASEAN+6 members.

The above implies that the process of bilateral and regional trade liberalization in ASEAN+6 is evolving rapidly, and becoming increasingly complicated as PTAs expand both intra-regional and extra-regional trade. Thus, it is very important to understand why the effect of PTAs on trade creation (creating intra-bloc trade post PTA) or trade diversion (reducing extra bloc-trade post-PTA) might vary between major member countries of ASEAN+6, viz. India and China when all its trading partners (including former ones) are considered. It is also important to analyse these asymmetries taking into account zero and missing values in the trade data, which has not yet been sufficiently addressed in the India-China or ASEAN+6 context.

[5] See Petri,, et. al. (2011)

3. Literature Review

When analyzing the impact of PTAs as overall trade creating or trade-diverting, understanding the magnitude of these effects and why it varies across different countries is critical (Krueger, 1999; Adams et al (2003); Soloaga and Winters (2001)). Majority of studies to date have examined the impact of PTAs on bilateral trade flows of member countries by measuring to what extent it reflects trade creation (i.e. due to elimination in distortions between the relative prices of domestic goods and those of other members) or to what extent it reflects trade diversion (i.e. due to the introduction of distortions between the relative prices of member and non-member goods) employing gravity model, with the results being mixed subject to the size of the sample, the time period, the specification of the gravity equation and the particular PTAs considered (Polak, 1996;. Eventt & Keller, 2002).

Lee and Park (2005) argue that if a PTA has stronger trade diverting than trade creating effects then it could become a stumbling block for global free trade. However, the evidence is mixed and open to debate as some studies find that PTAs expand intra-bloc trade, while contracting output and trade in non-member countries. Two approaches have largely been followed in the literature. The first is that of simulations using an applied general equilibrium model of trade, which generally observes that there are positive welfare effect of PTAs on members measured in terms of real GDP or equivalent variation and a net trade-creation effect, with possibilities for trade diversion with non-members[6]; these results are often influenced by the model's underlying assumptions and the method of estimation. Further, this indicative approach emphasizes the potential trade creation and trade diversion effects that may not be actually realized due to slow implementation or compliance costs.

[6] See Robinson and Thierfelder (1999), Panagariya and Dutta-Gupta (2001) and Lloyd and Maclaren (2003). In the context of East Asia that includes some ASEAN+6 members, see Scollay and Gilbert (2001) and Urata and Kiyota (2003).

The second approach has been to use the gravity model of bilateral trade. The gravity model of bilateral trade is based on the idea that trade between two countries is a function of economic mass and distance. This model was first analyzed by Tinbergen (1962) and Poyhonen (1963) for estimating bilateral trade flows between some European countries. Studies such as Anderson (1979), Bergstrand (1985), Sanso *et al*. (1993), Matyas (1997, 1998) and Anderson and van Wincoop (2003) have improved upon its theoretical foundations and these models have been applied by several recent empirical studies including Sharma and Chua (2000), Lee and Park (2005) and Pusterla (2007) in the Asian context. The standard gravity model's explanatory variables, such as economic size and common language or currency, are expected to have a positive effect on bilateral trade, while greater distances between countries are expected to yield a negative effect.

Aitken (1973) was the first study to include a dummy variable to estimate the effect of a PTA that takes a value of one if the two trading countries are both members of the same agreement and zero otherwise, with a positive coefficient on this variable indicating that PTAs tend to generate more bilateral trade among their members and are trade-creating for members. Similar studies applying a gravity model to estimate the effect of a PTA include Frankel (1993) and Braga *et al*. (1994).

A number of more recent studies building upon this set of literature have delved further into this issue and estimated the effect of trade creation and trade diversion due to the existence of PTAs; see, for instance, Bayoumi and Eichengreen (1997), Frankel (1997) and Frankel and Wei (1998). These studies added another dummy variable, representing extra-bloc trade, which takes the value of one for the bilateral trade between a PTA member and a non-member country. Hence, the coefficient for this 'extra-bloc trade' indicates the degree of trade-diverting effects of the PTA. These studies have largely observed that PTAs tend to increase trade between members and the rest of the world, and thereby foster greater trade worldwide, indicating they are more of a building block. However, Dee and Gali (2003) control for some unobservable factors for nontrade provisions of PTAs and find that that 12 of 18 recent PTAs have diverted more trade with non-members than they have created among members, and it is particularly apparent when the analysis is extended beyond the trade in goods.

The formation of PTAs can have a different effect on trade for different country-pairs. A number of arguments suggest that such differences may be related to the (relative) levels of development of PTA partners, as measured by their per capita income. In particular, differences in per capita income may represent differences in tastes, as suggested by Linder (1961) Alternatively, differences in per capita income across countries may be interpreted as differences in capital-labour ratios (see for example, Helpman and Krugman 1985). Similar arguments can be employed when considering the level (or product) of trade partner's per capita income: Trade partners with a higher product of per capita income may benefit to a greater extent due to their higher level of development and having a higher demand for differentiated products, or because their higher capital-labour ratios result in greater trade in differentiated products. Globerman (1992) argues however that the formation of a PTA between country-pairs with dissimilar per capita income especially in the context of developing countries would benefit from the powerful stimulus toward rationalisation of production provided by free trade, owing to high levels of industrial concentration and potential economies of scale that remain unexploited. Further, Martincus and Estevadeordal (2009) argued that reducing MFN tariffs is associated with increasing production specialisation. They found that that bilateral preferential trade liberalisation (as measured by MFN applied tariff) and differences in the degree of unilateral openness (using ten Latin American countries over the period 1985–1998), have resulted in increased dissimilarities in manufacturing production structures across countries.

