CURRENCY HEGEMONY AND INTERNATIONAL TRADE – FINANCIAL INTEGRATION: AN EMPIRICAL ANALYSIS

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Abstract

China's growing economic prosperity and its increasing integration with the global economy as the second largest economy provide it with a competitive advantage on the global stage. One important aspect of this ongoing discussion is the diversification of the international monetary system. This development indicates that there are changes occurring in the world's currency regime and global financial architecture. The bilateral swap agreements between the people's bank of china and various central banks further contribute to the internationalization of the Renminbi. In our research, we utilize the gravity model to examine the relationship between china's renminbi bilateral swap agreements and trade flows. In this paper, we empirically analyze the factors influencing countries' decisions to engage in currency swapping through China's Reminbi swap route. This study is based on a comprehensive panel data set covering 180 countries from 1980 to 2025. The empirical findings indicate that currency swap, as a developing form of international agreement, fosters trade to a similar extent as other trade agreements such as currency unions and free trade agreements, as documented in the literature. This has the potential to offer international bilateral business and trade advantages for nations that adopt china's currency swap line. Additionally, the trade shares and export intensity ratios show a significant positive shift, particularly benefiting the swap provider. This indicates that the primary motivation behind the swap line may be driven by the self-interest of the provider country, despite the fact that the benefits are mutually advantageous for both the recipient and provider countries.

Keywords: Structural Gravity, Financial Integration, Currency Hegemony, and, Trade Flows

JEL CLASSIFICATION: F1, F3, F5,

1. Introduction

Given the China's growing importance in global affairs, particularly in international trade, it is therefore useful to understand the immediate motive for the internationalization of the use of the renminbi (Cheung et al., 2011; Cohen, 2012; Roubini, 2009; and Eichengreen, 2011). This also coincides with the collapse of trade finance during the 2007 global financial crisis. During this period, China's exports fell by 20 percent. The PBOC's response to the risks and problems was to encourage Chinese exporters and importers to conduct their trade in RMB. In addition, ownership of RMB-denominated deposits and bonds held by companies in the offshore markets is widespread around the world. For example, some RMB-denominated trade transactions had increased from zero in 2009 to over US$300 billion in the first three quarters of 2012 (BIS,

2013). The strategic element of the internationalization of the Chinese renminbi consists primarily of the negotiation of bilateral swap agreements (BSAs) between the People's Bank of China (PBOC) and a growing number of partner central banks around the world plan to facilitate cross-border trade and settlement to spread direct investments. To date, more than 25 duly signed bilateral swap agreements have come into force since 2008. The previous developments are arguments that provide sufficient motivation for this study.

Recently, few articles analyze the impact of the currency swap line on international trade flows. For example, Lin and Cheung (2016) used Heckman's two-stage procedure to analyze the swap partner's decisions whether to sign or not sign China's local currency line. They use some institutional, political and economic variables such as the size of the economy (GDP), political stability, the rule of law, corruption and the strategic partnership between China and its counterparties to explain what is likely to bind the currency swap agreement. Their argument, based on the empirical results, shows that China's swap line is not determined by purely economic considerations: political and institutional factors also play a key role. Edwin and Yu (2015)evaluate the potential of the Chinese renminbi as a trade settlement currency. Their quantitative experiments suggest that there is wide scope for the use of the renminbi in trade settlement in the Asia-Pacific region and beyond. Theoretically, the argument suggests that China needs to open its capital account and liberalize its financial market sector to achieve the high external market effects required for the renminbi to become the dominant currency of account.

The central objective of this work was dedicated to answering the question: Do bilateral currency swap agreements (China's RMB trade policy) increase the international trade of the signatories of this emerging international trade agreement? Interestingly, the main motivation was to explore the novelty of documenting empirical evidence using the gravity equation to estimate the average treatment effect of currency swaps on trade flows, which is rarely due to the lack of well-documented empirical evidence in the literature. Therefore, this seems important given the increasing prevalence of currency swap arrangements with a variety of central banks around the world, particularly those arrangements linked to the expansion of trade, of which China's swap line remains a prime example to date Aftermath of the global financial crisis in 2008. To achieve this goal, our empirical analysis also relies on large panel data from over 200 countries from 1990 to 2025 and the general theoretical basis of the gravity equation, which is consistent with the econometric technique for estimating average treatment effects of trade policy.

