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Article

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Effect of exchange rate uncertainty on bilateral trade performance in SAARC countries: a gravity model analysis

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Abstract

Purpose – Exchange rate uncertainty leads to an indecisive environment for imports and exports that would condense international trade, foreign direct investment, trade earnings, trade volumes, economic growth and welfare. This study aims to examine, empirically, the effect of exchange rate uncertainty on bilateral trade performance, focusing on eight SAARC member economies using the popular modified gravity model of trade.

Design/methodology/approach – The paper includes eight SAARC members – Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan and Sri Lanka panel data set over the period 2005–2018. The authors consider both standardized value (standard deviation) and conditional variance model to determine volatility of exchange rate. Primarily, ordinary least squares, random effects and fixed effects estimation techniques are employed to investigate the impact of exchange rate volatility. Endogeneity and robustness of the findings have been tested using the simultaneity-adjusted model and dynamic panel data two-step system GMM estimation techniques.

Findings – Empirical findings endorse the view that exchange rate volatility lowers trade flows in the SAARC regions. However, this adverse effect of exchange rate uncertainty on trade is pretty small. The negative correlation between exchange rate volatility and bilateral trade remains consistent and significant after controlling of simultaneous causality, autocorrelation, year effects, country-pair heterogeneity and endogeneity irrespective of panel data estimation techniques and different measures of volatility.

Originality/value – The present paper is original work.

Keywords Gravity model, SAARC, Bilateral trade, Exchange rate uncertainty

Paper type Research paper

1. Introduction

The effect of exchange rate uncertainty on bilateral trade is a crucial issue of academic investigation as well as an essential concern of monetary policy relevance. The evidently favorable impact on trade performance of restricting exchange rate instability has become one of the key controversies for the single currency union, regional economic integration and different types of agreements on the fixed exchange rate. The world has already experienced the Asian crisis in 1997–1998 due to the collapse of the exchange rate started in Thailand. The crisis swept over and seriously damaged exchange values of currencies, stock markets and other asset prices in the East and Southeast Asian countries. It became a global financial



crisis when it extended its effects to Russia and Brazil. Studies revealed that one of the possible causes of this crisis was maintaining a fixed exchange rate that was pegged such a rate (concerning US dollar), which is favorable to exporters. External economic forces were overlooked and left exposed to foreign exchange risk. In the mid-1990s, the Federal Reserve initiatives to raise interest rates against inflation directed to an appreciation of the US dollar value and attracted hot money to flow into the US economy. Currencies that are pegged to the US currency are also appreciated and, as a result, collapse the export growth and foreign investment. Though the South Asian Association for Regional Cooperation (SAARC) countries affected the least on this crisis, the experience of the crisis leads the SAARC policymakers to form a South Asian Customs Union (SACU) and South Asian Economic Union (SAEU) as early as 2015 and 2020, respectively, under the roadmap of 1999 with a vision titled “greater coordination of monetary and exchange rate policy” (Banik and Gilbert, 2008). The establishment of SAARCFinance in 2002 by the SAARC central bank governors and finance secretariats is the initial doorstep in this direction. Maintaining a stable exchange rate movement is an important policy agenda of the SAARCFinance because a sharp fluctuation in the exchange rate in one member country can badly affect other member economies’ external trade position where the exchange rate remains reasonably stable.

In general, excessive volatility or fluctuation of exchange rate triggers uncertainties that directly affect international trade and the economy. Extreme volatility sends terrible signals for foreign investors and restricts foreign investment flow by reducing foreign direct investment in overseas operational facilities and capital investment (Horvath, 2005; Hagen and Zhou, 2005). The more frequent exchange rate volatility leads to an uncertain environment for imports and exports that would condense international trade, trade earnings, trade volumes, economic growth and welfare (Hall *et al.*, 2010). Both international trade and investment choices become more complicated due to frequent change of exchange rates, and more volatility generates exchange rate risk. Because of exchange rate risk, exporters may prefer to shift to domestic market activities where returns are relatively less risky rather than continuing to export in overseas markets. Exchange rate volatility also pressures macroeconomic policy formulation, for example, for countries who are introducing an inflation-targeting regime, monetary authorities should amend the projected inflation target repeatedly because of modification of the level and volatility in the exchange rate.