The introduction of country-pair fixed effects is emphasized in the literature to control for unobserved country-pair heterogeneity. The literature suggests (Cheng and Wall 2005; Cheong et al, 2012), that if left unaccounted, PTA coefficients tend to be biased upward because they are likely to capture trade creation that is not specifically PTA related, but instead due to unobservables created by prices and the influence of FTA among other countries on the trade from i to j.[7]

Empirical literature on the gravity model specification and estimation issues continues to be refined. While Polak (1996) suggested caution in the use of absolute bilateral distance due to the introduction of misspecifications in the model, Dhar and Panagariya (1999) added that the use of total trade as a dependent variable in a pooled data across countries can also be problematic. Following Cheong et.al (2012), using bilateral imports as the dependent variable avoids bias induced from averaging trade flows. Further, dropping GDP variable from gravity model is suggested in some studies including (Baier and Bergstrand, 2007) as it might introduce potential endogeneity bias created by simultaneity[8].

Baier & Bergstrand, (2007) have further contributed to the understanding of the potential biasin cross-section gravity models caused by endogeneity of the FTA dummy variable; they argue that ccountries select endogenously into FTAs, and are possibly correlated with the level of trade. They utilize panel data with bilateral fixed and country-and-time effects or differenced panel data with country-and-time effects as opposed to previous studies by Baier and Bergstrand (2002, 2004b) and Magee (2003) that employ instrumental variables with cross section data to observe that traditional estimates of the effect of FTAs on bilateral trade flows have tended to be underestimated by as much as 75–85% and that, on average, an FTA approximately doubles two members' bilateral trade after 10 years. This study however, did not address the treatment of zero or near zero trade flows in the estimation process.

[7] Studies using cross-section data relies on estimations using instrumental variables and Heckman control functions, whereas with panel data, fixed effects and first differencing were employed.

[8]GDP being a function of net exports is potentially endogenous to bilateral trade flows (see Frankel and Romer, 1999). To account for this, GDPs taken on the LHS of the regression specification, PX_{ij}/, GDP_i (GDP_j), where PX_{ij} is the value of the merchandise trade flow from exporter i to importer j, GDP_i (GDP_j) is the level of nominal gross domestic product in country i (j), $DIST_{ij}$ is the distance between both country I and j.

Vicard (2011), adopting a similar econometric approach extended the measurement of membership in PTAs by measuring several characteristics of PTAs and member countries by including interaction terms between the dummy for PTA membership and the country characteristics of both the pair of member countries and all other members of the PTA. They further estimated the effect of the creation and enlargements of NAFTA and the European Union (EU) on different pairs of member countries. They observed that the size and distribution of GDP, between PTA members are important determinants of whether an RTA increases bilateral trade. The study observed that bilateral trade through RTAs are likely to expand much more when the two countries are large and symmetric and other RTA members are small and asymmetric. Therefore, the presence of large third countries in an RTA reduces bilateral trade creation, as it is likely to reduce the competitive advantage granted by tariff reduction. Notably, even this study also did not address the treatment of zero or near zero trade flows in the estimation process.

Quite often, a country may trade very little with its trading partner or even not at all in certain years resulting in zero or near zero trade flows in country pairs of the gravity equation with presence of heteroscedasticity. While some studies tend to ignore these trade flows, it can lead to misspecification[9]. With zero trade flows as a dependant variable, log-linear estimation of traditional or augmented gravity models using OLS is inappropriate.

Kohl (2012) suggests five ways to deal with zero trade flows in the data for estimation purposes using a dataset of 181 countries over the period 1948-2007. His study observes that ZINB MLE estimation increases the trade creating effect for WTO members far greater than suggested by Rose (2004). The first step would be to drop all observations with zero trade "flows" but that is at the cost of ignoring a large amount of trade data in the model[10]. Secondly, one can increase all zeros by a small constant, but when zero values are not randomly distributed, biased results are likely[11]. A third approach is to use a Tobit procedure but Santos

[9] The issue of zero trade flows has been dealt with in other studies such as Eichengreen and Irwin (1995) , Felbermyer and Kohler (2004).

[10] See Rose, 2004; Subramanian & Wei, 2007; Tomz et al., 2007

[11] See Bosker, (2008).

Silva and Tenreyoro (2006) argue that this method assumes homoskedasticity and normality that are also likely to yield biased results compared to OLS.

Santos Silva and Tenreyro (2006) provided a fourth approach to modelling zero trade flows and demonstrated that heteroskedasticity is present in both the traditional gravity equations of Tinbergen (1962) and Anderson and van Wincoop (2003), and then observed that the Poisson Maximum Likelihood (PML) estimation method yields more robust estimates than the OLS approach. Their study established that the PML estimator coefficients on GDP are not close to 1 and are much smaller. Further, the study argues that application of OLS methods will generate results that greatly exaggerate the roles of colonial ties and geographical proximity in a log-linearized gravity model. Further studies such as Siliverstovs and Schumacher (2009) and Herz & Wagner (2011) confirmed that a non-linear multiplicative Poisson specification of the gravity model such as the Poisson quasi maximum likelihood estimation (QMLE) performed better than traditional OLS estimates of a log-linear gravity equation.