The result of our empirical findings shows an apparently large influence of bilateral currency swaps on trade flows. In short, the estimates suggest that the bilateral currency swap increases counterparties' trade by more than three times. An important caveat in our view is that currency swap transactions may differ from other forms of international trade agreements, such as monetary unions, currency pegs and dollarization, and may actually have different effects on trade. Similarly, we also recognize that different econometric techniques produce different results. The magnitude of the measured impact of the results could raise concerns among skeptics, considering the impact merely too large to believe. However, we compare the results with other forms of international trade agreements in the literature to assess a possibility that lies in between. For example, Glick and Rose (2016) found a fairly large impact of monetary union

on trade, on the order of 114%. The earliest literature began with Rose (2000), who found triple effects of CUs on trade, although this sounds suspiciously large, and later empirical evidence even showed a more pronounced dampening effect (see Esposito 2017; Frankel 1997; Ghosh and Yamarik 2004; Baier and Bergstrand 2007; Magge 2008 and Eicher, Henn and Papageorgiou 2012).

This study is structured as follows. Section 1, introduces the empirical study, Section 2 provides an overview of the and empirical studies on currency swapand international trade, Section 3 describes the data and methodology used in the study and Section 4 contains main empirical results, Finally, section 5 concludes.

2. Literature Review

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, 2015).

As discussed in Detais (2016), currency swaps are another new channel through which central banks inject the equivalent amount of exchanged foreign currency into the domestic financial system. The funds are effectively borrowed from commercial banks and other companies to process imports to the cooperating country. Conversely, exporters in the partner countries receive most of their proceeds in their local currency, which also reduces the costs of money transfers. Additionally, the central bank's bilateral currency swaps are useful in addressing the unintended consequences of a capital market collapse, as some of the swap funds flow into financial markets, overall increasing the RMB's potential to emerge as a viable reserve currency for the global central bank Banks. It is important to note that given the rapid growth rate of China and most economies in the Asian region, the prospect of the renminbi is likely to continue to be more widely accepted than ever before (Eichengreen, 2011). Widespread adoption is an essential way to promote the development of China's capital markets. Given China's large and aging population, this will also result in higher returns as the population has immediate 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 is expected to lead to more significant international... in the coming decades.

Khurshed (2012) illustrated that Currency swap can be viewed as foreign exchange agreement between two parties to exchange principal and interest payments of a loan in one currency for equivalent aspect of an equal in net present value loan in another currency. This sort of arrangements is motivated by comparative advantage. Generally, currency swap that involves the

exchange of principal and in one currency for the same in another currency is a foreign exchange transaction that is not required by law to be shown on the balance sheet. Similarly, since the exchange payments take place in two different currencies, the prevailing spot rate is benchmark to calculate interest payment and the principal. Significantly, the swap agreement is a customized instrument of international finance used to hedge against exchange rate and interest rate risk which is particularly important for firms and countries whose major source revenue heavily relies on international trade.

Furthermore, Cheung et al. (2011), Ruan (2013), Yu (2012) and Ito (2011) emphasized arguments far from globalizing RMB as a store of value nor efforts build up a network of a financial hub in East Asia and beyond. They extend that the move is part of China's strategy to rebalance the lingering skewed international balance sheet - namely large and rapidly increasing exposure to foreign exchange rate risk. Stressing that the exposure derives from the combination of China's openness to direct investment from the rest of the world, current account surpluses, and lack of RMB internationalization. Furthermore, China like many advanced economies, at present it has a short position in its currency and a long position in other reserve currencies especially the US dollar (this accounts for inward direct investment and inward portfolio equity as RMB liabilities).

The government actively engages 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; Subramanian and Kessler, 2012; 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. 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. After that, in October 2013, some of the temporary BSAs were converted into standing arrangements with five developed countries, namely the Bank of England, the Bank of Japan, the European Central Bank, Swiss National Bank, and Bank of Canada (Detais, 2016 and Goldberg and Kenney, 2010).

