Survey of gravity models of trade and labour, and a proposed trade-employment gravity model for the Philippines

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Abstract

A review of literature on gravity models on international trade, with a proposed model for the Philippines linking trade and employment. This review of literature provides other aspects of gravity modelling, from its elementary formulation as proposed by Timbergen (1962) to current theoretical and empirical extensions.

Keywords: gravity model, trade facilitation, behind-the-border barriers, free trade agreements, globalization, labour markets, employment, Philippine international trade

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Introduction

Econometric analysis has become an indispensable tool for testing data based on economic theory and modelling real world economic conditions. For one, trade has been also a witness to the ever-evolving theory and the dynamics of these theories as they are continuously validated, modified and enhanced by research.

Note that classical models of trade focus on endowments of inputs of countries, world prices, and technology as the usual determinants that explains trade between economies. Depending on the assumptions and the model employed, under ideal conditions of economic theory (e.g., perfect competition), trade can be welfare-improving between countries (Markusen, et al. [1995]).

In this essay, we provide a survey of literature—from simple econometric models to the popular gravity models and some of its extensions—in providing the state of economic theory in international trade and the strength of evidence of data tried to be correlated with this evolving theory in literature. These models aim to provide a more general explanation to the seemingly simple yet complex dynamics of trade between two or more countries, given certain conditions of production, technology, input markets (particularly on the effect of the labour market on trade and vice-versa) and the global market in general.

Stylised facts linking [international] trade and employment

Labour (and in general, employment) has always become a focal topic of discussion in economic development literature, and in other areas of economic literature, whether theoretical or applied. In particular, it has always been a point of inquiry whether trade—particularly international trade—has been beneficial to employment generation (i.e., increased employment of labour as an input to production of goods and services).

As expected from standard microeconomic theory, it is always regarded that "labour is a derived demand": demand for goods and services (final and some intermediary forms of goods and services) will ultimately require labour for production, thus implying also a demand for labour. As this premise may sound logical, literature has provided a wide range of explanation to support or refute this argument.

Elementary models of trade has always exploited trade relations through varied hypotheses on levels of labour endowments in in countries participating in trade.

Ricardo (1817), Heckscher (1919) and Ohlin (1933), and later Stolper and Samuelson (1941), Krugman (1980), up to contemporary and relatively complex models of international trade relations have shown how trade has become beneficial to countries participating in it. These models collectively argued for demand generation locally and internationally, thus increasing demand for labour (and thus employment) plus reallocation of inputs to make production more efficient.

Such argument has been extended in contemporary jargon as "globalization", i.e., the increased interaction of economies of the world, which creates more economic opportunities for participating economies. In other words, globalization promotes a "win-win scenario", i.e., everyone benefits from participating in them (unlike in the zero-sum scenario of mercantilism in the pre-Smithian economy.

One such facet of international trade between two particular countries is not only asking whether such countries will trade among themselves given certain conditions, but rather the intensity of trade between the said countries. This, and some extensions, is expounded in the next section: the class of gravity models.

Some mathematical preliminaries on gravity models

Isaac Newton (1686)[2] postulated that given two bodies m_1 and m_2, the force F between them is given by the equation

$$F = G\frac{m_1 m_2}{r^2} \tag{1}$$

where G is some gravitational constant, and r is the distance between m_1 and m_2.

Translating this to economics, given two countries, can we describe some *potential force* of engaging in trade (similar to pull of gravity), ceteris paribus? This idea is proposed in the work of Timbergen (1962), which adapted this idea and proposed the known gravity model in econometrics and models of international trade. Because of the wealth of literature on international economics, a lot of proposed extensions and modifications have been incorporated, as in Reinert (2013). We then re-express the above as

$$T_{ij} = A\frac{Y_i^{\beta_1} Y_j^{\beta_2}}{d} u_{ij}, \quad E(u_{ij}) = 1 \tag{2}$$

where T_{ij} is the total trade (i.e., sum of exports and imports) from i to j, Y_k is the gross domestic product of economies (or countries) $k = i,j$, A is some constant, and d the distance between economies i and j. Note that in carrying out the regression, we use a double-log form model and have

$$\ln T_{ij} = \ln A + \beta_1 \ln Y_i + \beta_2 \ln Y_j - \ln d + \ln u_{ij} \tag{3}$$

In here, note that the regression model allows from some data flexibility that the coefficients of the regression need not be unity, which may be justified by economic

[2] Online version from Smith (2008).

theory or previous empirical studies. Note that the coefficients here are interpreted as elasticities of the regressand with respect to the regressors in the model. Reinert (2013) has provided numerous variants of the gravity model of Timbergen (1962) that incorporates other factors affecting trade between two countries (e.g., labour, population as demand, among others)[3].