However, a drawback of standard Poisson models is the assumption of equidispersion, which requires that the conditional mean and conditional variance are equal, which may not hold in case of excessive zeros in the trade data. Thus, the fifth approach to modelling zero trade flows in the gravity equation was suggested by Burger et. al (2009) who observed that Zero Inflated Negative Binomial (ZINB) estimation, which is a modification of the poisson MLE model based on the theoretical framework proposed by Hilbe (2007) is a better alternative to standard poission model, that has shortcomings owing to the problems of overdispersion.[12] The zero-inflated model theoretically considers two different kinds of zero-valued trade flows: i) countries that never trade and ii) countries that do not trade now but potentially could in the near future. Burger, et.al (2009) argues that zero-inflated models allow

[12] The Poisson Regression model only accounts for observed heterogeneity. However, not correcting for unobserved heterogeneity (that originates from omitted variables) results in inefficient estimation of the dependent variable (Greene, 1994). Since the conditional variance is most often higher than the conditional mean(given Poisson model assuming equidispersion), which means that the dependent variable is overdispersed. To deal with this, a negative bionomial regression model is most frequently used, as a modification of the Poisson regression model.

for the possibility of detaching the trade probability from the trade volume[13]. This paper follows the work of Burger *et al*. (2009) applying the zero inflated negative binomial estimator and comparing the results with other suggested methods as is standard in the literature.

Before embarking upon the empirical analysis using trade data, it would be useful to consider some data problems that one would encounter using UN COMTRADE Database, the most commonly utilized resource for bilateral trade data across developed and developing countries. As demonstrated by Yeats (2011), the 'reporting system' used for compilation of COMTRADE statistics suffers from seriously mis-stating dutiable import values, and also failing to correctly identify the goods facing trade restrictions. This occurs on account of two different methodologies that are used for compiling import statistics, namely, the general and special recording systems. Since COMTRADE database relies on general trade statistics, it has major shortcomings for analyses of trade restrictions[14], a caveat that needs to be noted. This could be particularly more serious for countries that involve a significant amount of trans-shipment in their trading activities, viz. Singapore and Hong Kong, both of which play a vital role in trade involving India, China and other ASEAN+6 members.

4. Empirical Specification and Data

4.1 Data

The present study analyzes the determinants of pair wise real trade flows (exports and imports in constant 2000 US dollars) for India and China with all other countries over the 1984-2009 period. All trade data are sourced from the United Nations Commodity Trade database (UNCOMTRADE..

[13] Cameron & Trivedi (2009, p. 316) show that the Poisson quasi-MLE is capable of providing consistent estimates even in the case of overdispersion (provided that the conditional mean function is correctly specified,) the more important question is whether excess zeros are modelled correctly.

[14] According to the study by Yeats (2011), the' general trade compilation' procedure used for COMTRADE may greatly amplify the detrimental effect of the Valuation bias. This is due to the fact that the U.N. records tabulate information on products entering a country's geographic territory, but may fail to record relevant information on the nature and value of the goods actually clearing customs. This problem occurs when imports experience significant transformation in foreign trade zones and then clear customs under a different HTS code than that recorded in COMTRADE. Thus, due to these special import provisions, general trade statistics could severely bias the results for analyses relating to tariffs and other trade barriers.

This is so because the notwithstanding the potential for import valuation bias as noted by Yeats (2011), it is by far the most comprehensive and internationally comparable bilateral trade dataset available, and widely used for gravity model estimations.

Real income is measured using the real value of GDP (in constant 2000 US dollars) and observations are drawn from the World Bank's World Development Indicators (WDI). Bilateral distance, common border and common language variables are taken from CEPII's distance database[15]. The total number of observations constitute an unbalanced panel of 11,354 observations (6649 for India and 4705 for China). Notably, a number of these observations include China and India's trade with "Former" trading partners that later either unified into a single country (e.g. Germany, Vietnam, Yemen, Panama) or broke up into smaller newer trading nations (e.g. Yugoslavia, Czechoslovakia, Soviet Union or USSR post-1991). Nearly 51% or 5,824 observations are recorded as "zero" when real exports are calculated, while about 60% or 6,823 observations are recorded as "zero" when real imports are calculated, justifying the importance of adopting an estimation approach that takes into the bias created by "excessive zeros' in the trade flows, as argued earlier in Section 3.

Merged into the above panel data set are a set of 22 PTA dummy variables. These consist of 11 pairs of Trade creating (TC) and trade diverting (TD) dummies. The TC dummies take a value equal to 1 if a pair of countries are trading partners within a PTA in a particular year, and equal to 0 otherwise. The TD dummies take a value equal to 1 if only one of a pair of countries is a PTA member in a particular year, and equal to 0 otherwise. The 11 sets of TC and TD dummies correspond to trade creation and trade diversion effects of memberships in eight major PTAs involving China, India and their major trading partners, viz. APTA, AFTA, ACFTA, CECA, SAFTA, USSFTA, AUSFTA, CER, NAFTA, EU and MERCOSUR (Appendix 1). All PTA dummies are specified according to their year of enforcement (and not signing), as enforcement may not immediately occur after signing. 7 of these are regional PTAs, while the remaining four are bilateral PTAs. Bilateral PTAs enforced post-2006 are not considered for separate analysis of

[15] See http://www.cepii.fr/anglaisgraph/bdd/distances.htm

Trade creation and Trade Diversion effects as gestation period of three years is considered too short to appropriately estimate a post-PTA effect in this model.

4.2 Econometric approach

A number of considerations strongly influence our econometric approach. First, our dependent variables, the real values of exports and imports (both in constant 2000 US dollars), are bounded from below at zero. To deal with the problem of overdispersion and excess zeros in the dependent variable of the trade data, the NB and ZINB regression models are estimated. However, following Burger et.al (2009), we compare these with the PPML regression results.

Our dependent variable is a non-negative count string of data. All three estimators typically require count data, and we round our raw data to fulfil this requirement, although Woodridge (2002) suggests that the Poisson estimator can present useful results when the data are non-negative continuous observations. We apply random effects to capture trading partner country specific time invariant effects, consistently incorporate exposure using time and apply inflation in the ZINB using data on the trading country's population. Using count data throughout permits the consistent use of incidence rate ratios, and these have been presented in the tables along with each coefficient's standard errors and indicators of statistical significance.

