China's Bilateral Currency Swap in International Trade Clearance: An Empirical Investigation

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ABSTRACT

The emerging economic prosperity of China and its increasing economic integration with the rest of the world as the second largest economy seems to give her an edge to amplify its global competitiveness. An important avenue for this ongoing debate relates to the diversification of the international monetary system. In effect, the development reveals a pertinent reason to expect that the world's currency regime and global financial architecture is changing. Evidently, the currency bilateral swap agreement signed by the People's Bank of China and some central banks is reinforcing the trend of Renminbi internationalization. The paper applies gravity model to investigate China's Renminbi bilateral swap agreements (BSAs) and trade flows. Lie beside the fore mentioned objective; we empirically investigate the decision of countries to engage in currency swapping through China's RMB swap route, using large panel data of over 200 countries from 1979 - 2013 for the first time to the best our knowledge. The empirical results show that currency swap as an emerging trade-type of international agreement is trade creating with a magnitude relatively close to what is documented in the literature for other kinds of trade agreements like the currency unions and free trade agreements, this may potentially provide bilateral trade preference for countries that embrace China's currency swap line.

Keywords: Central Banks, RMB Bilateral Currency Swap Line, China, Central Bank, and Trade Flows.

1. Introduction

The first half of the 21st century witnessed one of the powerful international financial instruments in the space of international economics, known as "central bank liquidity swap" by Federal Reserve, which provides backstop liquidity to emerging markets and OECD countries during the global financial crisis in 2008.[1] This phenomenal adoption of central bank currency swap agreements is at best described using the aphorism "necessity is the mother of invention" the currency swaps emerged to ease the severity of the 2008 global financial crisis (see Goldberg and Kennedy, 2010; Destais, 2016 and Kwon, 2015; Rose, and Spiegel, 2012;Liao and McDowell, 2015). Consequently, the central banks of some developed economies utilized and embraced a new international financial instrument (central bank currency swaps) as a swap line to one another to lessen the severe effect of the credit crunch (McGuire and Von Peter, 2012; Obstfeld, Shambaugh, and Taylor 2009).[2] In contrast, Campanella (2014) and Cheung et al. (2017) argued that the People's Bank of China's (PBOC's) objective was seemingly geared towards exploiting this tool to support trade, investment and promote the internationalization of its currency on a global scale with the aim to discard the domination of the US dollar in global trade (see Bank of Korea, 2012). Similarly, Cheung et al. (2011) opined that RMB-based trade policy relates to a combination of factors like China's openness together with its current account surpluses and the bid to internationalize RMB.

Wilson (2015) reports that the Chinese (RMB) barely not visible in international trade or financial flows in the last eight years; its emergence now appears in blossom level. Since 2008, the People's Bank of China (PBOC) had signed the bilateral swap agreements (BSAs) with more than twenty-five counterparties (central banks) in the bid to facilitate international trade and financial investment across the world. It is worthy to note that while several factors were at large behind the propagation of RMB usage in recent years, for example the emergence of China as the most significant trading nation provides an impetus for RMB internationalization. The share of China's world exports has grown from 3.9 percent in 2000 to 12.4 percent in 2014 surpassing

[1]Currency swaps enable central banks to exchange a set of amounts of local currency with another central bank at a fixed rate; this sort of arrangement is an important factor in the stabilization of financial market and facilitation of trade clearance. Foreign central banks could draw on those lines to provide liquidity to institutions within their jurisdiction, thereby, ensuring that domestic banks and firms have access to short-term capital for their trade activities.

[2]Currency swap provide short-term liquidity to help enhance financial stability for the both counterparts, especially in lubricating international trade.

the United States, a position it held over five decades (see Song and Zilibotti, 2009; Aizenman et al.,2017;Wilson, 2015 and Yang and Han 2013).

Therefore, with the growing importance of China in the arena of global affairs especially international trade, it makes sense for one to understand its proximate motive to internationalize the use of Renminbi (Cheung et al., 2011; Cohen, 2012; Roubini, 2009; and Eichengreen, 2011). This also coincides with the collapse of trade financing during the 2007 global financial crisis.[3] Within this period China's exports dropped by 20 percent. The PBOC'S response to the risk and problems was to encourage the Chinese exporters and importers to settle their trade transactions in RMB. In addition, the possession of RMB denominated deposits and bonds held by corporations in the offshore markets is quite prevalent around the world. For example, some trade transactions denominated in RMB had leaped from zero in the year 2009 to more than $300 billion in the first three-quarters of 2012 (BIS, 2013). Primarily, the strategic element of the internationalization of China's Renminbi involves the negotiation of the bilateral swap agreements (BSAs) between the People's Bank of China (PBOC) with a growing number of partner central banks across the globe with the plan to propagate the cross-border trade and settlement of direct investments. So far, since 2008 more than 25 duly signed bilateral swap agreements came into effect. The preceded developments are arguments that provide ample motivation for this study.

Recently, only a few papers analyze the effect of the currency swap line on international trade flows. For example, Lin and Cheung (2016) employed Heckman's 2-step procedure to analyze the swap line partner's decisions to sign or not sign the China's local currency line. They employ some institutional, political, and economic variables like the economics sizes (GDP), political stability, the rule of law, corruption and strategic partnership between China and its counterparties, to explain what likely binds the currency swap agreement. The point of their argument based on the empirical results shows that China's swap line is undetermined by pure economic considerations: political and institutional factor also plays a key role. Edwin and Yu (2015) evaluate the potentials of China's Renminbi becoming a trade settlement currency, their

[3]Obstfeld, Shambaugh and Taylor (2009) provides a detail empirical results related to the financial stability and foreign currency reserves. Showing that country's reserve holdings and predicted reserve holding after crunch of credit in 2008 can significantly predict exchange rate movements of both emerging and advanced countries. Further indicating that the amount of swap to the total foreign reserve for a country is an indicator to predict GDP movement.

quantitative experiments suggested that there is a broad scope for the use of Renminbi in trade invoicing in the Asia-Pacific and beyond. Theoretically, the argument suggest that China needs to open its capital account and liberalize its financial market sector to gain the required thick market externalities for the Renminbi to emerge as dominant invoicing currency. After investigating the determinants of currency invoicing share in trade using euro as the case study, subsequently, inferences drawn from the case study were used to benchmark the potentials of Renminbi as an invoicing currency at least in the Asia-Pacific region. Liao and McDowell (2015) empirically show that de facto trade interdependence and de jure economic integration are vital factors that determine the swap lines of China, with FDI inter-dependence having a partial effect. They argued that the existence of prior preferential trade agreement (PTA) and bilateral investment treaties (BIT) could increase the probability of the bilateral swap agreement (BSA) corporation. Aizenman et al. (2011) in general examine the possibility of swap lines to substitute or compliment international reserves, empirically they show that swap lines can reduce the need for reserve accumulation especially the Asia's stockpiling appetite.[4]

Evidently, suggesting that the scope for swaps to substitute reserves is limited, although the swap lines have weakened the precautionary motive for reserve accumulation in the Asian region. Similar studies that seek to analyze China's swap line in the light of RMB internationalization include Yang and Han (2013) applied inventory optimization to analyze the factors related to the optimal currency swap size between China and its trading counterparts. The findings show that the mean value of the foreign exchange demand, its volatility and the distribution form are essential for optimal swap size. Garcia-Herrero and Le (2015) argued that given the China's massive leverage position, it does not appear relevant for China to keep pushing for RMB internationalization since the leveraging process will continue to keep interest rates artificially low and makes the allocation of savings inefficient. More so, RMB internationalization is not sufficient to help Chinese government and corporate firms to fund themselves in the international markets without having a reliance on the US dollar.

[4] In the words of the Governor of the Central bank of Pakistan Anwar Yaseen, he says 'the currency swap agreement with China represented a watershed event. Without it, Pakistan would have faced a balance of payments crisis in 2013. Similarly, the swap deal helped Argentina's economy to boost its reserves. When the first swap took place in October 2014, the amount worth 814 million US dollars. Under the agreement, Argentina can also pay RMB when importing goods from China. In effect, the agreement saved Argentina from its financial woes, because if came shortly after it fell into its second default in 12 years (www.chinaview.cn 2015-08-24).

The literature is well established both regarding theory and empirics that 'currency swap' is an essential tool to manage the effect of exchange rate volatility on trade. Particularly, for firms and countries that engage in international trade and investment (see Wei, 1999; Adam-Muller, 2000; Wong, 2003 and Broll and Wong, 2003). An excellent specimen of currency swap in recent decade is the People's Bank of China's bilateral swap agreements with the intent to cope with the volatility of its currency and that of its trade partners. Simultaneously, other objectives include RMB internationalization, promotion of bilateral trade and investment between the two signatories that signed currency swap in their local currencies for a specific time frame. Indeed, such agreements indicate a positive signal on the prevalence of liquidity of the other country's currency in the onshore markets. Once currency swap line is into force, for example, China and say Korea, the exporter will borrow in the currency of importer, and sell the currency against the Renminbi and make use of Renminbi for its local exchange operations. On the expiration of the contract, the exporter will receive the currency of the importer to pay off the importing currency locally, with the respective differences having considered. Similar arrangement applies to Chinese importer. Therefore, in this respect the adoption of currency swap will substantially reduce the demand for an invoicing currency say US dollar.

In addition, once currency swap arrangements are into force, the exchange rate is determined, and naturally this give impetus to high imports, more especially when the other currencies are depreciating. Another major merit of swapping is the reduction of transaction costs and hedging against unforeseen volatility, which facilitate the removal of invoicing currency like the US dollar. In other words, currency swaps provide a suitable flat form for importers and exporters to counter currency risk. Similarly, another distinctive advantage of currency swap is the greater recognition of the currencies that entered into such international transactions. Invariably, today's dominance of China in the global currency swap agreements with many countries may likely pave way for RMB internationalization process.[5] Howbeit, whether this type of cross-currency swap agreements exert a substantial and significant impact on overall trade flows is an essential empirical question yet unanswered in the literature.

[5]Etymologically: the suffix international embodied international characteristics of a currency to RMB in the global economy (trade, investment and reserve currency). The measure of RMB internationalization in this premise is the recent bilateral currency swaps of the People's Bank of China (PBOC).