Another form of the general gravity model (WTO-UNCTAD [2012]) has the following specification

$$X_{ij} = GS_iM_j\varphi_{ij} \tag{4}$$

where X_{ij} is the level of exports from i to j, M_j is the imports of j, S_i is some variable of exporter-specific factors, φ_{ij} the degree of ease of exporter i to market j, and G is some constant. This may be more general, in terms of the different particular model specifications provided in Reinert (2013). However, theoretical and empirical literature is always necessary in comping up with a particular extension or specification of existing or gravity models. As the World trade Report (2015) states,

> *Gravity models are econometric models of trade that use historical data to determine the effect of past policy on trade flows. While they are ex post models—based on analysis of past outcomes—they can be used after estimation to simulate effects of policies ex ante, provided that these policies are implemented in comparable circumstances[4].*

As we will see in the next discussion, one of the key variables in this gravity modelling is the distance between trading economies. Also, the concept of gravity a la newton is that bigger bodies attract: translated in economics, bigger economies trade more (Shepherd [2016]). These are considered the two stylized facts of gravity models. Anderson (2012) puts it firmly in his introduction:

> *The gravity model in economics was until relatively recently an intellectual orphan, unconnected to the rich family of economic theory. This review is a tale of the orphan's reunion with its heritage and the benefits that continue to flow from connections to more distant relatives.*
>
> *Gravity has long been one of the most successful empirical models in economics, ordering remarkably well the enormous observed variation in economic interaction across space in both trade and factor movements. The good fit and relatively tight clustering of coefficient estimates in the vast empirical literature suggested that some underlying economic law must be at work, but in the absence of an accepted connection to economic theory, most economists ignored gravity. The authoritative survey of Leamer and Levinsohn (1995) captures the mid-90's state of professional thinking: "These estimates of gravity have been both singularly successful and singularly unsuccessful. They have produced some of the clearest and most robust empirical findings in economics.*

Observe carefully that such specification (in natural logarithms) requires that the data for the variables take positive values. This comes from properties of the natural logarithmic function, plus the fact that such variables for the specification also need to be positive to make economic sense.

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[3] A mathematical background is provided by Anderson (1979), cited by Reinert (2013).

[4] It is always important to take note and be careful of policy implications emanating from analyzing econometric models, which is known in economic literature as the "Lucas critique" (Lucas [1976]).

The distance variable in international trade and gravity models

The extensions of the gravity model of Timbergen (1962) have been updated to capture the theoretical underpinnings of classical and contemporary trade models. Note that these are due to continuous empirical work and further reevaluation of existing economic theory, particularly in the application of such gravity models to various phenomena in international economics.

We first begin with some econometric exercise investigating trends in trade in the nineteenth-century Philippines using ordinary least squares. Although this does not check for intensity of trade between economies, it investigates through recorded Philippine colonial data whether historical accounts hold.

Looking at Philippine exports and imports (1810-1896 data in Corpuz [1997]; figure in Abueg [2017a]), note that historical accounts claim and hypothesize that the opening of the Suez Canal in 1869 increased Philippine exports to the rest of the world. Figure 1 (adapted from Abueg [2017a]) shows the trend in exports and imports during the nineteenth century Spanish colonization of the Philippines. The graph suggests that by 1869, the opening of the Suez Canal was significant in effecting increases in total trade.