As analysed by Kohl (2012), NB Maximum Likelihood Estimation (NB MLE) is appropriate to model overdispersed data, but it may predict fewer zeros for a given mean value of trade than the actual number of observed zeros in the data. This is particularly the case if there is an excessive number of zeros in the dependent variable, in this case real exports or real imports, in which case a ZINB variant of the MLE model is estimated, which is a two-part model with the density function:

$$g\ (T_{ijt}) = f_1\ (0)+(1-f_1(0))\ f_2\ (0)\ \text{if}\ T_{ijt} = 0\ ;\ (1-f_1(0))\ f_2\ (T_{ijt})\ \text{if}\ T_{ijt}\geq 1 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Wherein f_1 represents a binary function that is estimated with logit regression. f_2 represents the second part of the model that is a count process that estimates the model with poisson or NB splitting trade values into zero and non-zero groups. When outcome of logit is zero, the trade flows (exports or imports) T*ijt* for country i, trading partner j and time period t are zero ($T_{ijt}=0$) with probability f_1 (0), and when its 1 with probability f_1 (1), they take on count values from the second part[16].

Another useful feature of NB and ZINB models is that they include an overdispersion parameter, α. If α = 0, the conditional mean is equal to the conditional variance and a standard Poisson model is the most appropriate fit. However, if α > 0, there is evidence of overdispersion in the data and the NB is preferred to Poisson. However, to determine whether the NB or ZINB is more appropriate, a Vuong (1989) test is conducted. It is noted that positive Vuong z-statistics suggest that ZINB MLE is preferable to the NB MLE model.

The basic model specification for the ZINB MLE gravity model is

$$T_{ijt} = \beta_0 \times \beta_1 Hit \times \beta_2 Pjt \times \times \beta_3 Dij \times \beta_4 Comborder_{ij} \times \beta_5 Comlangij \times \beta_6\ TCAll_{ijt} \times \beta_7\ TDAll_{ijt} \times e_{ijt} \quad \text{……………………………………………………………..(2)}$$

Wherein Tijt refers to the count or occurences of trade flows (either exports or imports) from/to country i to/from country j at time t, Hit refers to the home country (country i's GDP[i] at time t), Pjt refers to the partner country (country j's GDP at time t), Dij refers to the distance between countries i and j, and Comborder and Comlang refers to the control variables for Common language or Common border shared between the two countries. Apart from these variables in the standard gravity model, the above augments the model by adding two dummy variables capturing the trade creation (intra-bloc) and trade-version (extra-bloc) effects for all trading partners of India and China over 1984-2009, for all the 41 PTAs listed in Appendix 1. TCAll refers to the trade creation dummy variable for all these PTAs, wherein $TCAll_{ijt}$ takes a value 1 if both countries i and j are a member of any of those 41 PTAs at time t and 0 otherwise. TDAll refers to the trade diversion dummy variable for all these PTAs, wherein $TDAll_{ijt}$ takes a value 1 if either countries i or j are a member of any of those 41 PTAs at time t and 0 otherwise.

[16] See Kohl (2012) and Cameron and Trivedi (2009) for further details on the ZINB specification.

The above model is estimated using Poisson, NB MLE and ZINB MLE regression methods following Burger et.al (2009) and Kohl (2012), after all converting to real values and their logarithms. The Likelihood Ratio tests for $\alpha=0$ helps decide whether NB MLE model is a better fit, and further, the Vuong test results provide inference on whether ZINB model is an appropriate fit for the above models.

However, the above model does not provide any further insight into the trade-creation or diversion due to specific bilateral or regional PTAs. Hence the above model is further augmented in the next stage of the estimation incorporating 11 PTA specific C dummies for creation and D dummies for trade diversion for APTA, AFTA, ACFTA, CECA, SAFTA, USSFTA, AUSFTA, CER, NAFTA, EU and MERCOSUR respectively. As an example APTA-C_{ijt} measures the effect of being a member to APTA and takes the value one if the *j*th country is a member to APTA with country *i* at time *t*, and zero otherwise. APTA-D_{ijt} measures the effect of either country not being a member of APTA and takes a value 1 if either country i or j is a member to APTA at time *t*, and zero otherwise. Thus, India is a current member in APTA, CECA and SAFTA, while China is a current member in APTA and the ACFTA, so APTA-C_{ijt} gets a value 1 when country i and j are India and China, but APTA-D_{ijt} gets the value 0 for the same pair at the same time period.

Once again, the Likelihood Ratio tests for $\alpha=0$ helps decide whether NB MLE model is a better fit, and further, the Vuong test results provide inference on whether ZINB model is an appropriate fit for the above augmented gravity model with 22 specific PTA dummies (11 each for C and D dummies).

5. Results and policy implications

The above estimations provide six set of regression results each for India and China's exports and imports respectively. Tables 1 and 2 present the results for India's exports and imports, while Tables 3 and 4 present the same for China. All results are reported in terms of Incidence Rate Ratios or IRRs as regression coefficients have to be interpreted as the difference between the log of expected counts in a NB or ZINB MLE model. The IRR measures this difference as log of the ratio of expected counts. The IRR estimates rate ratio for a one unit increase in the independent variables, given the other variables are held constant in the model. An IRR greater than 1 indicates a positive impact and a possible increase in the rate of count of the dependent variable, while an IRR <1 suggests a possible decrease in the rate of count of the independent variable.