The paper seeks to explain the ex-post behavior of China's Renminbi trade policy and the pattern of world trade, an essential novelty in this piece of work is to investigate the effect of currency swap on trade empirically. The literature of international trade provides a scanty evidence in this area. Therefore, our empirical investigation provides more elaborate discussion on currency swap and trade which will be of interest and relevance to the world. There are two novelties to this study. First, we take a line variant of the previous studies, and the foremost objective is to investigate empirically trade creation and trade diversion effect of the RMB-based trade policy-the bilateral currency swap agreements (BSAs) on bilateral trade. The study examines the positive impact on the counterparties to the agreement (trade creation) and the adverse effect on non-partner countries (trade diversion). Using the gravity model, we intend to show the empirical evidence of trade creation via ex-post analysis of the trade flows. Methodologically, the theory consistent structural gravity model is an essential tool in our research kits to unbundle our goal. Regarding the sample, we drew sample 27 countries that were into China's currency swap line for empirical analysis. Similarly, our analysis relies on a panel approach which accounts for country-pair fixed effects solely to circumvent the embedded endogeneity in trade policy analysis, and phase-in effects of the bilateral currency swap agreement, which has important implication for future significance of swaps on trade.

The outcome of our empirical findings reveals an apparently large impact of bilateral currency swaps on trade flows. Succinctly, on average, the estimates suggest that bilateral currency swap increases counterparts trade more than three times. An important caveat we hold is that currency swap might be different from other forms of international trade agreements, such as the currency unions, currency peg, and dollarization, and indeed they have a different impact on trade. In a similar vein, we also acknowledge that different econometric techniques deliver different results. The magnitude of the measured effects of the findings might skeptically rise concerns merelyweighing the effects to have been too large to believe. However, we square the results with other forms of international trade agreements in the literature to gauge a possibility that lies in between. For example, Glick and Rose (2016) found a fairlylarge impact currency union on trade in the magnitude of 114%. Earliest literature began with Rose (2000) that found triple effects CUs on tradethough this sound suspiciously large, and subsequent empirical finding even set out a more dampeningeffect (see Esposito 2017; Frankel 1997; Ghosh and Yamarik 2004; Baier and Bergstrand 2007; Magge 2008; and Eicher, Henn and Papageorgiou 2012).

2. Renminbi Swap Line and Currency Network of China

Renminbi (RMB) internationalization is receiving attention on commencement comparable to some of the China's initiatives such as the Asian infrastructure investment bank (AIIB) and the one Belt, and one Road initiative scheme. The government actively engage in the efforts to internationalize its currency (RMB). Although the Chinese capital account is, still relatively closed, non-resident investors cannot have access to RMB in international markets (Lin and Cheung, 2016; Gao and Yu, 2009; Park, 2010; Yu, 2012; and Chen and Cheung, 2011). Therefore, the alternative way to increase and encourage the international trade flow is through the swap line agreements even without opening of the capital account. The main aim of the currency swap agreement is to solve the problem of illiquidity in the time of downturn. For instance, taking the remote example of Asian financial crisis, after the crisis many Asian countries, including China, embraced a currency swap agreement under the canopy of the Chiang Mai Initiative (CMI). It follows that the United States entered a currency swap with several countries (such as Switzerland, Korea, Brazil, Mexico, and Singapore) to mainly provide liquidity in the form of US dollar to these countries. Most of the swaps are denominated in US dollars while others are in the local currencies (Liao and McDowell, 2015; Aizenman et al. 2011; Bowles and Wong, 2013; Cohen, 2012; Mcguire and Peter, 2012). Going beyond the Asian regional cooperation, the currency swap line of China continuously raises to approximately 30 countries since 2008 (see Table 1). Besides, In addition, the broader purpose is to facilitate bilateral trade and investment.

Furthermore, the usage of RMB as trade and investment currency will help in the elimination of exchange rate risk both for Chinese firms and for their trading partners that requires funding for international investment. Liao and McDowell (2015) argued that economic motivations rather than geographical considerations drive the RMB internationalization. For example, trade and investment dependence concerns due to break off in credit market liquidity have motivated the People's Bank of China (PBOC) to provide swap line to obtain liquidity for trade and investment. Ruan (2013), Aizenman (2011), and Ito (2011)) maintained that bilateral currency swap cooperation is mutually symbiotic mechanism that is benefit to both countries. First, it provides trade-financing insulation against international liquidity shocks. Secondly, it benefits both partners reduced transaction costs that may arise in cross-border trade and investments.

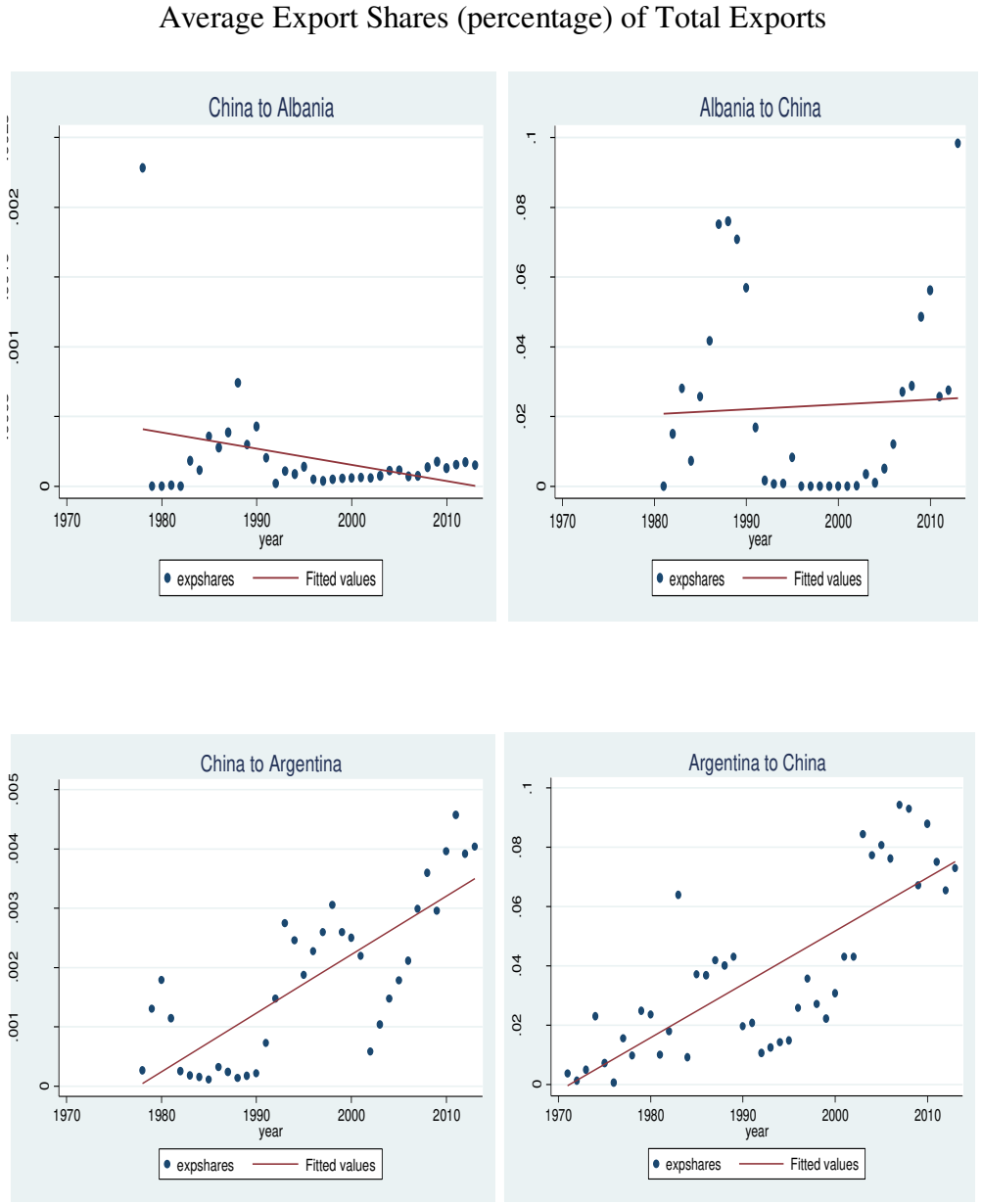
Bilateral currency swapsare also an alternative means for lubricating and financing international trade.[6] The initiative of bilateral currency swap agreements (BSAs) enable China and its trading partners to revert the over-dependence on US dollar for invoicing and settlement of trade. Therefore, PBOC's initiative makes economic sense as they help to reduce the risk of abrupt shocks and shield the exporters against currency risk, by eliminating the costs of hedging against foreign exchange rate risks. As whole, this help to lower the transaction costs of trade and investments (Wilson, 2015; Yang and Han, 2013; and Bowles and Wang, 2013).

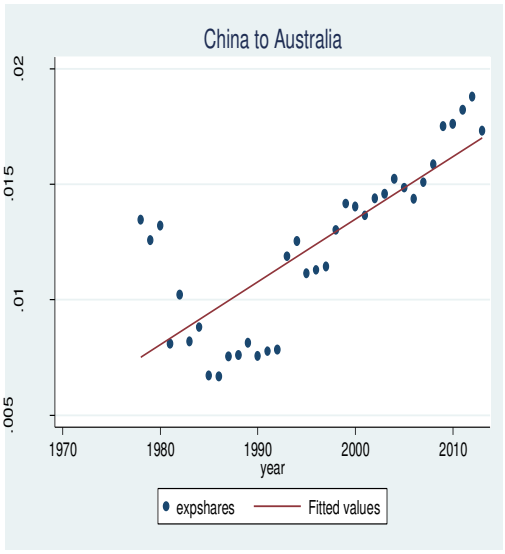
As discussed in Detais (2016) currency swaps is another new channel through which central bank inject the equivalent amount of swapped foreign currency into the domestic financial system, in effect, the funds will be borrowed by commercial banks and other business entities to settle for imports the collaborating country. Conversely, exporters in the partner countries receive the proceeds mainly denominated their domestic currency, which will also reduce the cost of fund transfer. Furthermore, the central bank bilateral currency swaps are useful for managing the unintended consequences of capital markets break down, since some of the swap funds are channel into financial markets, at large this will elevate RMB's potential to emerge as the viable reserve currency for global central banks. It is relevant to note that with the rapid growth rate of China and most of the economies in the Asian region, Renminbi's prospect is likely to continue to manifest with greater acceptability than ever before (Eichengreen, 2011). The wide acceptability is an essential way to enhance the development of the Chinese capital markets. With the large and aging population of China, this will also provide a higher yield as the populace finds a proximate capital investment at home and a new source of investment from global investors. Kwon (2015), Wilson (2015) and Cui, 2013 argued that Asia's emerging economic dominance could be projected in the coming decades will see the more significant interaction between central banks both in the region and across the globe, especially if the Renminbi sustains a pivotalposition as a unit of account in the special drawing rights (SDRs). Importantly, for the fully fledge internationalization to accrue to RMB in the international monetary system, Chinese authorities must consolidate its position in the international community by establishing both economic and political role globally (Liao and McDowell,

[6]The BSAs approach supplies RMB to central banks of China's trade partners for clearing trade.