Bilateral swap agreements (BSAs) is not an entirely a new phenomenon. For example, in the aftermath of the global financial crisis, the Association of the South East Asian Nations plus the three largest East Asian economies – Japan, South Korea, and China signed the Chiang Mai Initiative (CMI) to guide against the future occurrence of liquidity shortage (see Aizenman et al. 2011 and Aizenman and Lee, 2008). 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. It is important to note that, 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; Song and Zilibotti, 2009; McCauley, 2011; Cohen 2012).

Arguably, (Aizenman, Jinjazak, and Zheng, 2017) stressed that these policies deliberately pursued by the Chinese authorities intend to delay and slow the real appreciation associated its

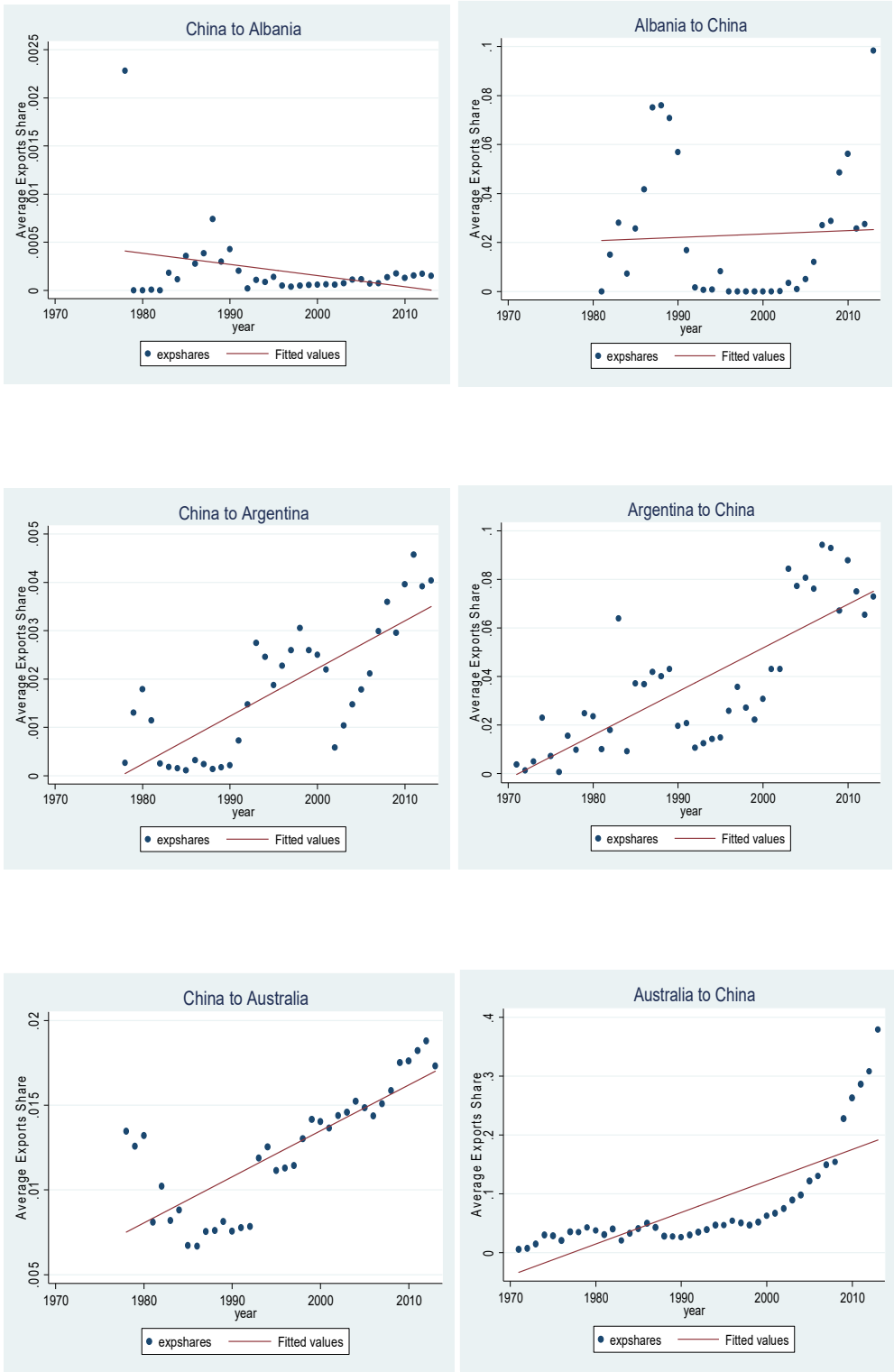
rapid growth success. The Asian region had seen the proliferation and build-up of FX reserves unprecedentedly since after the Asian financial crisis of 1997-1998. The Asia's reserve swelled from US$202 billion in 1990 to US$3371 billion in 2008, and the growth continues to gallop at 20% per year. It is important to note that China's contribution to this buildup accounted for than 50% of the realized growth of 1990-2008. Aizenman et al. 2011 opined that the Asian's crisis had a devastating impact socially and economically in the region. Even though five countries – Indonesia, Korea, Malaysia, Philippines, and Thailand bore the weight of the shock, but the psychological impact of the crisis spread to the whole region. On the precise cause of the crisis, a considerable deal of controversy clouds discussion of academics and policy circle. However, the consensus was that of a shortage of international liquidity.