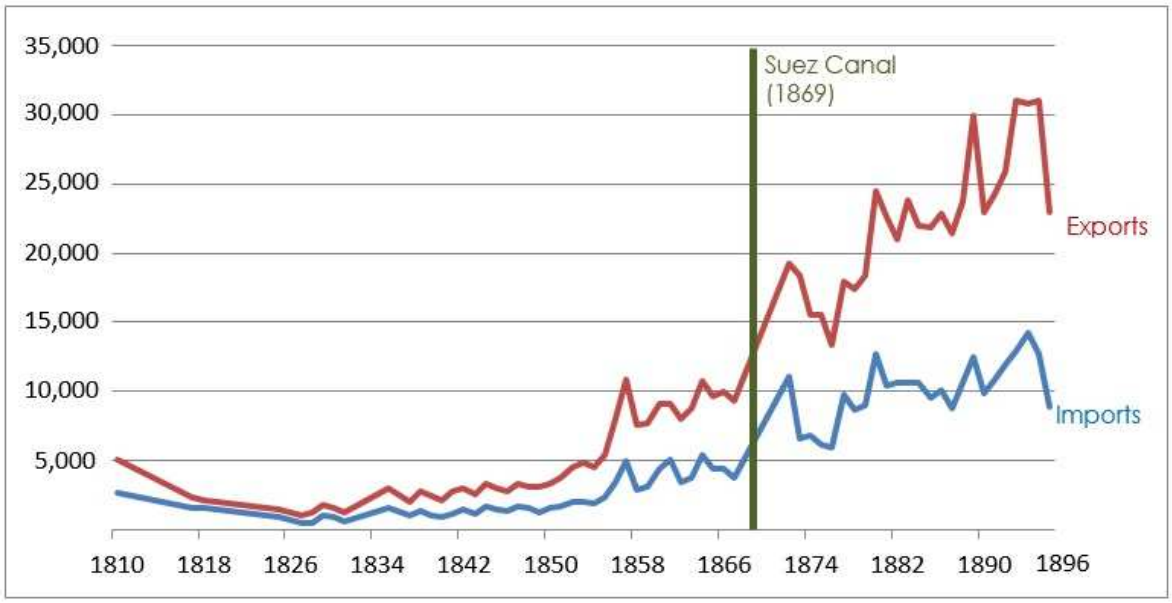

Figure 1. Trend of exports and imports from data in Corpuz (1997), adapted from Abueg (2017).

In this econometric exercise, it used a dummy variable to check whether there is a difference in imports or exports after 1869[5] (the year when the Suez Canal opened in Egypt). This exercise provided statistical evidence that anecdotal and historical

[5] Note that in the testing of structural stability, i.e., manually implementing Chow's breakpoint test, the decision to use a particular year or time point (in this case the year 1869) came from an a priori information (historical account) where such structural break is suspected to manifest. In advanced algorithms of Chow's breakpoint test in statistical softwares, it may now be possible to let the software locate the possible timepoint (or points) where the structural break (or breaks) may occur.

accounts on the supposed positive effect of the opening of the Suez Canal in maritime travel between the East Asia (in this case, those traveling to Europe from the Philippines and vice versa). Of course much of maritime trade will affect trade between the Philippines (and perhaps the region in general) and Europe, as documented by earlier sources.

This ordinary least squares (extended to autoregressive distributed lags) may have provided some statistical support of historical claims that in that period, the shortening of time travel from Madrid to Manila and vice-versa may have affected positively the total trade during the period. Note that this cannot be isolated by the fact that a more liberal policy in international trade was adapted during the period (Corpuz [1997], Legarda [1999]). Although the above may be highly susceptible to measurement errors, it may have given some modest statistical evidence supporting historical claims analyses on the event of the opening of the Suez Canal in 1869 (Abueg [2017a]).

A similar argument is also posed in Taningco and Hernandez (2010), wherein some other variables apart from inputs and prices may affect trade behaviour between countries. Going beyond the distance variable in a gravity model, the exercise estimated effects of economic and non-economic variables affecting trade facilitation in East Asia. This economic exercise tried to investigate the trends on trade in East Asia as it enters the era of globalization, i.e., increased trade globally and within East Asia while lifting the traditional barriers of trade such as quotas and tariffs. However, the paper noted that not only these are the limits to trade. There are also "technical barriers" to trade such as time to deliver the output from one destination to another, cost of delays, availability of physical infrastructure (such as airports and ports), among other things. Note that in classical models of trade, these things are assumed not to affect trade between two countries. However, in the real world conduct of trade, these factors affect significantly the quantity and perhaps the quality of trade between two countries (and not only the distance as what Timbergen [1962] had initially suggested).