2015). Figure 3 below depicts the average exports shares of China from 1970 to 2013 to its bilateral swap partners, and mirror exports shares of partners to China. Overall, we show that exports shares from both directions exhibit an upward trend. In fact, this cursory signal reveals the increasing relevance of the role of Chinese swap agreements in the expansion of trade and investment in the global economy.

Figure 1: Average Total Exports Shares of China and Bilateral Swap Partners




China to Australia
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1970
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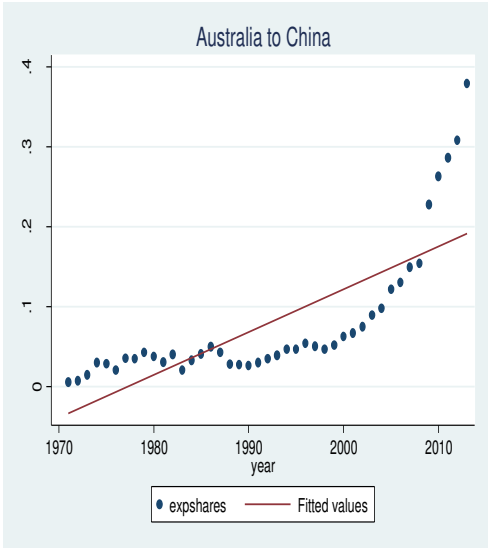
Australia to China
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1970
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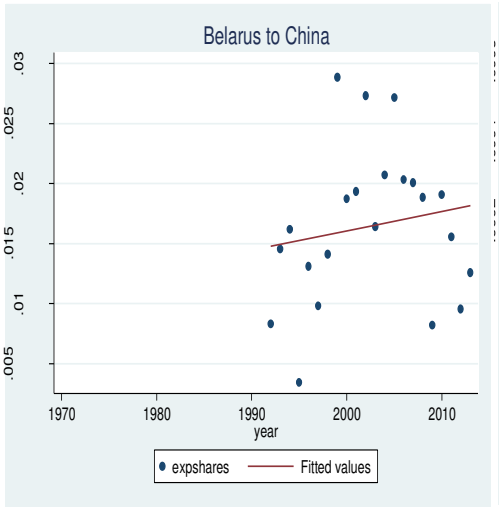
Belarus to China
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.01
.015
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.025
.03
1970
1980
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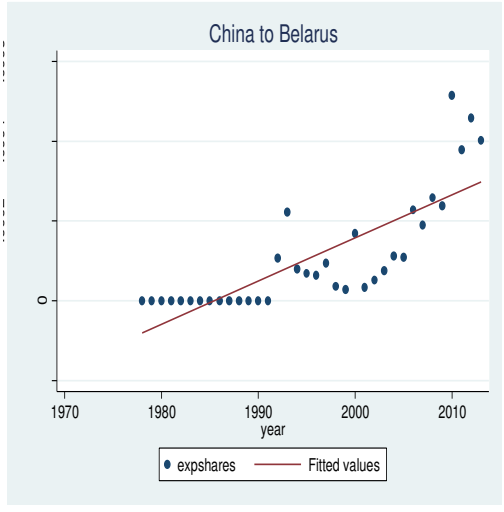
China to Belarus
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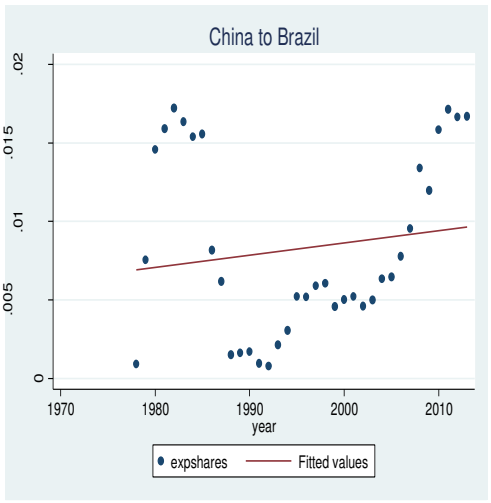
China to Brazil
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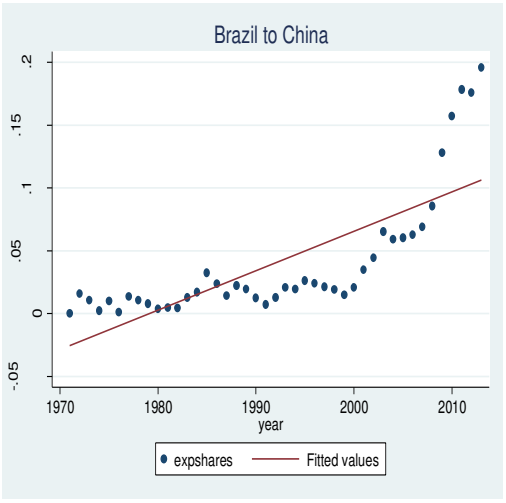
Brazil to China
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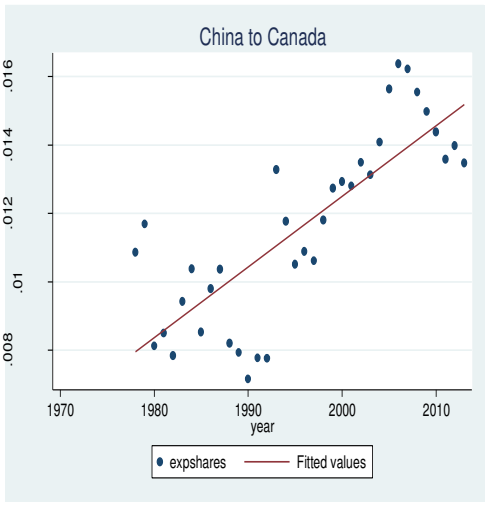
China to Canada
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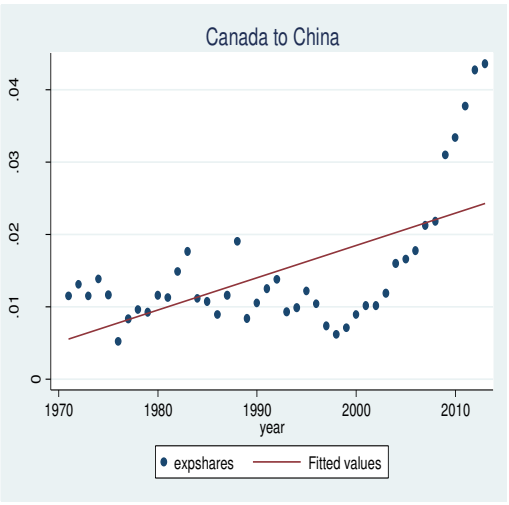
Canada to China
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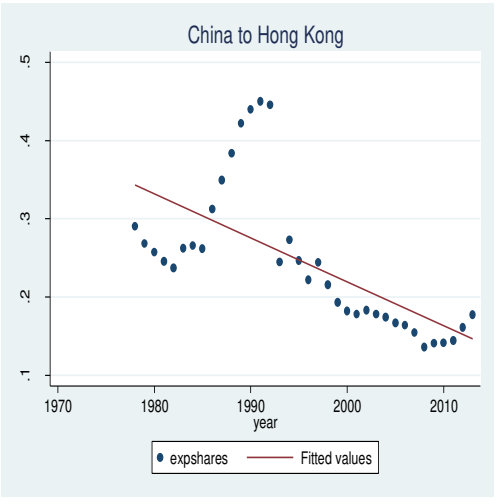
Fitted values


China to Hong Kong
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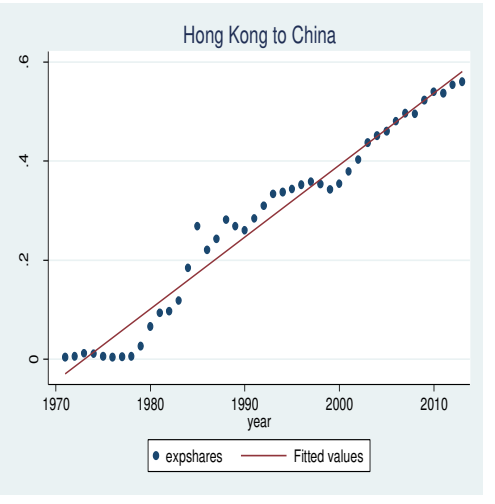
Hong Kong to China
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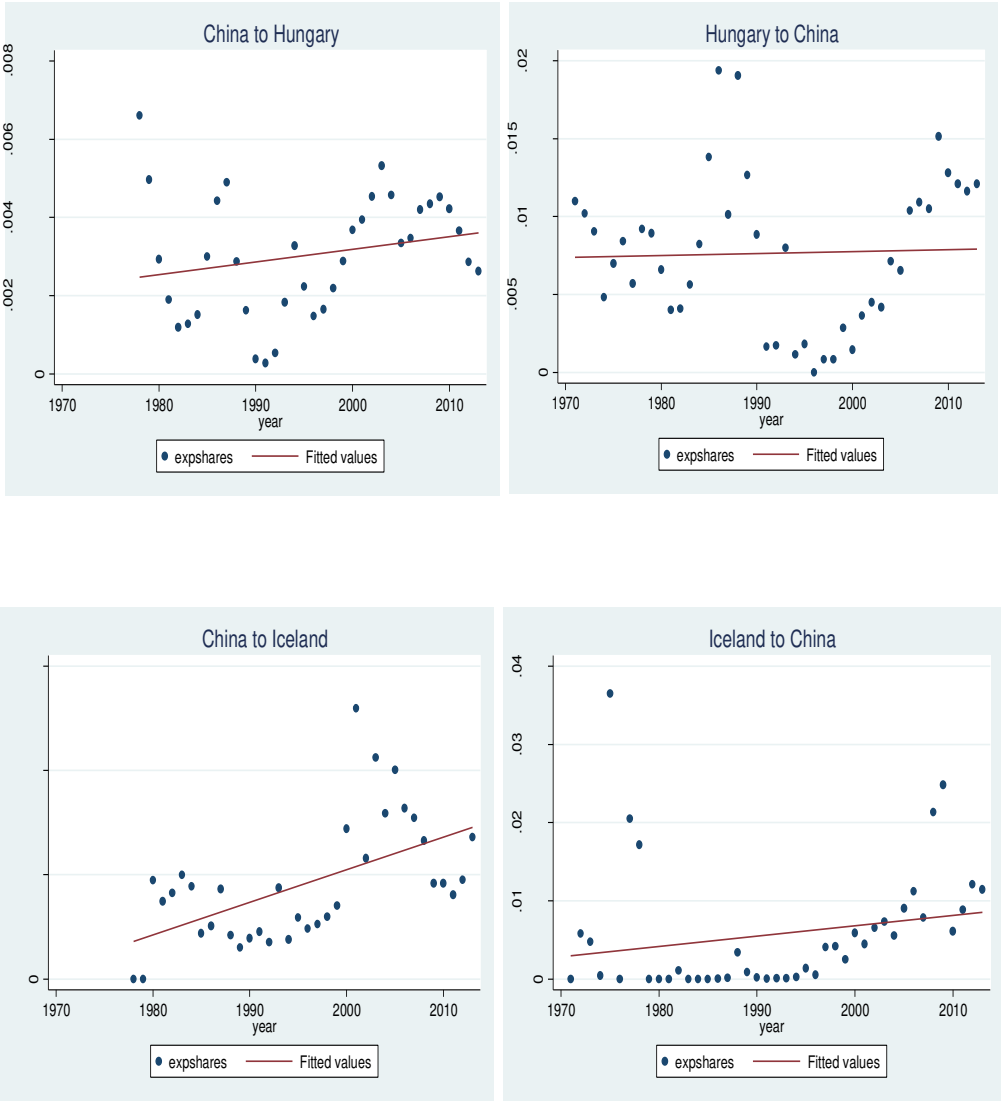