The SAARC established on December 8, 1985, with a common objective of accelerating economic growth and social development of South Asia. One of the successful initiatives of the SAARC is the formulation of SAARC Preferential Trade Arrangement (SAPTA) in 1993 to speed up and sustain mutual international trade through trade liberalization process (i.e. reduction of tariff rate). Lessening of tariff barrier through SAPTA allows the SAARC members for specialization in the capacity of production, which in turn helps to decrease the cost of production, increase in demand and leads to progress of bilateral trade among members. However, facilitating trade liberalization of each country to the international market is not only depending on lessening of tariff or nontariff barrier, but also there are substantial external shocks that could adversely affect bilateral trade among nations. Exchange rate uncertainty is one of the crucial external shocks for the efficient and smooth operation of international trade flows. Though SAARC member countries have introduced a flexible exchange rate regime after the 1990s, each member country has different monetary policy framework to determine their exchange rate regime. Thus, the degree of exchange rate uncertainty for each nation is different, and this uncertainty could affect bilateral trade performance of the SAARC countries.

Numerous empirical studies have analyzed this issue, and definitely, these studies reveal mixed effects. The earliest empirical studies (Hooper and Kohlhagen, 1978; IMF, 1984) consider a few numbers of high-income countries and show no consistent trade effect of exchange rate fluctuation. The most recent studies apply popular gravity model approach

considering a sort of bilateral trade data to measure the impact of real exchange rate shock (Clark *et al.*, 2004; Hayakawa and Kimura, 2009; Asteriou *et al.*, 2016; Kang, 2016; Senadza and Diaba, 2017; Nguyen and Vo, 2017; Lin *et al.*, 2018). Studies in this cluster find adverse and statistically significant effects; some show this negative effect is relatively small, and others argue that this negative effect is not robust using different econometric methods. A group of studies employs autoregressive conditional heteroskedasticity (ARCH) or generalized autoregressive conditional heteroskedasticity (GARCH) type of time-series methods (Grier and Smallwood, 2007; Hooy and Choong, 2010) to investigate the effect of exchange rate uncertainty on trade, but their findings are also mixed. Therefore, despite numerous efforts, the existing literature on the effect of exchange rate volatility on trade remains inconclusive. Prior empirical evidence on assessing the impact of exchange rate uncertainty on bilateral trade among the SAARC countries using panel data and the gravity model of trade is still absent. Existing literatures on how exchange rate fluctuation affects trade in SAARC countries are based on time-series analysis, very few and inconclusive.

Thus, this paper investigates and contributes to the literature by analyzing the bilateral trade effects of exchange rate uncertainty using a sample of SAARC economies employing a gravity model approach. Second, it uses the SAARCFinance database on the determinants of the bilateral trade performance of eight SAARC countries. Third, the data covers the most up-to-date data from the year 2005 to 2018. Forth, the study assesses the effect of the volatility of exchange rate controlling for a broad set of bilateral information using the gravity model, for the first time, for the SAARC region. Finally, the study has significant policy implications related to the benefit of regional economic integration and free-trade policies of the SAARC region.

The key findings in this study endorse the view that exchange rate volatility lowers trade flows in the SAARC regions. However, in line with the empirical results, the adverse effect of exchange rate uncertainty on trade is pretty small. Furthermore, the level of output between the countries is positively and significantly related to bilateral trade. The negative correlation between exchange rate fluctuation and bilateral trade remains consistent and significant after controlling of simultaneous causality, autocorrelation, country-pair heterogeneity and endogeneity irrespective of static and dynamic panel data estimation techniques.