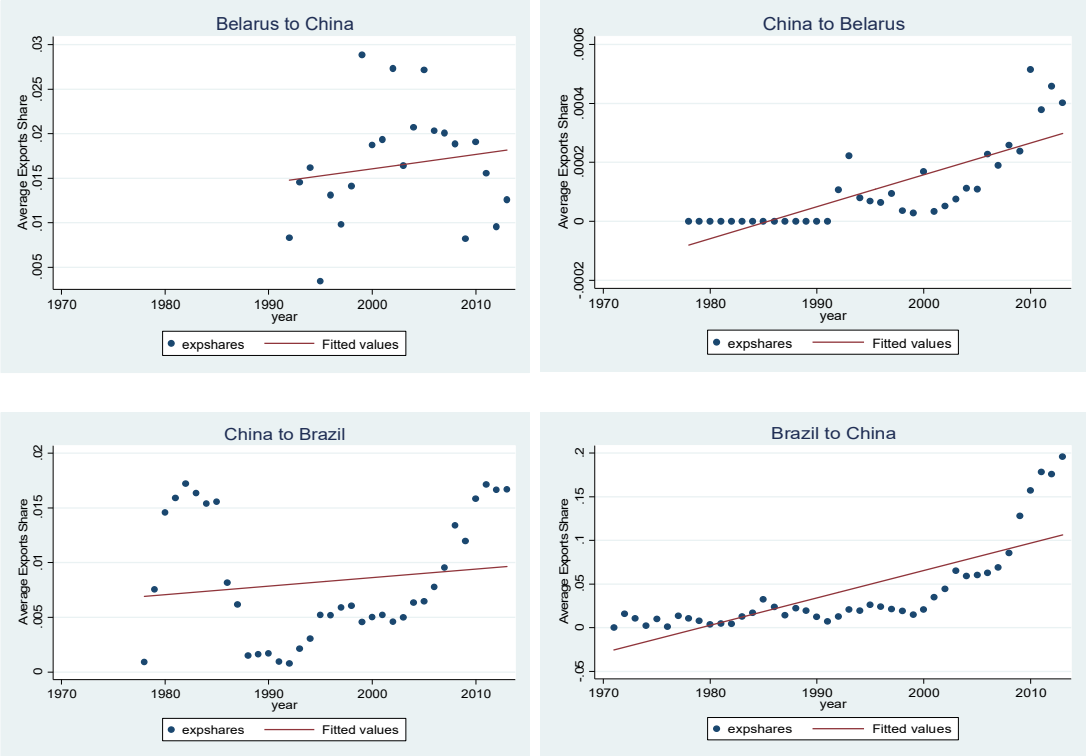
Caglayan and Demir (2013) also find a significantly negative of exchange rate uncertainty on trade flows in emerging markets. Furthermore, the results show that the direction of trade matters under the condition of exchange rate uncertainty, especially the direction of south-south or south-north trade. Asteriou et al. (2016) tested four empirical models for the impact of exchange rate volatility on export and import demand for the MINT countries. The existence of swap lines as a hedging facility is one way of reducing the exchange rate uncertainty on international trade. Theoretical studies long established the expected impact of exchange rate volatility on international trade (see Ethier 1973; Viane and Vries, 1992; Allayannis, 2001; and Brollet al. 2015).