In terms of economic growth and development, Nasira and Kalirajanb (2014) proposed a similar strategy as in Taningco and Hernandez (2010). This involves reduction in "behind-the-border" constraints that will aid in trade facilitation in East Asia, particularly on information and communication technology (ICT). A stochastic frontier gravity model[6] was employed to analyze "economic potentials" given identified sectors of growth apart from ICT.

In Anderson and van Wincoop (2003) (cited in WTO-UNCTAD [2012]; and Shepherd [2016]), a gravity model was used to measure some "relative trade costs" of countries, i.e., countries engaging trade may have some degree of resisting imports from other countries if there is another large economy proximal to it. Observe that this is a modification of the original Timbergen (1962) idea, where distance have some influence in trading behaviour of countries. This might also be a factor deterring trade of cone country to another small economy because of a presence of a large economy nearby. This is one of the realities of trade flows and studies in international trade which are not captured by elementary and neoclassical models.

[6] Stochastic frontier gravity models are used to analyze the maximum potential benefits from countries or economies participating in international trade, under the same theoretical specifications of the standard gravity model.

An empirical study by McCallum (1995) has initially shown this observation using Canada and US trade data, thus Anderson and von Wincoop (2003) calls this the "McCallum border puzzle".

Linking trade and [un]employment through gravity models

Distance being important in gravity models, plus the stylized fact that bigger economies trade, the next issues is how do markets for goods influence markets for inputs as demand increases due to trade participation. This is where the labour—and its demand and market structure—will be the next to be investigated in studying international trade.

As known in theory and literature, labour is one of the key inputs in production. From the classical hypothesis of homogeneous labour quality to the real world analysis introducing varying quality of labour as input, we see that there may be some theoretical basis for linking labour (and employment) in international trade movements.

Some of the literature provides evidence in linking international trade and unemployment through gravity models. In Belenkiy (2015), a survey of literature provides some empirical development linking trade policy impacts on unemployment rates. The paper initially highlighted the observation of Harrigan (2011) that "economic models of the effects of trade on labour market outcomes have relied almost entirely on the assumption of full employment. Yet unemployment is a fact of life, and net job creation is often a stated goal of trade policies." In addition, empirical studies are also included in the work that provides a modest view of what he said to be seemingly "small branch of a much larger economics literature on the link between international trade and employment outcomes". Due to the limits of the review, Belenkiy (2015) focused on literature pertaining to trade linking to aggregate unemployment models.

As apparent and may be argued by elementary models of trade and literature from economic history, trade and movement of factors (in this case, labour), may come hand-in-hand (or in econometric language, positively correlated). However, the literature shows that empirical evidence is mixed. On the one hand, a number of models show the a priori expectation of theory, that is, trade movements and employment rates are positively correlated. On the other hand, some current literature shows a significant disconnect between the two—possibly due to data limitations. This is one of the findings in Anderson and van Wincoop (2003), saying that "the estimated gravity equations do not have a theoretical foundation". They attribute this to omitted variable bias, i.e., some other explanatory variables should have been incorporated into the model by is not[7].

Nonetheless, gravity models also provided ample empirical evidence on capturing variables that will help explain behavior between and among countries. In WTO (2008), empirical studies cited show that time requirements to export (i.e., delays) have negative impact on volume of exports. Similarly, the report argued that similarities in language, and ease of communication have shown to positively affect

[7] This problem in econometric modelling happens when there are variables that are not measurable but should be incorporated into the specification, or worse, there is no data to reflect measurements for that variable.

trade flows. This is also an observation found by Andal and Clarete (2015) in the case of the ASEAN free trade area (AFTA).

Trade and labor, and extensions to globalization

Recall that one of the fundamental puzzles of neoclassical trade theory began in Leontief (1951) when an empirical investigation of the predictions of Heckscher (1919) and Ohlin (1933) was done using USA data. However, Leontief (1951) had shown that USA being a capital abundant country had turned out to be exporting labour-intensive goods. This became the famous "Leontief paradox", in which was rectified by dividing labour into the skilled and the unskilled labour, which made the predictions of Heckscher (1919) and Ohlin (1933) more accurate: exporting goods that are intensive to skilled labour, while importing goods that are intensive in unskilled labour (Miberg [1996]).

This observation of Leontief (1953) which propelled extensive revisit of the results of Heckscher (1919) and Ohlin (1933) made some significant advances in literature, tapping the dynamics of the labour as a market of varying quality of labour input, away from the neoclassical assumption of homogeneous quality across industries and countries.