Source: Author's Computation.

Alternatively, this piece of work seeks to explain the motive of PBOC's currency swaps from mercantilist export promotion as a way of intensifying the continuous Chinese economy's export-led drive towards growth. In Figure 3, depicts the computed the average trade shares of China's exports and that of the 26 counterparties to the bilateral swap agreements with People's Bank of China from 1948-2013.[7] Evidently, our analysis suggests that export markets are highly significant between China and most of the 26 counter-parties to the bilateral swap agreements

[7] The remaining of the entire mirror trade shares of the rest of the counterparties of the bilateral swap agreement is shown in the appendix.

(BSAs) over time. The relative trade shares depict a positive trend especially for the provider, further suggesting that swap lines primal motive perhaps resolves around the provider country's self-interest, even though the benefits are substantially symbiotic for the recipient and provider country.[8]

4. The Data and Econometric Methodology

4.1 Data description

Our dataset on bilateral trade data for 213 countries and standard gravity variables comes from Glick and Rose (2016), and the data span from 1948 – 2013. In the data set, trade data relies on the direction of trade statistics (DOTs), real GDP and population come from the World Bank's *World Development Indicators,* augmented with the Penn World Table 7.1 as well as the IMF's International Financial Statistics. Glick and Rose exploit CIA's *World Factbook* for some country-specific variables such as latitude, longitude, landlocked, island status, contiguous border, shared language, colonizers. Information on regional trade agreements originates from the World Trade Organization. Our definition of China's RMB-swap is that Renminbi serves as a clearing trade currency between China and counterparties to the swap agreement or among whole signatories. The analysis covers 213 countries, out of which 26 countries are the counterparty to the China's bilateral currency swap agreement (RMB-trade based policy). We show the lists of the signatories in Table1; we also indicate the size of the swap exchanged with the effective date in which the agreement came into force, inclusive the expiration date and duration of the bilateral currency swap, which is extendable.

Figure 2: Geographical Location of China's RMB Swap lines

[8]Buying foreign currencies to hold back domestic currencies is an effective measure to improve the external balance (competitiveness of a country) and hence exports promotion. This is referred to as mercantilist demand for reserves or seeking to accumulate foreign currency via swap lines, which contrast the demand for reserves associated with precautionary self-insurance.

Source: People's Bank of China's News Release.

Significantly, another important factor that provides stimulus for China's volume of trade growth was the accession of China into World Trade Organization (WTO) in 2001. Fundamentally, synthesis of these factors has beset and driven the emergence of China as a global player on a world economics scale (see Kwon, 2015; Bowles and Wang, 2013; Roubini, 2009; Lao and McDowell, 2015; McCauley, 2011; Cohen 2012). Therefore, China is becoming a global economic player by many measures. Besides, all these advances, the country's strength is not parallel to its currency strength and internationalization, if the RMB does not play significant role in international trade and investment. In recent years, China has been making headway to strengthen its role and participation in the international monetary system, by exerting efforts to propagate the use of its currency, Renminbi (RMB). The green spot in Figure 2 depicts the geographical location where RMB usage is used as trade clearing currency through the bilateral swap agreement with the Peoples' Bank of China (PBOC) and some central banks in the world across continents. Moreover, Renminbi enters the special drawing rights (SDR) in November 2015 with a share of 10.9%, which makes it among the most important currency in the unit, just behind the dollar and euro. Within the existing SDR arrangements with the IMF and quite some countries that are a signatory to the swap line. Central banks can draw Renminbi under swap agreements and can potentially convert fund drawn from swap funds into SDR and then into US

dollars via a set of transactions (Love and Chen, 2015; Lucia, 2016; and David, 2016). Therefore, countries that are a signatory to the swap line with People's Bank of China have access to US dollars. In a way, bypassing the restrictive Federal Reserve swap network, mainly to OECD countries and some emerging markets.[9] The size PBOC's swap line over eight years across continents amounts to more than 3 trillion renminbi ($500 billion). Among those countries that join PBOC's swap line deals include some European countries such as Albania, Belarus, Iceland, Hungary, Kazakhstan, Ukraine, United Kingdom, Russia, and Turkey. The Asian countries include Hong Kong, South Korea, Mongolia, Singapore, Malaysia, Indonesia, Pakistan, Uzbekistan, Thailand, Sri Lanka, Qatar, and United Arab Emirate. Some countries in the South America include Argentina and Brazil. Again, countries from Australia and Oceania continent include New Zealand and Australia (Lin and Cheung, 2016).

[9]It is also an alternative to highly institutionalized and multinational source of finance, and one of these consequences could to generate boost to global liquidity and augmenting to world arsenal of international financial instruments outside the established western – controlled policies. Arguably, the significance could manifest in nearly 10 to 15 years.

Table 1: China's RMB Currency Swap line and Partner Countries

Partner Economies	Currency Swap line size	Effective Date	Expiration Date	Duration (year)
South Korea	RMB 180 bn/KRW 38,000 bn	12 Dec. 2008	Dec. 2011	3
Hong Kong	RMB 200 bn/HKD 227 bn	20 Jan. 2009	Jan. 2013	3
Malaysia	RMB 80 bn/MYR 40 bn	8 Feb. 2009	Feb. 2012	3
Belarus	RMB 20 bn/BYR 8,000 bn	11 Mar. 2009	Mar. 2012	3
Indonesia	RMB 100 bn/IDR 175,000 bn	23 Mar. 2009	Mar. 2012	3
Argentina	RMB 70 bn/ARS 38 bn	2 Apr. 2009	Apr. 2012	3
Iceland	RMB 3.5 bn	10 Jun. 2010	Jun. 2013	3
Singapore	RMB 150 bn/SGD 30 bn	23 Jul. 2010	Jul. 2013	3
New Zealand	RMB 25 bn/NZD 5bn	18 Apr. 2011	Apr. 2014	3
Uzbekistan	RMB 0.7 bn	19 Apr. 2011	Apr. 2014	3
Mongolia	RMB 5 bn	6 May 2011	May 2014	3
Kazakhstan	RMB 7 bn	13 Jun. 2011	Jun. 2014	3
Thailand	RMB 70 bn/THB 320 bn	22 Dec. 2011	Dec. 2014	3
Pakistan	RMB 10 bn/PKR 140 bn	23 Dec. 2011	Dec. 2014	3
UAE	RMB 35 bn/AED 20 bn	17 Jan. 2012	Jan. 2015	3
Turkey	RMB 10 bn/TRY 3 bn	21 Feb. 2012	Feb. 2015	3
Australia	RMB 200 bn/AUD 30 bn	22 Mar. 2012	Mar. 2015	3
Ukraine	RMB 15 bn/UAH 19 bn	26 Jun. 2012	Jun. 2015	3
Brazil	RMB 190 bn/BRL 60 bn	26 Mar. 2013	Mar. 2016	3
England	RMB 200 bn/GBP 20 bn	22 Jun. 2013	Jun. 2016	3
Hungary	RMB 10 bn/HUF 375 bn	9 Sep. 2013	Sep. 2016	3
Albania	RMB 2 bn/ALL 35.8 bn	12 Sep. 2013	Sep. 2016	3
EU	RMB 350 bn/EUR 45 bn	9 Oct. 2013	Oct. 2016	3
Switzerland	RMB 150 bn/CHF 21 bn	21 Jul. 2014	Jul. 2017	3
Sri Lanka	RMB 10 bn/LKR 225 bn	16 Sep. 2014	Sep. 2017	3
Russia	RMB 150 bn/RUB 815 bn	13 Oct. 2014	Oct. 2017	3
Qatar	RMB 35 bn/QAR 20.8 bn	3 Nov. 2014	Nov. 2017	3
Canada	RMB 200 bn/CAD 30 bn	8 Nov. 2014	Nov. 2017	3

Source: People's Bank of China news releases and Lin et al. (2016).