The effect might negatively assert influence on trade depending on some factors such as the structure of production such as the small number of firms, risk preferences, presence or absence of forward contract markets or currency swap options, and degree of economic integration (see Auboin and Ruta, 2013; Kawai, 1986; Doganlar, 2002; Ethier, 1973; and Clark, 1973; Barkoulas, et al., 2002; Broll and Wessel, 2011; Wong, 2003). Goswami et al. (2004) theoretically show that high economic exposure determines firm's preference to currency swaps. The economic exposure is positive if the foreign currency denominated cash inflows negatively correlate with foreign exchange rates. Their theory suggests that currency swaps help global firms to achieve long-term financing and financial risk management goals.

Figure 1 below shows China's average export shares to its bilateral swap partners from 1990 to 2025, reflecting the partners' export shares to China. Overall, we show that export shares from both directions show an upward trend. In fact, this superficial signal highlights the increasing importance of the role of Chinese swap agreements in expanding trade and investment in the global economy.

Figure 1: Average Export Shares (percentage) of Total Exports of China and swap partners





Source: Author's Computation.

3. Methodology

3.1 Data Description

Our dataset of bilateral trade data for 180 countries and standard gravity variables is from Glick and Rose (2016) and the data range from 1990 to 2025. In the dataset, trade data is based on The Direction of Trade Statistics (DOTs), real GDP and population come from the World Bank's World Development Indicators, supplemented by Penn World Table 7.1 and the IMF's International Financial Statistics. Glick and Rose use the CIA's World Factbook for some country-specific variables such as latitude, longitude, landlocked land, island status, contiguous border, common language, colonizers.

Our definition of China's RMB swap is that the renminbi serves as a clearing trading currency between China and the counterparties to the swap agreement or between the entire signatories. The analysis covers 180 countries, 27 of which are the counterparty to China's bilateral currency swap agreement (RMB trade policy). We show the lists of signatories in Table 1; We also indicate the size of the swap exchanged with the effective date of the agreement, including the expiration date and term of the bilateral currency swap, which is renewable.

3.2 Econometric Methodology

Applying the gravity model to bilateral interactions between the pair of countries predicts that trade between two economies is directly proportional to the product of their sizes and inversely proportional to the trade conflicts between them. Early applications of this model relied on the physical analogy of Newton's law of gravity without formal economic foundations (see Tinbergen, 1962; Linnnemann, 1966; Aitken, 1973; and Sapir, 1981). In 1979, the formal theoretical economic foundations of gravity were developed, assuming that place of origin differentiates goods, as in Armington (1969), and that consumer preferences are homothetic, identical across countries, and approximated by a CES utility function. Anderson (1979) formally derives the basic foundation of economic gravity, which is rooted in economic theory.

The theoretical structural gravity system framework suggests that:

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

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

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 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:

$$\ln X_{ij,t} = \ln E_{j,t} + Y_{i,t} - \ln Y_t + (1-\sigma)\ln\tau_{ij,t} - (1-\sigma)\ln P_{j,t} - (1-\sigma)\ln\Pi_{i,t} + \epsilon_{ij,t} \quad (3)$$

This specification (3) is core to our analysis of 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 (vector of control variables that represent the trade costs) in equation (3), 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.

4. Results and Discussion

4.1 Baseline Model

Recalling equation (3) we depict the intuitive gravity in equation (4) and (5) shows all sort of trade cost incorporated in our model thus:

$$lnX_{ij,t} = \alpha_0 + \alpha_1 lnE_{j,t} + \alpha_2 lnY_{i,t} + \alpha_3(1-\sigma)ln\tau_{ij,t} + \epsilon_{ij,t} \quad (4)$$

$$\begin{aligned}(1-\sigma)\, ln\tau_{ij,t} = {} & \alpha_3 lnDIST_{ij} + \alpha_4 lnCNTG_{ij} + \alpha_5 lnLANG_{ij} + \alpha_6 lnCLNY_{ij} + \alpha_7 lnCMTRY_{ij} \\ & + \alpha_8 lnLLD_{ij} + \alpha_9 lnRTA_{ij,t} \\ & + \alpha_{10} ln\lambda'_{ij,t} \quad (5)\end{aligned}$$

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 (5) above represent the trade costs with set of robust gravity proxies.[7] 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 swap 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[8].