Another issue in international economics literature is determining the direction of trade, whether exporting, importing, or both. Helpman, et al. (2008) have done a documentation of the directions of trade and its implication to trade behaviour among countries. Such documentation of evidence uses also gravity models, under the stylized facts of international trade, as attributed by the data used.

Such directions in trade argument is also documented in Andal and Clarete (2015), i.e., the trade-creation argument (in the case of the Philippines) due to the membership in AFTA. In general, free trade agreements (FTAs) or more generally, preferential trade agreements (PTAs) have become increasingly becoming the practice of countries in trade creation and trade facilitation. Cheong (2010) have argued for using gravity models as a way of evaluating the efficacy of FTAs, covering Cambodia, Indonesia, and Vietnam.

As argued earlier in Taningco and Hernandez (2010), there are nonclassical variables that might affect trade flows between countries and in their study, in the whole of East and Southeast Asia. A good primer on the different policies on labour particularly in Southeast Asia can be found in Orbeta (2013), which may provide some explanation for the possible labour movements in the region, that might affect trade. On the contrary, Shepherd (2010) posited that if institutions are weak and prone to corruption (which is one of the recurring issues in Philippine customs administration and government revenue collection), such weak institutions may hinder trade facilitation[8].

Brun, et al. (2005) investigated through gravity models, whether indeed globalization made the distance variable less and less significant (citing the cliché that "the world is becoming smaller and smaller". They continued,

[8] On that argument, Shepherd (2010) coins the phrase "speed money" to mitigate the negative effects of corruption and perhaps improve the speed of trade between the exporting country and the importing country.

> *This paradoxical result was initially investigated by Brun and others (1999) in a traditional gravity model framework. Earlier, Leamer and Levinsohn (1995), reviewing the literature on international trade and distance, noted that "the effect of distance on trade patterns is not diminishing over time. … They conclude that "dispersion of economic mass is the answer, not a shrinking globe" for this result. In a recent examination of the paradox Coe and others (2002) review explanations in the literature. One is the exclusion of zero observations from the model, which could bias estimation of the impact of distance over time because of the changing composition of trade. Another is that the traditional gravity model omits what is now being referred to as "multilateral trade resistance"*[9].

The pioneer work of Krugman (1980) and extended later by Melitz (2003) have shown that countries with imperfect competition—the former paper assumes homogeneous firms, while the latter assumes heterogeneous firms—have welfare improving effects as they are exposed or decide to engage in international trade. As always, the question on the input requirements remain: how do the entry of new firms and the increase in production will affect the labour market (which is the usual source of input for production)? Also, note that in this contemporary age, labour market have varying degrees of quality, and the simplest assumptions made to capture this varying quality is to classify them dichotomously as "skilled labour" versus "unskilled labour"[10].

Eswaran (2014) has argued through the lens of gender economics that international trade have promising benefits to equalize wages among the unskilled and skilled labour, particularly that the less developed countries constitute more unskilled labour (usually women) and developed countries have more endowment on skilled labour. However, there are other undesirable effects of globalization, which are manifested usually by black markets on labour, e.g., human trafficking, child labour, among others.[11]

One of the counterarguments that is posed against globalization and international trade is argued by Kremer and Maskin (2003), where a theoretical argument is presented connecting the undesirable effects of globalization to employment and labour markets in trading countries. Simply put, trade theories may perfectly predict the countries' benefits of engaging into international trade, but a lot of empirical work suggests otherwise. This is cited in Maskin and Kremer (2003): the counterfactuals in Wood (1994, 1995, 1997), which exploits empirical evidence of Latin American and East Asian Countries using the Heckscher-Ohlin model.

Such conclusions from Kremer and Maskin (2003) are similar to the work of Heid and Larch (2012), which presented a mathematical model on how to incorporate labour market unemployment phenomena on gravity models, linking trade behaviour and employment, particularly unemployment. One of the major drawbacks they state was

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[9] Concept from Anderson and van Wincoop (2003). This is also argued by a discussion in the Asian Economic Integration Report (ADB [2016]).

[10] Some other work would even have a classification of a "semi-skilled labour", which is much more studied in the area of labour and development economics.