4.2 Econometric Methodology: Structural Gravity Model

The application of Gravity model to bilateral interactions among the pair of countries, predicts trade between two economies as directly proportional to the product of their sizes and inversely proportional to the trade frictions between them. Early applications of this model resort to

physical science analogy of the Newtonian Law of Gravitation without formal economic foundations (see Tinbergen, 1962; Linnnemann, 1966; Aitken, 1973; and Sapir, 1981). In 1979, the formal theoretical economic foundations of gravity emanated, under the assumptions that place of origin differentiates goods as in Armington (1969) and that consumers preferences are homothetic, identical across countries, and approximated by a CES utility function. Anderson (1979) formally derives the fundamental foundation of economic gravity rooted in economic theory. Since then several studies surfaced (see Baier and Bergstrand, 2001; Eaton and Kortum, 2002) and later Anderson and van Wincoop (2003) refine and popularize the idea in Anderson (1979). One notable attribute common to all these models is the explicit role for price levels or some form multilateral resistance term, for example, Balwin and Taglioni (2007) argued that ignoring the multilateral resistance term is tantamount to committing a gold medal mistake in the estimation of the gravity equation.[10] The framework of theoretical structural gravity system suggests the following;

$$X_{ij,t} = \frac{Y_i E_j}{Y}\left(\frac{\tau_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \quad (1)$$

$$\Pi_i^{1-\sigma} = \sum_j \left(\frac{\tau_{ij}}{P_j}\right)^{1-\sigma} \frac{E_j}{Y} \quad (2)$$

$$P_j^{1-\sigma} = \sum_i \left(\frac{\tau_{ij}}{\Pi_i}\right)^{1-\sigma} \frac{Y_i}{Y} \quad (3)$$

Equation (1) is the representation of the theoretical gravity system that derives trade flows between pair of countries, conveniently we can decompose the size term, $Y_i E_j / Y$, and the trade cost term, $\left(\tau_{ij}/\left(\Pi_i P_j\right)\right)^{1-\sigma}$

Here the interpretation of the size term, $Y_i E_j / Y$, denote the hypothetical level of frictionless trade between a pair of countries i and j without trade costs. Mechanically, setting the bilateral

[10]An important departure from the analogy of Newtonian gravity model is the multilateral resistance terms (MTR), which captures general equilibrium forces in a structural gravity system. Anderson and van Wincoop (2003) show that the more a country is resistant to trade with a given country, the more it shall trade with others, including itself and this captures the general equilibrium effect.

frictions to equality (τ_{ij}=1), and re-deriving the gravity model, will intuitively, imply a frictionless world where consumers face the same price for a few goods regardless of their physical location. Similarly, the expenditure share on goods from a country will be equal to the share of production trace to source destination country in the global economy (say $X_{ij}/E_{ij} = Y_I/Y$). In effect, the economics size term carries a very useful information in relation to country size and bilateral trade flows. For example, large producers will naturally export more almost all destinations; richest and biggest markets also import more from almost all sources; also, trade flows between i and j will be larger if the pair countries are similar in size. Similarly, the trade cost term, $\left(\tau_{ij}/\left(\Pi_i P_j\right)\right)^{1-\sigma}$ captures the effect of trade costs that is the driving force of the realized and frictionless trade between a pair country. The literature divides the trade cost term into three components. First, the bilateral trade between a pair of country i and j, τ_{ij}, which is typically denoted by various historical, geographical variables. For example, bilateral distance, common border, language, colonizer, countriesever in colonial relationship and landlocked countries and trade policy variables regional trade agreement, (RTAs) between country pairs say i and j are the gravity controls in the literature. Secondly, the structural terms P_j, denotes the inward multilateral resistance term, which represents importer j's ease access of market. Thirdly, Π_i, indicates the outward multilateral resistance term that measures the exporter I's ease of market access. Primarily, the multilateral resistance term are vehicles that translate into the initial analysis of partial equilibrium effects of trade policy at the bilateral level to measure the country specific effects on consumer and producer prices. The initial effects of trade costs on trade flows account for the direct effect, while the taking into the trade cost changes into prices, incomes and expenditure is capture using the general equilibrium (Head and Mayer 2014 and Yotov et al., 2016). The structural gravity is multiplicative in nature, therefore, log-linearizing equation (1) with error term expansion we obtain the estimating equation thus:

$$\ln X_{ij,t} = \ln E_{j,t} + Y_{i,t} - \ln Y_t + (1-\sigma)\ln\tau_{ij,t} - (1-\sigma)\ln P_{j,t} - (1-\sigma)\ln\Pi_{i,t} + \epsilon_{ij,t} \quad (4)$$

This specification (4) is core to our analysis of central bank bilateral currency swap agreement, trade flows and various determinants of bilateral trade. $X_{ij,t,}$indicates the bilateral trade between country i and j at time t. Which depends positively on $E_{j,t}$and $Y_{i,t}$i.e., the importer expenditure and exporter income, and negatively on distance as a form of trade cost.The proxy of trade cost

in the standard structural gravity system is$(1-\sigma)\ln\tau_{ij,t}$, it incorporates all manner of a series of observables that approximate bilateral trade cost. Interchangeably, we replace $(1-\sigma)\ln\tau_{ij,t}$ with $\ln\Gamma'_{ij,t}$as a measure of all sort of trade cost (a vector of control variables that represent the trade costs) in equation (5), these geographical and historical variables such as common border, language, colonial ties, countries that are an island, landlocked, and prevalence of regional agreements. While $\lambda'_{ij,t}$ (a dummy variable, 0/1 for swap status) which captures the central bank bilateral currency swap between China and members signatory to the agreement. From equation (4) $\ln P_{j,t}$and $\ln\Pi_{I,t}$ are unobservable, to obtain theoretically consistent estimates $\pi_{I,t}$ and $\chi_{j,t}$ captures exporter-time and importer-time fixed effects, which account for the outward and the inward multilateral resistance term, as well as other unobservable exporter-time and importer-time country specific attributes that influences trade. Constant term is not included in the presence of fixed effects.

$$\ln(X_{ij,t}) = \pi_{i,t} + \chi_{j,t} + \rho_1 \ln Y_i + \rho_2 \ln E_j + \rho_3 \ln\Gamma'_{ij,t} + \rho_4 \lambda'_{ij,t} + \epsilon_{ij,t} \qquad (5)$$

While μ_{ij}, in equation (6) captures the unobserved country-pair fixed effects, i.e., it controls bilateral country-pair unobserved heterogeneity and time-invariant unobservable trade-related factors that influence trade. Of relevance to note, all the time-invariant regressor lumped into the pair-specific fixed effects, absorbing all sort of similarities that are constant over time among the trading partners.

$$\ln(X_{ij,t}) = \pi_{i,t} + \chi_{j,t} + \mu_{ij} + \rho_1 \ln Y_i + \rho_2 \ln E_j + \rho_3 \ln\Gamma'_{ij,t} + \rho_4 \lambda'_{ij,t} + \epsilon_{ij,t} \qquad (6)$$

In addition, this makes our regression to rely on time series variation, and it compares the pair observations of each country before and after swap line accession to determine the $\lambda'_{ij,t}$coefficient. In both equation (5) and (6), $\lambda'_{ij,t}$, captures intra-$\lambda'_{ij,t}$ trade creation. The inclusion of fixed effects specification and country-pair fixed effects represent a theory consistent structural gravity formulation to account for unobserved heterogeneity (see Baier and Bergstrand, 2007; Feenstra, 2004; Anderson and Yotov, 2011; Olivero and Yotov, 2012). In the context of estimating average treatment effects of swap agreement on trade across swap member

countries, the specification is in line with Baier and Bergstrand (2007) to yield unbiased coefficient estimates.[11]For robust estimation, we also consider the following PPML regression:

$$X_{ij,t} = \exp[\pi_{i,t} + \chi_{j,t} + \mu_{ij} + \beta_1 \ln Y_i + \beta_2 \ln E_j + \rho_1 \ln \Gamma'_{ij,t} + \rho_2 \lambda'_{ij,t}] + \epsilon_{ij,t} \quad (7)$$

The preceded models applied OLS estimator in log linear form. Econometric theory suggests that pooled or cross section regression satisfy the classical assumptions. Hence, OLS is unbiased, consistent and efficient estimator. However, as discussed in Santos Silva and Tenreyro (2006) standard log linearization is inappropriate and infeasible. First, the dependent variable can be 0. Second, even if all the observations of the dependent variable are strictly positive, the expected value of the log-linearized error will overall the depend on the covariates and therefore OLS will be inconsistent (Santos Silva and Tenreyro, 2006, p.644). Similarly, the error terms are heteroskedastic and therefore its variance depends on the exponential function of the independent variable. Therefore, the pattern of heteroscedasticity, makes all the higher moments of the conditional distribution of the error term to affect the consistency of the estimator. In a nutshell, log linearization process drives the inconsistent estimates because of the correlation of the error term with explanatory variables.

Santos Silva and Tenreyro (2006) applied Poisson Pseudo Maximum Likelihood estimator to estimate gravity model; they show that the PPML estimator performs reasonably well even in the presence of high proportion of zero.[12] Estimating the empirical gravity in multiplicative is the convenient way to deal with the significant amount of zeros, instead of logarithmic form. Similarly, heteroscedasticity is another major concern in dealing with trade data. The problem is importantbecausein the presence of heteroscedasticity and Jensen's inequality as pointed by Silva and Tenreyro (2006), the gravity model estimates of the effects of trade policy and trade costs are likely to be biased and inconsistent with OLS estimator in logarithmic form.

For example, the mean of $ln\epsilon_{ij,t}$depends on a higher moment of $ln\epsilon_{ij,t}$, therefore, including its variance is important. Suppose $ln\epsilon_{ij,t}$ is heteroskedastic, and in practice this possibility might be

[11]Essentially, the omission of this control will make the $CSWAP_{ij,t}$coefficient to have upwards bias because they tend to pick up trade creation that is unrelated to $CSWAP_{ij,t}$simply due to unobservable factors. Therefore, the introduction of country-pair fixed effects absorbs all the non-time varying variables that are likely to bias our coefficient of interest.

[12]Silva and Tenrenyro (2006) depicts the multiplicative gravity expressed as an exponential function of the gravity equation, which provides a nonlinear least square estimator (NLS).

prevalent. Then the expected mean of the error term depends on one or more covariates due to inclusion of variance term. Therefore, this tends to violate the first assumption of OLS which is suggestive of the fact that the estimator may be biased and inconsistent. More so, this kind of heteroskedasticity is not address simply by applying a covariance matrix estimator, because it affects the parameter estimates in addition to standard errors. Our investigation of currency swap on trade applied structural gravity using both OLS and PPML in order to gauge between the two alternative approaches.