It is clearly observed upon comparison of the results for PPML, NB and ZINB gravity models applied to Indian and Chinese exports and imports across Tables 1 -4 that the LR test for $\alpha=0$ is significant, which suggests that the Poisson results are inferior compared to the NB MLE models. Further, the Vuong test statistics in all Tables are positive and significant, suggesting that the NB model results are inferior compared to the ZINB model. This provides additional evidence to the existing literature by Burger et.al (2009) and Kohl (2012) that presence of zero trade flows cannot be ignored in a a gravity model estimation, and can provide biased results. The results also point out to the fact that if there are excess zeros in the dataset, overdispersion is likely and ZINB model provides better estimates of the effectiveness of the gravity model compared to Poisson and NB MLE when applied to the regionalism context.

Tables 1 and 3 presents the results for India and China's exports. Focussing first on the results for the ZINB model without PTA specific dummies (column 6), it is observed that the IRR for home country GDP is significant and greater than 1 for both India and China, but the effect of a one unit increase in home country GDP on the exports is stronger for China (2.145), compared to that for India (1.519). However, the IRRs for the effect of an increase in the partner country GDP was significant and almost of equal magnitude (2.064 for India and 2.104 for China). Further, it is also observed that the distance decay effect is almost non-existent for both China and India's exports with the IRR being equal to 1 and significant, which questions the relevance of its inclusion in standard log-normal gravity model specifications, and supports earlier findings by Santos Silva and Tenreyoro (2006). Common Border and Common language effects are largely positive and significant as expected, with Chinese exports likely to increase more than 10 fold due to the presence of a common language, while that for India is likely to increase 1.7 times.

The most interesting results are observed for the aggregate effects of the 41 PTAs on India and China's exports. Comparing Tables 1 and 3, the results in column 6 for All-C and All-D suggests Chinese exports were more likely to be net trade creating while India's exports were more likely to be net trade diverting due to an All-D IRR of 0.692 (suggesting a decrease in exports by a rate of 1/0.692 or 1.445 times which is not only more significant, but also greater than 1.265 times increase for India suggested by the All-C IRR.

Tables 2 and 4 presents the results for India and China's imports. Focussing first on the results for the ZINB model without PTA specific dummies (column 6), it is observed that the IRR for home country GDP is significant and greater than 1 for both India and China, but the effect of a one unit increase in home country GDP on the imports is also stronger for China (2.129), compared to that for India (1.544). Similarly, the IRRs for the effect of an increase in the partner country GDP was significant and greater for China (2.562) compared to 2.027 for India. Further, it is also observed that the distance decay effect is almost non-existent for both China and India's imports as well with the IRR being equal to 1 and significant. Common Border effects are not found to be significant for Indian imports, with Chinese imports likely to increase more than 5.6 times due to the presence of a common language, while that for India is likely to increase 1.1 times.

The most interesting results are observed for the aggregate effects of the 41 PTAs on India and China's imports. Comparing Tables 2 and 4, the results in column 6 for All-C and All-D suggests Chinese imports were more likely to be net trade creating while India's imports were unlikely to be affected by the PTAs as suggested by the insignificance of the All-C and All-D IRRs.

Preferential trading agreements effects

As the focus of this study is on the trade agreements of India and China, it would be astute to focus the majority of our results description on the estimated effects of PTAs on export or import counts and whether these have created more trade among members or diverted trade among non-members. We approach these trade agreement issues in turn. These results are summarized for exports and imports in Tables 5 and 6 respectively, where a + signifies a statistically significant IRR>1 due to trade creation/diversion and a X signifies an associated drop in trade due to IRRs being statistically significant but <1. To indicate the relative magnitudes of these effects and for clarity in interpretation we emphasise these effects by inserting either more +s or Xs in accordance with the strength of the effect.

Trade Creation effects

It is expected that the efficiency gains through trade creation can be enhanced from establishing PTAs with the largest possible grouping of countries that have a higher share of pre-PTA trade and a non-uniform pre-PTA tariff structure. China and India have been members of APTA post-2001, China has been a member of the ACFTA involving AFTA members, while India has been a member of the bilateral CECA with Singapore since 2005, and the regional agreement SAFTA involving its South Asian neighbours since 2006. Hence, trade creation effects are likely to be present only among these 4 PTAs.

APTA is found to generate significant net trade creation on exports for India, which indicates that such efficiency gains have been reaped through this PTA. This can be confirmed further from column 7 of Table 1 wherein APTA-C IRR for India's exports is 1.433 which is greater than and more significant than (1/0.890) or 1.123 decline in the rate of export count due to APTA-D. Similarly for China (Table 3, column 7), APTA-C IRR for China's exports was 3.031, which was greater than APTA-D IRR (1.697), suggesting that China also experienced a net trade creation in its exports due to APTA membership.

However, on the import side, APTA-C IRR for its imports (1.735) , while greater than APTA-D IRR (1.647), was observed to be statistically less significant, suggesting that net trade creation for Chinese imports was weaker than that for its exports due to this PTA. Given that APTA is a PTA on only a few albeit strategically important goods covering less than 20-25% of total value of bilateral trade among their members, the above results suggests potential for stronger trade creation through APTA for both India and China if they were to extend the coverage of APTA to all goods traded.

It is notable that simple management process under regional agreements such as APTA have helped to reduce the negotiation cost significantly, thereby improving the overall efficiency gains (Laird, 1999; Summers, 1991). APTA has so far adhered to a simple, common Rules of

Origin with minimum local value content requirement of 45 per cent f.o.b. (35 per cent for LDCs). Further, a set of operational procedures for the certification and verification of the origin of goods was adopted in October 2007, for the first time among developing countries in the region[17], which may have also contributed to the strong net trade creation on the export side.

ACFTA membership is observed to also generate a significant net trade creation on exports for China, with its ACFTA-C IRR (2.849) being of a higher value than ACFTA-D (2.701). However, membership in CECA or SAFTA do not suggest to have significantly impacted on India's exports or imports count, which may not be surprising given that only 5 years of post-PTA trade data have been analysed in this dataset.