[11] Eswaran also mentioned that such evidences of undesired effects of globalization on labour is not new: earlier in colonial history, slavery has become one of the practiced methods of employment, and child labour as documented formally during the [first] Industrial Revolution.

> *Our framework allows counterfactual analysis of changes in trade costs and labor market reforms on trade flows, prices, employment, and welfare. We demonstrate that standard gravity models which neglect adjustments on the labor market typically underestimate welfare effects of trade liberalization by deriving a sufficient statistic for welfare.*

As one may recall, these has been also one of the concerns in neoclassical models of trade beginning from the work of Heckscher (1919) and Ohlin (1933). Note that the studies on evaluating the effects of preferential trade agreements have been positive empirically for countries participating in it (e.g., Andal and Clarete [2015]). However, As Heid and Larch (2012) have also considered in their empirical work:

> *We apply our methodology to evaluate the trade effect of endogenous preferential trade agreements (PTA) for a sample of OECD countries and reconsider the border puzzle. On average our estimates imply that welfare effects of PTAs are doubled when taking into account employment effects. However, some countries experience higher unemployment and lower welfare after trade liberalization.*

Such observation and examples set forth by Kremer and Maskin (2003) have been empirically supported by Lee and Vivarelli (2006), which provided reasons for the possible divergent effects of globalization on employment:

> *A general result is that the optimistic Heckscher-Ohlin/Stolper-Samuelson predictions do not apply, that is neither employment creation nor the decrease in within-country inequality are automatically assured by increasing trade and FDI. The other main findings of the paper are that: 1) the employment effect can be very diverse in different areas of the world, giving raise to concentration and marginalisation phenomena; 2) increasing trade and FDI do not emerge as the main culprits of increasing within-country income inequality in DCs, although some evidence emerges that import of capital goods may imply an increase in inequality via skill-biased technological change; 3)increasing trade seems to foster economic growth and absolute poverty alleviation, although some important counter-examples emerge.*

Given these particular observations and evidences in the literature, it is important to validate country-specific elements of trade and globalization affecting labour and employment. Following the scope of this paper, we provide some model specifications for the case of the Philippines, given the above.

A simple gravity model applied to Philippine data

We start with an ordinary least squares (OLS) specification of a gravity model for the Philippines given as follows:

$$\begin{aligned}\ln X_{ijt} = a + b_1 \ln Y_{it} + b_2 \ln Y_{jt} + b_3 \ln N_{it} + b_4 \ln N_{jt} - b_5 \ln D_{ij} + b_6 L_{ij} \\ + \mathbf{p}^{\mathrm{T}} \mathbf{x}_i + \mathbf{q}^{\mathrm{T}} \mathbf{x}_j + u_t\end{aligned} \tag{5}$$

where

X_{ijt} = exports country *i* to country *j* at time *t*

Y_{it} = national product of exporting country *i* at time *t*

Y_{jt} = national product of importing country *j* at time *t*

N_{it} = population of exporting country *i* at time *t*

N_{jt} = population of importing country *j* at time *t*

D_{ij} = distance of country *i* and *j*

L_{ij} = language dummy variable (1 = *i,j* have the same language; zero otherwise)

$\mathbf{x}_i$ = vector of country-specific variables for *i*

$\mathbf{x}_j$ = vector of country-specific variables for *j*

u_t = error term

Note that in the above, we impose the a priori hypothesis on b_5: distance is negatively proportional to the level of exports. This is one of the main theoretical hypotheses of the gravity model, as what Timbergen (1962) originally proposed. The specification of the country-specific variables for countries *i* and *j* are following a similar argument as in Cheong (2010).

As presented by the standard gravity model, the a priori expected signs for the coefficients of the national product and population variables are all positive, while the distance variable is negative. The language variable is expected to be positively correlated with trade, as suggested in the WTO Report (2008) as well as in Andal and Clarete (2015). The population variables may be incorporated coming form the justifications in Reinert (2013).