The benchmark model is as follows, we estimate the gravity model and discusses the estimation results via pooled OLS and Poisson Pseudo likelihood (PPML) followed by alternative variations of the benchmark model. We further proceed to discuss estimates related to the theoretical (structural) gravity model à la Anderson and Van wincoop (2003) model. It is relevant to note that the significant variance between the two approaches is the way estimates rely on many controls using econometric panel techniques to account for the multilateral resistance term (price indices). Given that, the price indices derived from the theoretical model are not observable. We discussed these two sets of techniques in equation (6),i.e., the fixed effects and the first difference estimation. Subsequently, we address an important issue of concern especially in the estimation of gravity model for applied trade policy research, namely, the possibility that some our explanatory variables may be endogenous in equation (6). Recalling equation (4) we depict the intuitive gravity in equation (8) and (9) shows all sort of trade cost incorporated in our model thus:

$$lnX_{ij,t} = \alpha_0 + \alpha_1 lnE_{j,t} + \alpha_2 lnY_{i,t} + \alpha_3(1-\sigma) ln\tau_{ij,t} + \epsilon_{ij,t} \quad (8)$$

$$\begin{aligned}(1-\sigma)\, ln\tau_{ij,t} = {} & \alpha_3 lnDIST_{ij} + \alpha_4 lnCNTG_{ij} + \alpha_5 lnLANG_{ij} + \alpha_6 lnCLNY_{ij} + \alpha_7 lnCMTRY_{ij} \\ & + \alpha_8 lnLLD_{ij} + \alpha_9 lnRTA_{ij,t} \\ & + \alpha_{10} ln\lambda'_{ij,t} \end{aligned} \quad (9)$$

In the standard literature, the $X_{ij,t}$ variable indicates the logarithm of nominal bilateral international trade flows from exporter i to j at time t. α_0 is a constant term, its structural interpretation represent the world output. While $lnE_{i,t}$ and $lnY_{j,t}$ denotes the logarithm of the exporter income and importer expenditure respectively. (1-σ)$ln\tau_{ij,t}$accounts for all sort of trade

cost. Equation (11) above represent the trade costs with set of robust gravity proxies.[13] For example, $lnDIST_{ij}$ is the logarithm of bilateral distance between the trading partners i and j. $lnCNTG_{ij}$ captures the presence of contiguous border between a pair country i and j. $lnLANG_{ij}$represent a dummy taking values one and zero otherwise for common language. $lnCNLY_{ij}$alsorepresent a dummy equals unity and zero otherwise representing countries ever in colonial ties. $lnCMTRY_{ij}$is another dummy equals unity and zero otherwise for common nations in bilateral data. Similarly, LLD_{ij} represent a dummy equals unity and zero otherwise for landlocked countries. Finally, $RTA_{ij,t}$and $\lambda'_{ij,t}$ are both trade policy variables, $RTA_{ij,t}$ denotes the presence of regional trade agreement between a pair country at time t. While $\lambda'_{ij,t}$ is the variable that accounts for the bilateral RMB-trade policy i.e., bilateral currency swap agreements between China and its counterparts at time t. Where $\epsilon_{ij,t}$ is the random disturbance term (error). The key objective is to estimate the value α as the unknown parameters, in the initial premise we start with the Pooled OLS, which is econometric equivalent to the line of best fit used to show the link between trade, economics sizes and trade costs. As an important econometric problem, it is suggestive that OLS minimizes the sum of squared errorϵ. Econometric theory provides three necessary and sufficient conditions for pooled OLS estimates of the gravity model to yield unbiased results: first, the errors $\epsilon_{ij,t}$ must have mean values zero and be uncorrelated with the explanatory variables (orthogonality assumption). Second, the errors $\epsilon_{ij,t}$ must be drawn independently from a normal distribution with a given (fixed) variance (the homoscedasticity assumption). Thirdly, none of the explanatory variables is a linear combination of other explanatory variables (full rank assumption). Suppose all the three properties hold, the pooled OLS yield consistent, unbiased and efficient estimates of the gravity system within the class of a linear model.[14]

Table 2 present the results of intuitive gravity model using aggregate data. An interesting number feature is apparent from these estimates. First, it relatively fits well with R-squared of 0.51. This denotes that the explanatory variables account for over 50 percent of the variation observed in

[13]In the gravity model literature, there is evidence each of these of factors exert significant impact on trade, this is because they increase or decrease the costs of moving goods internationally.

[14] The consistency of our estimates denotes that the pooled OLS estimates converge to the population values as the sample size increases. Unbiasedness mean that the coefficient estimates do not systematically differ from the population values, though they are based on a sample rather than the full population. Also, by efficiency we mean there is no other linear unbiased estimator that produces smaller standard errors for the coefficients estimates.

our bilateral trade data. The explanatory increases as we add more variables to the model using panel data. Furthermore, the economic sizes depict a positive association with trade as expected. One percent increase in exporter or importer size term (GDP) tend to have an approximately unity impact elasticity on bilateral trade, and this effect is statistically significant at 1 percent level. Similarly, the coefficient on distance is negative and statistically significant at 1 percent, an increase in distance reduces trade by 12%.

Table 2: Pooled OLS Intuitive Gravity Estimates

	[1]	[2]	[3]	[4]
Exporter Income	1.023***	1.125***	1.125***	1.119***
	(0.00823)	(0.00635)	(0.00635)	(0.00639)
Importer Expenditure	0.768***	0.841***	0.841***	0.835***
	(0.00807)	(0.00647)	(0.00647)	(0.00651)
Distance		-1.267***	-1.267***	-1.203***
		(0.0181)	(0.0181)	(0.0185)
Border		0.778***	0.778***	0.766***
		(0.0823)	(0.0823)	(0.0810)
Colony		1.644***	1.644***	1.656***
		(0.0964)	(0.0964)	(0.0966)
Island		0.358***	0.358***	0.331***
		(0.0303)	(0.0303)	(0.0303)

Landlocked		-0.686***	-0.686***	-0.691***
		(0.0282)	(0.0282)	(0.0280)
Common language		0.727***	0.727***	0.716***
		(0.0361)	(0.0361)	(0.0359)
Common nation				-0.0506
				(0.177)
Regional				0.490***
				(0.0351)
Swap				0.247
				(0.196)
Observations	635,137	635,137	635,137	635,137
R-squared	0.432	0.547	0.547	0.548

Notes: the standard errors are clustered by the countrypair and reported in parenthesis. The *p*-values reads *** p<0.01, ** p<0.05, * p<0.1.

Further, a cursory look to the determinants of bilateral trade in our data, we find that most of the coefficients have the expected signs except for commonnation variable that seems to have a negative impact on trade. For example, the existence of common border, colonial ties show an increase in trade of 78% and 91% ($e^{0.76} - 1$ and$e^{1.65} - 1$) respectively. The status of country been an island and land locked countries is also relatively important, the former boosted trade by 51% while the later decreases trade by 50%. Similarly, countries who share common language relatively trade more by ($e^{0.71} - 1 = 74\%$). Our regional trade dummy coefficient depicts a positive and economically largeimpact of ($e^{0.49} - 1 = 63\%$). Of relevance to note that our currency swap is positive though insignificant. To ensure that our results obtained using OLS estimator are robust, we also estimate the Poisson as the alternative gravity model. Similarly, the Poisson estimator has a few desirable properties for applied trade policy using gravity model. Firstly, it has the usual properties of nonlinear maximum likelihood estimators. Second, the model is also consistent with fixed effects estimations, which is particularly important for theory consistent gravity modelling that requires inclusion of fixed effects. Moreover, Poisson estimator includes observations for which observed trade is zero, while such observations simply dropped from log of gravity since the logarithm of zero is undefined. Therefore, the ability of Poisson to consider zero observations is desirable without any variation to the basic model. The importance is reiterated because dropping zero observations may increase the potential problem of sample selection bias, which remained an important issue of concern in empirical analysis (see Silva and

Tenreyro, 2006). This desirable property of Poisson estimator suggests the use of Poisson results rather than Pooled OLS. In this case, we present both Poisson estimates and Pooled OLS for comparable purpose and robustness check. Hence, the choice between the two is empirical one, for example, Silva and Tenreyro (2006) conduct a test to determine the most efficient estimator between Poisson pseudo maximum likelihood and Pooled OLS estimator and find a significant and robust scope in favor of Poisson pseudo maximum likelihood gravity equation.

Table 3: Poisson Pseudo Maximum Likelihood (PPML) Intuitive Gravity Estimates

	[1]	[2]	[3]	[4]
Exporter Income	0.806***	0.850***	0.851***	0.834***
	(0.0241)	(0.0198)	(0.0173)	(0.0166)
Importer Expenditure	0.813***	0.853***	0.853***	0.841***
	(0.0273)	(0.0234)	(0.0218)	(0.0210)
Distance		-0.831***	-0.873***	-0.740***
		(0.0445)	(0.0345)	(0.0298)
Border		0.606***	0.429***	0.415***
		(0.172)	(0.117)	(0.104)
Colony		0.574***	0.161	0.229**
		(0.0771)	(0.112)	(0.102)
Island		0.544***	0.519***	0.548***
		(0.0783)	(0.0784)	(0.0747)
Landlocked			-0.355***	-0.332***
			(0.0615)	(0.0611)
Common language			0.642***	0.592***
			(0.101)	(0.0926)
Common nation			0.0398	0.00337
			(0.483)	(0.492)
RTA				0.475***
				(0.0488)
Currency Swap				0.634**
				(0.270)
Observations	635,137	635,137	635,137	635,137
R-squared	0.322	0.595	0.676	0.727

Comparatively, the PPML estimates derived from the specification (9) enlisted in column (4) of the table (3) points to an essential difference regarding significance and magnitude though signs are the same. Notably, Table 3 depicts the Poisson model, and it fits relatively well better than the previous OLS estimator. A quick comparison of the R-squared reveals the later around 72 percent, compared to 54 percent for the former. The difference in explanatory power suggests that an alternative estimator is crucial to pick up significant features of the data. Similarly, the coefficient estimates under Poisson are statistically different compared with the Pooled OLS. For example, almost all the coefficients are smaller in absolute value, and this mainly reflects the probable impact of heteroskedasticity on the Pooled OLS estimates. Most of the covariates in

table 3 are statistically significant with expected signs. The distance estimates are also statistically significant relatively at the conventional level and approximately equal to benchmark estimates of minus one as documented in Head and Mayer (2014). Thisconfirms that distance poses a significant impediment to bilateral trade. In addition, the impact of common border, language, nation and colonial ties on trade are positive and statistically significant consistent with the literature. Income and expenditure estimates are close to one as expected, positive and statistically significant predicted mainly by structural gravity equation. One key possible explanation that may account for the unit elasticity of income and expenditure covariates is dynamic forces in the panel set up (see Yotov et al., 2016; and Olivero and Yotov, 2012). Estimates of bilateral currency swap obtained from the specification (10) and (9) are reported in table 2 and the PPML counterpart in table 3 respectively. The notable difference that stands out reveals a positive effect of the Pooled OLS results in table 2, but statistically insignificant. While the Poisson estimates in column (5) of table 3 reveala positive, economically substantive, and statistically significant impact of currency swap on trade. Thisimplies that countries that join China's bilateral currency swap trade more by 87% ($e^{0.63} - 1$) compared to the absence of the currency swap agreement.