The paper is structured as follows – the next section analyzes the existing theoretical and empirical literature of the study. Section 3 provides the methodology, data description and sources and stylized facts. Section 4 illustrates the estimation strategy and results. Section 5 discusses the empirical results, and the final Section 6 concludes.

2. Review of existing literature

2.1 Theoretical foundation

Several theoretical models have developed in the trade literature regarding the consequences of exchange rate uncertainty. The earliest and influential study by Clark (1973) illustrates a simple theoretical clarification on how the exchange rate fluctuation affects international trade. He assumes a small firm operating under a perfectly competitive market, produces single goods, does not require imported raw materials in the production process, fixed output and has access to financial hedging. The firm accepts only in foreign exchange; thus, the income and profitability of the firm depend on the exchange rate movement. Extreme exchange rates movement immediately transforms into uncertainty regarding the expected proceeds in domestic currency. As a result, the firm needs to reconsider the level of production as well as volume of exports to minimize the uncertainty. If the firm is risk-averse and concentrates to maximize its profit, the primary precondition is that the firm has to produce and export that level of output for which the marginal revenue surpasses its minimal cost to offset the risk of exchange rate fluctuations. In these uncertain situations, the firm's profitability from export hooks only on exchange rate. Notably, the more frequent volatility

of the exchange rate leads a decline in the firm's production and exports. Thus, this model confirms a negative association between exchange rate volatility and international trade. Considering the relative degree of risk aversion attitudes of the traders, [Hooper and Kohlhagen \(1978\)](#) also developed a theoretical model for evaluating the impact of exchange rate uncertainty on cost and volumes of trade. Their finding is that if the exporters are risk-averse, more volatility on the exchange rate will reduce the trade volume. [Gagnon \(1993\)](#) also has a supportive argument that volatility will contract the size of trade.

However, several theoretical studies argue against the negative effect of exchange rate volatility on trade. [Grauwe \(1988\)](#) argues that the uncertainty of the exchange rate may have a negative or a positive impact on trade based on a producers' risk aversion attitude and profit maximization motives. If a firm shows a minor aversion to risk, it will manufacture fewer goods to export as more volatility on the exchange rate lowers the estimated marginal utility of export earnings. But a highly risk-averse producer will produce more to export to avoid an acute decrease in their income streams. [Dellas and Zilberfarb \(1993\)](#) and [Broll and Eckwert \(1999\)](#) also have similar findings. They conclude that an increase in uncertainty has both substitution effect and income effect. Substitution effect entails higher uncertainty reduces trade flows as an increase in the exchange rate risk forces the exporter to move to less risky export from risky export activities, which are referred to as the substitution effect. Besides, the income effect stimulates more allocation of resources into the exports of goods and services as an increase in exchange rate risk induces more export activities to compensate for the potential loss of expected revenue from export. For an extreme risk-averse firm, the income effect controls the substitution effect, and higher uncertainty leads to higher international trade rather than reduction. Several studies have confirmed the consideration that risk could also boost trade performance by [Franke \(1991\)](#), and [Sercu and Vanhulle \(1992\)](#).

2.2 Empirical literature

Several studies have been carried out empirically to explore whether trade is influenced by exchange rate uncertainty. The most influential work on impact of exchange rate volatility on trade was conducted by [Chowdhury \(1993\)](#). Employing the multivariate error-correction model on time-series data set, he found that volatility of the exchange rate has a significant negative impact on the export volume of each G-7 member country. [McKenzie \(1999\)](#) surveys a comprehensive review of both the theoretical and empirical literatures to address the impact of volatility of exchange rate and trade flows. He points out that from both the theoretical and empirical point of view, impact of exchange rate volatility on trade flows is ambiguous and mixed. [Ozturk \(2006\)](#) conducts another detailed survey of empirical literature from 1978 to 2005. Till 2005, he addresses a total of 41 empirical works in his review and finds a mixed nexus between exchange rate volatility and trade. Majority of the studies have shown evidence of adverse effect, nine studies do not find any significant effect and ten studies have shown positive effect of exchange rate uncertainty on trade. Later on, [Coric and Pugh \(2010\)](#) extend the literature survey of [Ozturk \(2006\)](#) and employ MRA (meta-regression analysis) of the results of 64 existing studies. They concluded that 33 studies found an unfavorable effect of exchange rate risk on trade flows, six empirical papers found that volatility improves trade performance and rest 25 studies do not confirm these results.