We first note an econometric precaution by Santos Silva and Tenreyro (2006)[12], that "a log-linearized model will render OLS estimates inconsistent. This will also lead to sample selection bias" (Andal and Clarete, [2015]). We also adapt the specification of the error term in Andal and Clarete (2015),

$$y_t = \exp(\mathbf{x}_t\boldsymbol{\beta})V_t, \quad V_t = 1+\frac{u_t}{\exp(\mathbf{x}_t\boldsymbol{\beta})} \tag{6}$$

i.e., transforming the gravity model in a stochastic form, and implementing a Poisson regression as suggested by Shepherd (2013), noted in Andal and Clarete (2015):

> *To avoid the problem, the Poisson regression was used to estimate the gravity model, an equivalent to running a type of nonlinear least squares on the actual multiplicative form of the gravity model. The Poisson estimator provides consistent estimates of the original nonlinear model. Aside from this, the Poisson estimator naturally includes observations for which the observed trade value is zero. Furthermore, the interpretation of Poisson coefficient estimates follows the same pattern as that in OLS. The coefficients of any independent variables entered in logarithms can still be interpreted as simple elasticities, and the coefficients of independent variables entered in levels are interpreted as semi-elasticities (Shepherd, 2013).*

Note that the other variables are coming from the literature reviewed in this paper. Thus, the standard gravity model—originally a double-logarithm equation—is now transformed into a stochastic semi-logarithm model.

[12] Santos Silva and Tenreyro (2006) have highlighted more importantly the neglected mathematical truth in doing gravity models that involves natural logarithms, that $E[\ln(y)] \neq \ln[E(y)]$: known as Jensen's inequality (in fact, by the concavity of the natural logarithmic function, $E[\ln(y)] > \ln[E(y)]$.

To link the gravity model of [bilateral], we link employment through the national product *Y* of countries *i* and *j*, following a Cobb-Douglas specification, as in Mankiw, Romer and Weil (1992). Adapting their specification (and applying linearization), we specify a stochastic form of the Cobb-Douglas given by

$$\ln Y_{mt} = \ln A_m + c_1 \ln L_{mt} + c_2 \ln K_{mt} + c_3 \ln H_{mt} + w_{mt}, \quad m = i, j \tag{7}$$

where

Y_{mt} = national income of country *m* at time *t*
A_m = total factor productivity of country *m*
L_{mt} = labor employment inputs of country *m* at time *t*
K_{mt} = capital inputs of country *m* at time *t*
H_{mt} = human capital investment levels of country *m* at time *t*
w_{mt} = error term

In the above specification, we apply the Wald test (see Danao [2013]) on the restriction for a Cobb-Douglas production function:

$$c_1 = 1 - c_2 \ln K_{mt} \tag{8}$$

As in Mankiw, Romer and Weil (1992), we allow for a parameter capturing some disutility coming from investments in human capital (captured by the coefficient c_3).

To avoid possible multicollinearity problems on labour employment in the above and in the main stochastic least squares form of the gravity model (5) via the population variables, we employ a two-stage least squares regression. Firstly, we regress each country's Cobb-Douglas production functions (7) given the above specification with the usual restriction (8), and then use the fitted values of national income [denoted $\hat{Y}_{mt}$] and estimate the main gravity equation given by

$$\begin{aligned} \ln X_{ijt} = {} & a + b_1 \ln \hat{Y}_{it} + b_2 \ln \hat{Y}_{jt} + b_3 \ln N_{it} + b_4 \ln N_{jt} - b_5 \ln D_{ij} + b_6 L_{ij} \\ & + \mathbf{p}^{\mathrm{T}} \mathbf{x}_i + \mathbf{q}^{\mathrm{T}} \mathbf{x}_j + u_t \end{aligned} \tag{9}$$

Such specification may be regarded in similar argument with the empirical results obtained by Orbeta (2002) for the Philippines that "increases in the propensity to export shift the demand for labor upward". Thus, this result and that of Andal and Clarete [2015] provides remarkable results for the Philippines to participate in international trade[13] and improve more on its export production. However, a study by Hasan and Jandoc (2010) for the Philippines have noted such vital role of globalization on local employment:

> *A more substantial role for trade liberalization comes through trade-induced employment reallocation effects whereby reductions in protection appear to*

[13] One of the highlights in Andal and Clarete (2015) is that given the Philippines' membership in AFTA (ASEAN Free Trade Agreement) and RCEP (Regional Economic Cooperation Partnership) with the data showing that ASEAN PTAs are trade creating, it would be in the best interest of the Philippines to pursue TPP (Trans-Pacific Partnership) membership.