Trade diversion effects

Trade diversion effects in the context of this study largely estimate the positive or negative effects of India and China's trade with extra-bloc regional PTA members in NAFTA, EU, MERCOSUR, CER and two other recent bilateral PTAs involving the US (the US-Singapore FTA (USSFTA) and the Australia-US FTA) wherein both India and China are non-members. A + sign in Tables 5 and 6 suggests that exports and/or imports with these extra bloc-member countries have increased in spite of their PTAs not including India or China, in which case the trade diversion impact is not serious. However, a × sign suggests that exports and/or imports with these extra bloc-member countries have decreased due to their PTAs not including India or China as members. Some interesting results are observed.

It is observed that APTA reduced India's exports to the extra-bloc member countries by a rate of 1.123. However, India's imports and China's exports and imports continued to grow in spite of these extra-bloc PTAs. In the case of AFTA, positive extra-bloc trade effects are observed for China's exports and imports, while for India these are observed to be insignificant, suggesting no evidence of trade diversion for India's exports or imports due to AFTA. This implies that

[17] See www.**unescap**.org/tid/**apta**/factsheet08.pdf

creation of AFTA as an extra-bloc for India and China did not reduce their bilateral trade with AFTA members, i.e. the ten-member ASEAN countries of Southeast Asia.

However, the enforcement of the ACFTA (in which China was an intra-bloc member and India was a non-member) seems to have reduced India's exports and imports count by a rate of 1.597 and 1.069 respectively, although this effect is statistically significant for India's exports only. In contrast, the enforcement of the SAFTA (in which India was an intra-bloc member and China was a non-member) seems to have reduced both China's exports and imports count by a rate of 2.65 and 26.32 respectively, suggesting that Chinese imports suffered a strong trade diversion due to this regional PTA. Once again, it needs to be qualified here that this result may be biased by the fact that only 4-5 years of post-PTA trade data has been analysed for ACFTA and SAFTA.

There appears to be also a trade diversion effect of CECA on China's exports reducing its count by a factor of 1.715, while increasing India's exports to and imports from non-CECA members. An important caveat here is that there is a data valuation bias as Singapore's total exports to India and China include a significant proportion of re-exports (estimated to be about 40% or more of its total exports) that are originating from other Southeast Asian countries and are only transhipped through Singapore to India and China.

Since neither India nor China are members of the remaining 5 PTAs, viz. NAFTA, EU, MERCOSUR, CER, USSFTA and AUSUSFTA, it is interesting to further analyze whether these regional or bilateral PTAs have generated any significant trade diversion effects. It is often argued that large regional PTAs, such as NAFTA and EU could particularly reduce India or China's exports to and imports from the member countries of these PTAs. Table 6 and the ZINB model IRRs for specific PTA effects in Tables 3 and 4 suggests that the IRRs are less than 1, and that NAFTA, EU and MERCOSUR did reduce China's import counts by a factor of 3.077, 2.610 and 1.647 respectively. Further, EU was also observed to have reduced India's imports count by a factor of 1.182. On the export side, IRRs for NAFTA-D were greater than 1 and significant for both India and China, with a higher value 1.703 for China compared to India (1.666), suggesting that NAFTA increased India's and China's exports to their member countries.

EU-D was observed to be not significant for both India and China's export, while MERCOSUR-D IRR was significant and greater than 1 for India's exports (1.851). CER, USSFTA and AUSUSFTA seem to have no significant effect on India or China's exports. Similarly, USSFTA and AUSUSFTA seem to have had no effect on India or China's imports, while CER-D suggested a significant IRR > 1 for China's imports only.

A couple of caveats are to be noted while obtaining these results. First, the model does not capture the effect of all PTAs and their interactions at this stage. As an example, the effect of Singapore's PTA with US on its CECA agreement with India is not captured here. In a similar manner, the effect of Mexico's PTAs with Japan and Korea and its effect on their trade with China is also not captured in these results. Second, ASEAN+6 members continue to enter into more new PTAs which might influence these results in the near future. As an example, ASEAN-India FTA and ASEAN-Australia-New Zealand FTA are two important regional PTAs which are likely to interact with the existing web of ASEAN+6 PTAs and therefore influence current levels of trade creation and diversion. Further research could address these issues.

5. Concluding remarks

The analysis in this paper deviates from the traditional log-linear approach of gravity model estimation and takes account of available information on all trading partners, which allows the possibility of zero trade flows as a dependent variable and confirms that the ZINB regression fits the model the best in such a situation. The early results for the ZINB model, provided only for India and China as the home country, confirms that Chinese exports and imports were more likely to be net trade creating in presence of PTAs while India's exports were more likely to be net trade diverting in the presence of the same PTAs, with imports having an insignificant effect. Thus, PTAs may be trade creating or diverting and there is no general thumb rule. For India and China so far, most ASEAN+6 PTAs seems to have created both intra-bloc and extra-bloc trade. APTA is observed to be the only significant export creating PTA for India, while APTA and ACFTA are both found to be export creating for China. This is in line with Srinivasan and Archana (2009) gravity model analysis on India's trade that concludes that rapid global spread of bilateral PTA and RTA towards which India is moving rapidly is largely deleterious or insignificant from India's perspective in terms of impacts on trade flows . It is also observed that India’s imports were likely to suffer trade diversion due to EU only, while China’s imports were likely to suffer trade diversion due to the creation of NAFTA, EU and MERCOSUR.

However, this is only a partial picture as there’s a need to include the trade of all ASEAN+6 members (not just India and China), to analyze the complex interactive effects of the evolving economic integration process in Asia. The inclusion of an overarching RCEP involving all ASEAN+6 members is certainly expected to further complicate these interactions in the process of Asian Economic Integration.