The empirical results analyzing China's bilateral currency swap agreements (BSAs) and international trade flows reveal several key findings across the estimation models. For example pooled OLS estimates (Table 1): In the baseline Pooled OLS intuitive gravity specifications, bilateral economic scale (lnY and lnE) and standard geographical controls (border, common language, colony, island, landlocked) perform as expected. However, the initial Pooled OLS bilateral currency swaps dummy (BcSwap) yields a coefficient of 0.247, which is statistically insignificant in the basic model setup.

Moreover, the poisson pseudo maximum likelihood (PPML) Estimates (Table 2) Applying the PPML estimator shows a statistically significant positive effect for the bilateral currency swap agreement (BcSwap) with a coefficient of 0.634 ($p < 0.05$) in model 4. This intuitive gravity estimate corresponds to an approximate 87% increase[exp(0.634) - 1]x100 in trade between counterparties.

From panel gravity equations with Pair fixed effects (Tables 3 & 4), when applying theory-consistent structural gravity specifications with country-pair fixed effects to account for unobserved heterogeneity, the average treatment effect of the bilateral swap line increases substantially. In Table 3, the PPML pair fixed effects model yields a Bcswap coefficient of 1.570 ($p < 0.01$), implying that bilateral currency swaps increase trade among counterparties by more than three times (specifically 3.80 times or 280% based on [exp(1.570) - 1]). In Table 4's structural gravity specifications, the initial treatment effect (Bcswap) ranges from 1.506 (Pooled OLS pair fixed effect) up to 5.115 under PPML pair fixed effects.

[7]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.

[8]Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 as shown in the table above.

The Phase-in And lagged effects (Tables 3 & 4) Similar to Free Trade Agreements (FTAs), China's currency swap lines demonstrate a strong "phase-in" effect over time. Accounting for lagged impacts shows significant lagged effects: the 4-year lag variable (Bcswap_LAG4) yields positive coefficients of 0.693 in Table 3 and 1.106 in Table 4, demonstrating that the trade-expanding benefits of currency swaps persist and build over several years following implementation.

However, distribution of trade benefits depends on descriptive patterns and trade share ratios indicate that while the benefits are mutually advantageous to both recipient and provider countries, trade shares and export intensity ratios shift significantly in favor of the swap provider (China).

Table 1: Pooled OLS Intuitive Gravity Estimates

	(1) Model	(2) Model	(3) Model	(4) Model
ln_Y	1.023***	1.125***	1.125***	1.119***
	(0.00823)	(0.00635)	(0.00635)	(0.00639)
ln_E	0.768***	0.841***	0.841***	0.835***
	(0.00807)	(0.00647)	(0.00647)	(0.00651)
ldist		-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)
Landl		-0.686***	-0.686***	-0.691***
		(0.0282)	(0.0282)	(0.0280)
Comlang		0.727***	0.727***	0.716***
		(0.0361)	(0.0361)	(0.0359)
Comctry				-0.0506
				(0.177)
Regional				0.490***
				(0.0351)
BcSwap				0.247
				(0.196)
Constant	-43.06***	-37.26***	-37.26***	-37.52***
	(0.338)	(0.286)	(0.286)	(0.281)
Observations	635,137	635,137	635,137	635,137
R-squared	0.432	0.547	0.547	0.548

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.[9]

4.3 Alternative Structural Gravity Model

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.

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.

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

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 equations (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).

[9] 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.