> *have led to a shift of employment to more protected sectors, especially services where wage inequality tended to be high to begin with. Nevertheless, the key drivers of wage inequality appear to be changes in economywide returns to education and changes in industry membership over and above those accounted for by our estimates of trade-induced employment reallocation effects.*

It is also noteworthy to note that a major limitation of the gravity model is its being bilateral in nature; moreover, it is one-directional (i.e., from country *i* to country *j*), as predefined by the left hand side variable (i.e., exports from country *i* to country *j*).

A potential data source for such modelling can be obtained from CEPII Geography Dataset[14] (used by Heid and Larch [2012]) in estimating the required equations. Note that a precaution by Yücer, et al (2014), highlights problem of biased estimates in gravity models when export profiles are largely intermediate goods. Supplemental data may also be obtained from the Direction of Trade Statistics (DOTS) of the International Monetary Fund (IMF)[15], and the UN Comtrade Data[16].

In addition to the above specification, there can be possible models for different types of goods. For example, the report in ADB (2016), differentiated different types of merchandise exports in the left hand side of the gravity model estimation. A similar technique was done in Walsh (2006), providing different gravity equations for different services by importing countries.

Value-added also plays a role in measuring output, as one of the major studies areas in economic theory. Yücer, et al. (2014) also provided an empirical evidence (in the case of Brazil) showing that value-added may be better in modelling trade through gravity equations, as supported by a report by WTO-OECD (2012). Such report highlights the importance of "job content" in traded goods, particularly those that are countries exploiting trade value added through global value chains.

Conclusions

Econometric models are very much important in literature, in almost all areas of economic theory. This does not spare international economics—trade, finance, macroeconomics, and development—which has a vast contribution to the development and continuous updating of economic theory given empirical research.

Two things are of utmost importance in econometrics: estimation and forecasting. On the one hand, we would want to determine factors that affect some economic variables. For example, we might want to determine what influences trade behaviour. This concern requires data and model specification through functional forms, which should be supported by some relevant and extensive review of literature. On the other hand, forecasting is knowing what would be the likely behaviour of our economic variables in future time. But this require significant statistical checks in the estimates we have obtained in our estimation part.

[14] Available at http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8
[15] Available at http://www.imf.org/en/Data
[16] Available at http://comtrade.un.org/

Gravity models and its extensions have provided a lot of econometric advantages on modelling trade behaviour, from the earliest recorded historical data up to contemporary models, which are much exploited in modern economic literature. However, economic theory and working knowledge on econometrics come hand-in-hand in extending the basic framework of gravity models to analyse the real-world dynamics of international trade flows and welfare analysis. As in econometric modelling, modification of the standard gravity models should be done with utmost caution based on two things: the inclusion of correct variables, and the possibility of endogeneity that may arise among them (Shepherd [2016]).

In the survey of literature done on trade and employment using gravity models, it has been documented that gravity models may have provided a better and differing perspective on international trade relations and behaviour among countries, that are not captured in elementary models of trade. However, empirical literature on international economics has also provided a divergent evidence on whether trade has indeed affected trade positively (as posited a priori from elementary models) or negatively (due to other variables not captured in proposed models, usually due to either data limitations or due to omission of variables in specification).

A lot has been done in the pioneer work of Timbergen (1962) resulting to different extensions: inclusion of language (e.g., ADB [2016]; WTO [2008]), effects of trade agreements (e.g., Heid and Larch [2012]; Andal and Clarete [2015]), border puzzles (e.g., McCallum [1995]), relative trade costs (e.g., von Wincoop [2003]) "behind-the border" (e.g., Taningco and Hernandez [2010]; Nasira and Kalirajanb [2014]), among others. However to limit the scope of the paper, it focused on one of the main issues of trade and development: on relating employment behavior in countries participating on international trade (e.g., job creation, job displacement, to name a few).

Apart from theoretical specifications, econometric considerations are also employed and accounted to prevent biases and provide a sound model that may be used for possible forecasting for future behaviour. Note that such is limited owing to the bilateral nature of the model (as specified theoretically), and the empirical consequences of the variables being contemporaneous.

Econometrics rely on the framework of induction, i.e., from specific to general. A sample cannot be used to generalize a phenomenon, nor it can be used to refute any existing economic theory. A regression function only indicates [generally, a linear] correlation or variation among the independent and the dependent variables, but not causation. A substantial theoretical review supported by economic literature is always necessary.

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