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Table 1: Estimates of gravity models for India's exports

	Poisson IRR	**Poisson IRR**	**Neg. binomial Obs. IRR**	**Neg. binomial Obs. IRR**	**ZINB Obs. IRR**	**ZINB Obs. IRR**
ln GDP home	1.067 (0.000)***	0.643 (0.000)***	2.388 (0.061)***	1.811 (0.064)***	1.519 (0.045)***	1.019 (0.043)
ln GDP partner	3.723 (0.000)***	4.076 (0.000)***	1.256 (0.010)***	1.207 (0.010)***	2.064 (0.015)***	2.047 (0.018)***
Distance	1.000 (0.000)***	1.000 (0.000)***	1.000 (0.000)	1.000 (0.000)	1.000 (0.000)***	1.000 (0.000)***
Common border	2.180 (1.603)	2.745 (2.135)	0.350 (0.034)***	0.394 (0.039)***	1.613 (0.179)***	1.651 (0.182)***
Common language	2.211 (0.617)***	2.349 (0.710)***	0.839 (0.029)***	0.865 (0.031)***	1.712 (0.066)***	1.705 (0.067)***
All – C	1.170 (0.000)**	–	2.479 (0.235)***	–	1.265 (0.157)*	–
All – D	0.636 (0.000)***	–	0.720 (0.036)***	–	0.692 (0.047)***	–
APTA – C	–	1.497 (0.000)***	–	3.912 (0.488)***	–	1.433 (0.192)***
APTA – D	–	0.958 (0.000)***	–	0.805 (0.041)***	–	0.890 (0.061)*
CECA – C	–	1.541 (0.000)***	–	1.865 (0.716)	–	3.054 (2.653)
CECA – D	–	1.707 (0.000)***	–	1.331 (0.078)***	–	1.830 (0.193)***
SAFTA – C	–	1.000 (0.000)**	–	1.446 (0.223)**	–	1.517 (0.440)
SAFTA – D	–	1.252 (0.000)***	–	1.070 (0.060)	–	1.336 (0.146)***
ACFTA – C	–	–	–	–	–	–
ACFTA – D	–	1.028 (0.000)***	–	1.141 (0.114)	–	0.626 (0.152)*
AFTA – C	–	–	–	–	–	–
AFTA – D	–	0.931 (0.000)***	–	2.614 (0.263)***	–	1.014 (0.142)
AUSUSFTA – C	–	–	–	–	–	–
AUSUSFTA – D	–	0.597 (0.000)***	–	0.618 (0.155)*	–	0.479 (0.245)
CER – C	–	–	–	–	–	–
CER – D	–	0.628 (0.000)***	–	2.156 (0.349)***	–	1.314 (0.250)
EU – C	–	–	–	–	–	–
EU – D	–	1.222 (0.000)***	–	2.646 (0.153)***	–	0.931 (0.065)
MERCOSUR – C	–	–	–	–	–	–
MERCOSUR – D	–	7.595 (0.002)***	–	3.585 (0.436)***	–	1.851 (0.290)***
NAFTA – C	–	–	–	–	–	–
NAFTA – D	–	1.212 (0.000)***	–	2.084 (0.286)***	–	1.666 (0.344)**
USSFTA – C	–	–	–	–	–	–
USSFTA – D	–	1.255 (0.000)***	–	1.063 (0.309)	–	2.563 (1.550)
Intercept	0.000 (0.000)***	0.003 (0.001)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***	0.000 (0.000)***
Trading country pop	–	–	–	–	2.4e-09 (0.000)***	2.36e-09 (0.000)***
Intercept	–	–	–	–	-1.947 (0.038)***	-1.946 (0.038)***
Observations	4705	4705	4705	4705	4648	4648
Vuong	–	–	–	–	27.41***	27.49***
alpha	2.836 (0.231)	3.169 (0.255)	–	–	1.745 (0.028)	1.701 (0.028)
LR test alpha=0	1.1e+10***	9.7e+09***	–	–	1.1e+10***	9.9e+09***
LR test vs. pooled	–	–	6617.47***	6112.33***	–	–
Log Likelihood	-1.71e+09	-1.42e+09	-80799.85	-80541.72	-80820.57	-80723.95

Note: ***, ** and * refer to variables found to be statistically significant at 1%, 5% and 10% respectively. Standard errors are in parentheses. All estimates are generated with partner country random effects. Exposure obtained with time. Logit inflation in ZINB is achieved using trading country's population.