4.3 Addressing potential Endogeneity Bias

In the estimation of the gravity model, we must give attention to the likely problem of endogeneity, more especially the inclusion of policy variable in the model. From an econometric consideration, the existence endogeneity violates the orthogonality assumption of pooled OLS, by creating a correlation between the right-hand variables and the error term. The potential sources of endogeneity bias of the right-hand side variable's coefficient estimates fall under omitted variable bias, simultaneity bias, and measurement error (see Wooldridge, 2002), believing that these factors can severely be a potential source of bias caused by the RMB-trade policy (swap line).[15]Similarly, reverse causality can ensue as another source of this type econometric problem. For instance, the accession trade policy like the renminbi currency swap may be determined by the degree of country's overall integration in the global markets. Similarly, open economies have incentives to subscribe more to liberal policies, in this case, one has to be cautious in drawing firm conclusion about the impact of such kind of policies on trade.

[15]This issue endogeneity of trade policy in the trade literature can be trace since (Trefler, 1993).

Baier and Bergstrand (2004) empirically examine the economic determinants of RTAs and show that there is a robust cross-sectional evidence that most countries select well their partners, say country pairs are signing RTAs to some extent share some economic traits capable of enhancing the benefit of RTAs. Indeed, it is reasonable to note that there remains large unobserved heterogeneity, for example, suppose exporting firms from a given country suffers from inadequate sources of financing their business activity, because international trade requires additional cost such as shipping, foreign exchange risk among others. Here the anticipated gains from bilateral currency swap between China its counterparts would be substantial, and therefore, governments of countries with this type of weak financial depth would be more likely to select into the swap line. Similarly, as shown in Aizenman (2011) countries use the swap line as a way of complimenting reserves to guide against the unforeseen contingency of illiquidity or complimenting some fiscal spending in infrastructure since the swap funds are not restricted to trade financing.

In fact, these traits are unobservable to the econometrician, these factors may likely correlate with decision into Renminbi swap line. In this sense, swap line and goal of complimenting reserves of fiscal spending may exhibit a positive correlation in the cross-section of the data. But that create a negative error term $\epsilon_{ij,t,}$in the gravity equation, and the swap line coefficient may be underestimated. Also, assuming unobserved cultural or historical features shared between China and its swap counterparts increase concomitantly with trade flows and the likelihood of entering into a bilateral swap agreement, by reducing cost-related barriers compared to when this type of corporation does not exist, this will make the estimated coefficients to exhibit upward bias. Since we care about the consistency, efficiency, and unbiasedness of our coefficient estimates, it is important to note that failure to account for potential endogeneity of $\mathrm{CSWAP}_{ij,t}$, may bias our gravity estimates. Comparable to other trade policy analysis like currency unions (CUs), free trade agreements (FTAs), our approach of dealing with the problem follows that of Baier and Bergstrand (2007) to address some of the endogeneity in FTA regressions: they propose the use panel data with country-pair fixed effects and country-time fixed effects or using first differenced panel with country-and-time fixed effects. Showing that the inclusion of country-pair fixed effects or differencing the data removes the bias attributed to the omission of the unobserved variables affecting bilateral trade and the explaining variable ($\lambda'_{ij,t,}$membership

dummy) which also considers the endogeneity related to selection, since it's mainly a cross-sectional issue.[16]

Table 4: Structural Gravity Estimates with Restricted Sample 1979 – 2013

	Time Fixed effects	Bilateral Fixed Effects	Pair Fixed effects	PPML Pair Fixed Effects	PPML Phase-in Effects
Currency Swap	1.714*** (0.198) (0.0195)	1.409*** (0.199)	1.409*** (0.199)	1.578*** (0.0612)	1.520*** (0.0747)
currency Swap_{t-4}					0.313*** (0.0684)
Observations	564,384	564,384	562,647	562,647	562,647
R-squared	0.713	0.689	0.689	0.672	0.678

Table 4 reports the estimates of structural gravity model with some controls, column (2) depicted results when bilateral fixed effects were included, i.e., both exporter-time and importer-time respectively in the specification (6). To obtain theory consistent estimates, these terms are particularly relevantto account for both outward and inward multilateral resistant terms properly and more inclusively to absorb other unobservable characteristics thatare exporter and importer specific likely to influence bilateral trade. We noted earlier failure to account for the endogeneity of λ'might bias the gravity estimates. Column (3) and (4) reports results that are augmented by

[16] Using a cross section data, instrumental variable method is one of the recommended econometric approach to address the endogeneity problem. However, no exogenous, strong and reliable instrument are available. For example, (Magge, 2003; and Baier and Bergstrand 2004) were among the early studies that instruments with little success. Magge (2003) conclude, "We should be cautious in using gravity equation estimates to draw strong conclusions the effect of PTA on trade." Similarly, Baier and Bergstrand (2007) surveyed and summarize most of the existing findings of IV studies, at best, they found mixed evidence in trying to isolate the effect of FTAs on trade flows. However, same authors argued that one could draw strong and reliable influence about the average treatment effect of FTAs on trade using panel data. Particularly using country-pair fixed effects and first differencing eliminates or account for the likely unobserved linkages between the endogenous trade policy covariates and the error in the gravity regression. Egger and Nigai (2015) and Agnosteva et al. (2014) show that the country-pair fixed effects will absorb all bilateral time invariant covariates and therefore, account for any unobservable time invariant trade cost components, they argued that pair-fixed effects are a better measure of bilateral trade costs than the set of standard gravity regressors.

pair fixed effects in the gravity equation to control for endogeneity in line with the specification (6) via alternative estimators (OLS and the PPML). The estimated coefficient of the CSWAP variable is statistically significant and positive as much large as 1.409 and 1.578 in absolute value for the pooled OLS and PPML estimation results respectively, though with a difference from the specification that imposes time fixed effect. Thissuggests that all else equal, currency swap formation leads to an average increase in trade of [exp(1.578)-1] = 3.80 more than three times with members, though the magnitude is reasonablylarge but empirically closer to other existing findings of other type of international agreements in the literature. Column 3 of table 5 depict the results of the restricted sample (1990 – 2013) of the structural gravity estimates, all else constant currency swap increase trade at least three times [exp(1.286)-1] = 3.61.

4.4 Strict Exogeneity Test for Potential "Reverse Causality" between Trade and Currency Swap

We set to test equation (6) for the possibility of reverse causality because obtaining a reliable estimate is our major concern within the gravity model.[17] The trade policy $\mathrm{CSWAP}_{ij,t}$, may suffer from reverse causality type of endogeneity i.e., assuming, all else constant, a country might choose to liberalize its trade with a trading partner that is hitherto a significant partner. This is known as the natural trading partner hypothesis. Therefore, we tend to have feedback from trade to our trade policy variable (swap) which is opposite to prior expectation. Through the pair fixed effects, we further implement the strict exogeneity test of $\mathrm{CSWAP}_{ij,t}$ by adding a new future level of swaps, $\lambda'_{ij,t+1}$, to specification (6) (Wooldridge, 2002; and Baier and Bergstrand, 2007). Suppose the swap line variable is exogenous to trade flows, the coefficient of the parameter associated to $\lambda'_{ij,t+1}$, should be statistically and economically different from zero. If this is true, swap line is uncorrelated with the concurrent level of trade flow, which is suggestive of confirming the absence of this type endogeneity.

$$\ln(\mathrm{X_{ij,t}}) = \pi_{\mathrm{I,t}} + \chi_{\mathrm{j,t}} + \mu_{\mathrm{ij}} + \rho_1 \ln \mathrm{Y_i} + \rho_2 \ln \mathrm{E_j} + \rho_3 \ln \Gamma'_{\mathrm{ij,t}} + \rho_4 \lambda'_{ij,t} + \rho_5 \lambda'_{ij,t+1} + \epsilon_{\mathrm{ij,t}} \quad (10)$$

In column (5) of table 5 we show the results of specification (10) considers reverse causality between trade and currency swap agreement (trade policy) through pair fixed effects. This assessment is implemented through strict exogeneity test of λ' by adding a new variable that captures the future level of λ'. Suppose λ' are exogenous to trade flows the parameter associated with the future level of currency swap in specification (10) should not be different from zero. Our result from the strict exogeneity test depicts a value that is economically and statistically not different from zero, which confirms the absence of reverse causality in the results related to specification (10). Therefore, it means future changes in currency swap has no significant effect on trade flows. Similarly, our panel estimates in the first difference that uses exporter-time and importer-time and pair fixed effects were negative though significant, and the results are omitted for brevity.

5. Accounting for "Phasing in" Effect of Swap Line and Lagged Terms Trade Effects

We conjecture that swap line may exhibit phase in effect on trade in the manner of free trade agreements. For example, (Anderson and Yotov, 2011; and Baier and Bergstrand 2007) argued that free trade agreement has a strong phase in effect due to its institutional nature, and therefore capturing the lagged changes of FTA on trade provides more information about the impact. Baier and Bergstrand (2007) show that the entire economic treatment effect is hardly measured wholly in the concurrent year of which FTA came into force, and typical FTA "phase in" over ten years. Moreover, this type of agreements tends to alter terms of trade, is well known in the large empirical literature on international economics; terms of trade changes tend to have lagged effects on trade volumes. For instance, FTA entered legally in 2000 may not yield impact on the trade until 2010. In accounting for the phase in effect of this type of agreement, three lagged terms for the bilateral swap agreements are imposed in equation (11) with four years interval.

$$\ln(X_{ij,t}) = \pi_{I,t} + \chi_{j,t} + \mu_{ij} + \rho_1 \ln Y_i + \rho_2 \ln E_j + \rho_3 \ln \Gamma'_{ij,t} + \rho_4 \lambda'_{ij,t} + \rho_5 \lambda'_{ij,t-4} + \rho_6 \lambda'_{ij,t-8} + \rho_7 \lambda'_{ij,t-12} + \epsilon_{ij,t} \quad (11)$$