Table2:Poisson Pseudo Maximum Likelihood Gravity Estimates

	(1) Model	(2) Model	(3) Model	(4) Model
ln_Y	0.806***	0.850***	0.851***	0.834***
	(0.0241)	(0.0198)	(0.0173)	(0.0166)
ln_E	0.813***	0.853***	0.853***	0.841***
	(0.0273)	(0.0234)	(0.0218)	(0.0210)
ldist		-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)
Landl			-0.355***	-0.332***
			(0.0615)	(0.0611)
Comlang			0.642***	0.592***
			(0.101)	(0.0926)
Comctry			0.0398	0.00337
			(0.483)	(0.492)
Regional				0.475***
				(0.0488)
Bcswap				0.634**
				(0.270)
Constant	-36.43***	-32.39***	-32.12***	-32.48***
	(0.988)	(0.895)	(0.845)	(0.799)
Observations	635,137	635,137	635,137	635,137
R-squared	0.322	0.595	0.676	0.727

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.[10]For robust estimation, we also consider the following PPML regression:

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

[10]Essentially, the omission of this control will make the $BCSWAP_{ij,t}$coefficient to have upwards bias because they tend to pick up trade creation that is unrelated to $BCSWAP_{ij,t}$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.

The preceded models applied OLS estimator in log linear form[11]. Econometric theory suggests that pooled or cross section regression satisfy the classical assumptions. Hence, OLS is unbiased, consistent and efficient estimator.

Table 3: Panel Gravity Equations

	(1) OLS Pair fixed effect	(2) PPML Pair fixed effects	(3) PPML Future lead	(4) PPML Phase in effect
ln_Y	1.156***	0.782***	0.782***	0.782***
	(0.00782)	(0.0272)	(0.0272)	(0.0272)
ln_E	0.891***	0.780***	0.780***	0.780***
	(0.00745)	(0.0311)	(0.0311)	(0.0312)
Bcswap	0.656***	1.570***	1.570***	1.447***
	(0.195)	(0.432)	(0.432)	(0.415)
Bcswap_LAG4				0.693**
				(0.349)
Constant		-34.36***	-34.36***	-34.36***
		(1.069)	(1.069)	(1.069)
Total ATE	0.656	1.57	1.57	1.47
Observations	633,959	635,137	635,137	635,137
R-squared	0.862	0.349	0.349	0.350

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

[11] Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
[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).

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 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.

Furthermore, 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.

Table 4: Panel Gravity Equations and Phase in Effect

Variables	Pooled OLS Pair Fixed effect	PPML Pair Fixed effects	PPML Future lead	PPML Phase in effect
Bcswap	1.506***	5.115***	5.115***	4.947***
	(0.204)	(0.499)	(0.499)	(0.483)
Bcswap_LAG4				1.106***
				(0.345)
Constant		5.797***	5.797***	5.798***
		(0.162)	(0.162)	(0.162)
Observations	730,063	731,826	731,826	731,826
R-squared	0.841	0.039	0.039	0.041

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 (8) with four years interval.

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

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 enhances the efficiency of our estimation. Similarly, using fixed effects is almost equivalent to differencing the data around the mean, and this is problematic, as Tgets 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.[13]

[13]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 positive serial correlation.

5. Conclusion and Recommendations

The result of our empirical findings shows an apparently large influence of bilateral currency swaps on trade flows. In summary, on average, the estimates suggest that the bilateral currency swap increases counterparties' trade by more than three times [exp(1.578)-1] = 3.80. Comparatively, our intuitive gravity estimate shows an increase of [exp(0.63)-1] = 87%. An important caveat we raise is that currency swap transactions may differ from other forms of international trade agreements, such as monetary unions, currency pegs and dollarization, and may actually have different effects on trade. Similarly, we also acknowledged that different econometric techniques produce different results. Our analysis is based on a panel approach that considers the country pair fixed effects exclusively to circumvent the embedded endogeneity in trade policy analysis and introduces the effects of the bilateral currency swap agreement, which has important implications for the future role of swaps in trade.

While the results are quantifiably remarkable, we believe they are relatively reasonable given why different international trade policies appeared to have different impacts on trade flows. However, we addressed the (multilateral resistance) conditions of a given country pair using the exporter and importer time fixed effects, which technically explain external and internal multilateral resistance. We have not addressed the general equilibrium effects of the "comparative statics" of bilateral currency swaps on the trade of two members, nor the effects of the agreement on the trade of non-members and the possible welfare effects of currency swaps. These potential limitations remain for future research. Our central focus in this study was primarily to examine a novelty that provides policymakers and scholars alike with an unbiased estimate of the average treatment effect of currency swaps on the trade flows of signatories to this emerging international trade agreement.

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