Table 2: Estimates of gravity models for India's imports

	Poisson IRR	Poisson IRR	Neg. binomial IRR	Neg. binomial IRR	ZINB IRR	ZINB IRR
ln GDP home	1.283 (0.000)***	0.562 (0.000)***	3.486 (1.595)***	1.028 (0.441)	1.544 (0.088)***	0.577 (0.041)***
ln GDP partner	3.954 (0.000)***	3.491 (0.000)***	1.456 (0.228)**	1.462 (0.116)***	2.027 (0.023)***	2.050 (0.024)***
Distance	1.000 (0.000)**	1.000 (0.000)	1.000 (0.001)	1.000 (0.000)	1.000 (0.000)***	1.000 (0.000)***
Common border	7.704 (7.157)**	6.444 (5.641)**	2.172 (1.507)	2.767 (1.784)	0.805 (0.148)	1.048 (0.161)
Common language	0.867 (0.304)	1.059 (0.342)	0.685 (0.268)	0.710 (0.229)	1.127 (0.074)*	1.084 (0.064)
All – C	1.522 (0.001)***	–	1.206 (9.316)	–	0.781 (0.396)	–
All – D	0.874 (0.000)***	–	0.669 (5.358)	–	0.602 (0.311)	–
APTA – C	–	3.599 (0.000)***	–	1.293 (0.313)***	–	0.928 (0.189)
APTA – D	–	1.338 (0.000)***	–	1.513 (1.432)***	–	1.652 (0.183)***
CECA – C	–	0.966 (0.000)***	–	1.636 (6.293)	–	2.379 (2.599)
CECA – D	–	1.624 (0.000)***	–	1.748 (0.361)***	–	1.723 (0.246)***
SAFTA – C	–	1.359 (0.000)***	–	1.670 (0.507)*	–	1.723 (0.661)
SAFTA – D	–	2.080 (0.000)***	–	1.610 (0.113)***	–	2.405 (0.349)***
ACFTA – C	–	–	–	–	–	–
ACFTA – D	–	1.008 (0.000)***	–	1.465 (4.063)	–	0.935 (0.280)
AFTA – C	–	–	–	–	–	–
AFTA – D	–	0.909 (0.000)***	–	1.529 (0.419)	–	1.237 (0.216)
AUSUSFTA – C	–	–	–	–	–	–
AUSUSFTA – D	–	0.807 (0.000)***	–	0.979 (0.935)	–	0.959 (0.601)
CER – C	–	–	–	–	–	–
CER – D	–	1.348 (0.000)***	–	1.340 (1.283)**	–	2.255 (0.568)***
EU – C	–	–	–	–	–	–
EU – D	–	0.929 (0.000)***	–	2.201 (0.782)**	–	0.846 (0.078)*
MERCOSUR – C	–	–	–	–	–	–
MERCOSUR – D	–	0.765 (0.000)***	–	1.876 (0.771)	–	0.923 (0.197)
NAFTA – C	–	–	–	–	–	–
NAFTA – D	–	0.536 (0.000)***	–	1.170 (0.440)	–	0.827 (0.222)
USSFTA – C	–	–	–	–	–	–
USSFTA – D	–	1.194 (0.000)***	–	0.975 (0.378)	–	1.961 (1.436)
Intercept	0.000 (0.000)***	0.519 (0.200)*	0.000 (0.000)***	0.0000 (0.000)***	0.000 (0.000)***	70.012 (130.666)**
Trading pop	–	–	–	–	0.000 (0.000)***	0.000 (0.000)***
Intercept	–	–	–	–	-1.275 (0.038)***	-0.876 (0.029)***
Observations	4705	4705	4705	4705	4648	4648
Vuong	–	–	–	–	13.12***	15.10***
alpha	4.374 (0.354)	3.919 (0.314)	–	–	2.973 (0.067)	2.864 (0.056)
LR test alpha=0	1.2e+10***	1.4e+10***	–	–	1.4e+10***	1.7e+10***
LR test vs. pooled	–	–	4141.64***	3051.05***	–	–
Log Likelihood	-2.56e+09	-1.32e+09	-51026.572	-50892.632	-52770.11	-48269.3

Note: ***, ** and * refer to variables found to be statistically significant at 1%, 5% and 10% respectively. Standard errors are in parentheses. All estimates are generated with partner country random effects. Exposure obtained with time. Logit inflation in ZINB is achieved using trading country's population.

Table 3: Estimates of gravity models for China's exports

	Poisson IRR	Poisson IRR	Neg. binomial Obs. IRR	Neg. binomial Obs. IRR	ZINB Obs. IRR	ZINB Obs. IRR
ln GDP home	2.839 (0.000)***	1.535 (0.000)***	6.721 (0.149)***	7.273 (0.184)***	2.145 (0.975)***	1.295 (0.062)***
ln GDP partner	3.141 (0.000)***	1.915 (0.000)***	1.053 (0.009)***	1.015 (0.009)*	2.014 (0.016)***	2.025 (0.018)***
Distance	0.999 (0.000)	0.999 (0.000)	1.000 (0.000)***	1.000 (0.000)***	0.999 (0.000)***	0.999 (0.000)***
Common border	2.458 (1.230)*	2.474 (1.002)**	1.568 (0.135)***	1.757 (0.151)***	1.775 (0.157)***	2.016 (0.179)***
Common language	1.882 (1.596)	8.662 (6.129)***	2.059 (0.302)***	1.750 (0.248)***	10.166 (1.381)***	10.589 (1.417)***
All – C	0.657 (0.000)***	–	0.805 (0.071)**	–	1.592 (0.226)***	–
All – D	0.833 (0.000)***	–	0.923 (0.033)**	–	1.161 (0.075)**	–
APTA – C	–	3.128 (0.000)***	–	0.945 (0.153)	–	3.031 (0.684)***
APTA – D	–	1.408 (0.000)***	–	0.757 (0.027)***	–	1.697 (0.108)***
CECA – C	–	–	–	–	–	–
CECA – D	–	0.787 (0.000)***	–	1.350 (0.325)***	–	0.583 (0.269)***
SAFTA – C	–	–	–	–	–	–
SAFTA – D	–	1.618 (0.000)***	–	0.982 (0.127)	–	0.377 (0.105)***
ACFTA – C	–	1.677 (0.0001)***	–	2.616 (0.370)***	–	2.849 (0.565)***
ACFTA – D	–	1.574 (0.000)***	–	0.954 (0.031)***	–	2.701 (0.178)***
AFTA – C	–	–	–	–	–	–
AFTA – D	–	0.888 (0.000)***	–	2.900 (0.353)***	–	1.435 (0.188)***
AUSUSFTA – C	–	–	–	–	–	–
AUSUSFTA – D	–	0.978 (0.000)***	–	1.029 (0.114)	–	1.276 (0.586)
CER – C	–	–	–	–	–	–
CER – D	–	1.788 (0.170)	–	1.320 (0.221)***	–	1.219 (0.215)
EU – C	–	–	–	–	–	–
EU – D	–					