The motivation for the choice of alternative panel methodologies relied on conceptual and empirical grounds. We apply fixed effects estimation rather random effects estimations based on the following argument. Wooldridge (2002, p.252) show that in econometric parlance random

effect is equivalent to assuming a zero correlation between the observed explanatory variable, say in our case the swap variable and the unobserved heterogeneity say v_{ij}, and that a strong conditional mean independence assumption is required to fully justify the statistical inference. In most applied papersv_{ij}, or the individual random effect is assumed to be uncorrelated with the explanatory variable, which seems implausible in gravity equation. Since the unobserved effect v_{ij}, are likely correlated with our policy variable (swap), therefore, bilateral fixed effects estimations best control for any unobservable effects in the gravity equation (see Baier and Bergtrand, 2007; Anderson and Yotov, 2011; Egger and Nigai, 2015 and Egger, 2003). Empirically, recent econometric investigation of the gravity equation using panel data revealed a striking evidence for the rejection of random effect gravity model in comparison to a fixed effects model, which applies the use of country-pair fixed effects. In addition, Wooldridge (2002, p.284) offer standard econometric discussions on the choice of fixed effect and first differencing estimations especially in the treatment of the endogeneity problem. Showing that the choice of fixed effects or first differencing hinges on the assumption of the idiosyncratic term, $\epsilon_{ij,t}$. The fixed effect estimator is more efficient under the assumption that the error term $\epsilon_{ij,t}$ are serially uncorrelated, when (*T)* exceed two. On the Other hand, first difference estimator is more efficient when $\epsilon_{ij,t}$, is assume follow a random walk (i.e., the difference in the error term follow a white noise, $\epsilon_{ij,t} - \epsilon_{ij,t-1}$) when $T > 2$. Baier and Bergstrand (2007) shows first differencing panel data has some merits over fixed effects. For example, it is quite plausible and foreseeable that the unobserved effects in trade flows, and $\epsilon_{ij,t}$, exhibit contemporaneous correlation overtime. Given the high serial correlation, the inefficiency of fixed effects exacerbates, as *T* gets larger. In this case, first differencing the data enhance the efficiency of our estimation. Similarly, using fixed effects is almost equivalent to differencing the data around the mean, and this is problematic, as *T* gets large in our panel, because the data may tend to follow unit root process, and cause the problem of spurious regression. Using first differencing yields data that departs from the previous period of our panel, which is close to unit root process. Nevertheless, choosing between these methods is difficult, therefore, asa form of robustness check, reporting both methods will offer reassuring estimates.[18]

[18]Wooldridge (2003) recommends reporting results using both. However, if the number of periods is large enough; first differencing is likely to be more efficient especially when the error terms exhibit substantial

The results in table 5 somewhat corroborates those obtained from table 4. More so, the impact of phase-in agreement was realize as captured by bc–swap_lag4 variable in the second row of table 4 and 5 respectively, which means that the bilateral currency swap agreement manifested a mild impact on trade [exp(0.3)-1 = 34%] four years from the RMB-swap inception.

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positive serial correlation.

Table 5: Structural Gravity Estimates with restricted sample 1990 – 2013

	Time Fixed Effects	Bilateral Fixed Effects	Pair Fixed Effects	PPML Pair Fixed Effects	PPML Phase-in Effects
Currency Swap	1.258***	0.986***	0.986***	1.286***	1.223***
	(0.196)	(0.196)	(0.196)	(0.0751)	(0.0876)
$\text{Currency Swap}_{t-4}$					0.337***
Observations	444,290	444,290	442,584	442,584	442,584
R-squared	0.587	0.653	0.653	0.676	0.664

It is important to note that the positive and highly significant effects of the currency swap (RMB-trade policy) found are relatively in accordance with the impacts of other kind of trade agreements like the Currency Union (CU). In studies such as Glick and Rose (2016) who found a fairly large impact currency union on trade in the magnitude of 114%. Earliest literature began with Rose (2001) that found triple effects CUs on trade,though this sound suspiciously large, and preceded empirical findings even set out a more dampeningeffect. For example, Glick and Rose (2002) responded with a larger data sets, and still found that currency unions double trade even with the inclusion of country-pair fixed effects.[19] Thom and Walsh (2002) took into consideration several CU exits and argued that omitted variable bias lingers, such as wars of independence and communist takeovers. Klein and Shambaugh (2006) found a striking evidence that hard currency pegs have a more significant impact on trade than currency unions and show that indirect pegs do not affect trade. Baeir and Bergstrand (2007) addressed econometrically the endogeneity of free trade agreements (FTAs), and further demonstrate that control function and instrumental variable techniques over time do not workreasonably well for endogeneity, but panel data does. Accounting econometrically the endogeneity of FTAs, they found yet another striking empirical evidence of quintupled impact of FTAs on trade flows. Similarly, accounting for phase-in effect on the average FTAs doubles members' bilateral trade after ten years. Barro and Tenreyro (2007) relied on the use of some geographic instrumental variables technique and

[19]The findings of Rose (2000) was so robust and remarkable, in 2005 Harvard's Jeffrey Frankel called the large and significant impact of currency union on trade the most significant finding in international macroeconomics in the preceding 10 years. Rose himself has this to say "I have always maintained that the measured effect of a single currency on trade appears implausibly large…."

found that CUs increases trade up to 14 folds. Baldwin (2006) discussed several reasons why the more significant impact of currency union on trade may likely be suspicious and concluded that on the average Euro increased trade in the magnitude of 5-10%. More so, Bun and Klaassen (2007) incorporate dynamic controls to shrink the high impact of currency union on trade, and the effect is still relatively substantial at 25%. Campbell (2013) also apparently showed the impact of currency unions on trade to have declined over ten years. The findings were the sensitive to exclusion of the CU observations coterminous with some political events or missing data. Similarly, the paper included UK colony time trend, thus accounting for the negative pre-trend, one could find a point estimates of currency unions on trade that is negative and insignificant. The mixed findings in the literature of currency unions made Glick and Rose (2016) respond again with updated data set from 1997 to 2013 and considering some modifications such as switches of around 423 compared to 136 in Glick and Rose (2002).

Nonetheless, some level of doubt lingers, Nitsch (2005) found the absence impact for currency union entries on trade. Similarly, for dollarization episode, Klein (2005) found that their no strong evidence that dollarized countries of western hemisphere have seen an increase in trade with the United States. Also, Santos and Tenreyro (2009) showed that euro has no effect on trade, using meta-analysis Havranek (2010) found a great deal of publication bias for euro studies, and a low impact of 3.8% compared to old 60% for non-euro episodes. We allow for non-linear effects of CSWAP and attempt to capture the possibility that the effects of CSWAP variable may change over time, results are based on the specification (11), and we impose three lags with four years interval up to 12 years of the currency swap agreement. At a glance, column (5) of table 4 shows the estimated coefficients CSWAP at lag four. While lag eight and twelve were not different from zero, and we omit the values for brevity. Notably, the results suggest a relatively mild average treatment effects of CSWAP over the first four years from the inception of the bilateral currency swap of China (RMB-trade policy). Hence, the effects CSWAP maintain significance over four years after the commencement of the RMB-trade policy which explains that currency swap (RMB-trade policy) is economically and statistically buoyant in increasing the level of trade flows.

6. Conclusion

The central objective of this thesis was devoted to answering the question: Do bilateral currency swap agreements (RMB-trade policy of China) increases international trade of signatories to this emerging international trade agreement. Interestingly, the key motivation was to explore the novelty of documenting empirical evidence using gravity equation to estimate the average treatment effect of currency swaps on trade flows, rarely due to the absence of well documented empirical evidence in the literature. Therefore, this is seemingly important in the light of the proliferation of currency swap arrangement with a myriad of central banks across the globe, particularly those agreements that are contingent with the of motive trade expansion of which China's swap line remain an excellent specimen to date in the aftermath of the global financial crisis in 2008. In achieving this goal, our empirical analysis also relies on the on large panel data of over 200 countries, spanning from 1948 – 2013, and the general theoretical foundation of the gravity equation that is consistent with the econometric technique of estimating the average treatment effects of trade policy. The outcome of our empirical findings reveals an apparently large impact of bilateral currency swaps on trade flows. Succinctly, on the average, the estimates suggest that bilateral currency swap increases counterparts trade more than three times [exp(1.578)-1] = 3.80. Comparably, our intuitive gravity estimate shows [exp(0.63)-1] = 87% increase. An important caveat we hold is that currency swap might be different from another form of international trade agreements, such as the currency unions, currency peg, and dollarization, and indeed they have a different impact on trade. In a similar vein, we also acknowledged that different econometric technique delivers different results. Our analysis relies on a panel approach which accounts for country-pair fixed effects solely to circumvent the embedded endogeneity in trade policy analysis, and phase in effects of the bilateral currency swap agreement, which has important implication for future significance of swaps on trade.

The magnitude of the measured effects of the findings might skeptically rise concerns merelyweighing the effects to have been too large to conceive. However, we square the results with other forms of international trade agreements in the literature to gauge a possibility that lies in between. For example, Glick and Rose (2016) found a fairlylarge impact currency union on trade in the magnitude of 114%. Earliest literature began with Rose (2000) that found triple effects CUs on tradethoughthis sound suspiciously large, and subsequent empirical finding even

set out a more dampeningeffect. Baeir and Bergstrand (2007) addressed econometrically the endogeneity of free trade agreements (FTAs), and further demonstrate that control function and instrumental variable techniques over time do not workfairly well for endogeneity, but panel data does. Accounting econometrically the endogeneity of FTAs, they for found yet another striking empirical evidence of the quintupled impact of FTAs on trade flows. In addition, Barro and Tenreyro (2007) relied on the use of some geographic instrumental variables technique and found that CUs increases trade up to 14 folds. Baldwin (2006) discussed several reasons why the larger impact of currency union on trade may likely be suspicious and concluded that on the average Euro increased trade in the magnitude of 5-10%. While Bun and Klaassen (2007) incorporate dynamic controls to shrink the high impact of currency union on trade, and the effect is still relatively substantial at 25%. Another empirical finding that relative differs away from other studies on currency unions was evidenced in Campbell (2013) who apparently showed the impact of currency unions on trade to have declined over ten years. The findings were sensitive to the exclusion of the CU observations coterminous with some political events or missing data. Similarly, the paper included UK colony time trend, thus accounting for the negative pre-trend, one could find a point estimates of currency unions on trade that are negative and insignificant. Although the results are quantifiably remarkable, we believe they are relatively reasonable in the light of why various international trade policies appeared to have a varied impact on trade flows. However, though we have addressed the (multilateral resistance) terms of a given country pair using the exporter-time and importer-time fixed effects, which technically accounts for outward and inward multilateral resistances. We have not address general equilibrium "comparative statics" effects of bilateral currency swaps on two members' trade nor the effects of the agreement on non-members' trade and the possible welfare implication of currency swaps. These possible limitations are left for future research. Our centrifugal focus in this study has mainly been to explore a novelty that the provides policymakers and academics alike an unbiased estimate of the average treatment effect of currency swaps on trade flows of signatories to this emerging international trade agreement.

Conflict Of Interest /Ethical statements

The author declared that there is no conflict of interest associated to this peace of research.

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