[Table 1](#) summarizes recent empirical studies on how exchange rate volatility affects trade from 2010 and onward

Overall findings at both theoretical and empirical levels show that the effect of the exchange rate uncertainty on trade flow is unclear. From the theoretical point of view, the result may be negative or positive but subject to the model assumptions, precisely the attitude of exporters to meet up exchange rate risk. From an empirical perspective, most of the empirical papers generally rely on OLS estimations, which may suffer from omitted variable

Table 1.
Empirical literature
survey

Study	Sample period	Estimation strategy	Results (trade/export)
Chit <i>et al.</i> (2010)	1982–2006, Q	FE, RE, GMM, gravity	Negative, significant
Hooy and Choong (2010)	1981–2005, A	EGARCH, bound test	Positive, significant
Hall <i>et al.</i> (2010)	1980–2006, Q	GMM, TVC	Positive, significant
Olayungbo <i>et al.</i> (2011)	1986–2005, A	OLS, FE, GMM, gravity	Positive, significant
Umaru <i>et al.</i> (2013)	1970–2009, A	OLS, ARCH, GARCH	Positive, significant
Nishimura and Hirayam (2013)	2002–2011, M	ARCH, ARDL	Mixed effects
Serenis and Tsounis (2013)	1990–2012, Q	VECM	Negative, significant
Vieira and MacDonald (2016)	2000–2011, A	System GMM	Negative, significant
Asteriou <i>et al.</i> (2016)	1995–2012, M	ARDL, GARCH	Mixed effects
Chi and Cheng (2016)	2000–2013, Q	GARCH	Positive, significant
Kang (2016)	2003–2015, A	FE, gravity model	Positive, significant
Aftab <i>et al.</i> (2017)	2000–2013, M	GARCH, ARDL	Negative effects
Senadza and Diaba (2017)	1993–2014, A	GARCH, EGARCH	Mixed effects
Nguyen and Vo (2017)	2002–2015, A	OLS, FE, GMM	No clear evidence
Lin <i>et al.</i> (2018)	1970–2000, A	FE, 2SLS, gravity	Negative, significant
Vo <i>et al.</i> (2019)	2000–2015, A	GARCH, OLS, ECM	Negative, significant
Bajo-Rubio <i>et al.</i> (2019)	1994–2014, Q	GARCH, OLS	No clear evidence
Sugiharti <i>et al.</i> (2020)	2006–2018 M	ARDL, NARDL	Negative, significant
Kumar <i>et al.</i> (2020)	1981–2017, A	Panel ARDL, ECM	Negative, significant
Note(s): A = Annual, Q = Quarterly, M = Monthly			
Source(s): Authors' Compilation			

bias or endogeneity problems. A limited number of studies employ a GMM estimator to address the potential problem of endogeneity, but these studies do not care about on instrument proliferation issue. As a result, biased estimators might be derived.

Moreover, empirical studies have provided limited evidence of the effect of exchange rate uncertainty on bilateral trade performance for SAARC countries, mainly using the gravity model of trade and system GMM estimation. [Hooy and Choong \(2010\)](#) conduct an empirical analysis on the impact of exchange rate volatility on world and intratrade flows of four SAARC countries (Bangladesh, India, Pakistan and Sri Lanka). They employ exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model to compute the conditional exchange rate volatility and bound testing approach on export demand function and find that volatility significantly and positively induces real export in most of the SAARC countries. Using annual time-series data of three South Asian countries, [Mukhtar and Malik \(2010\)](#) investigate the effect of exchange rate volatility on export. Employing cointegration and vector error correction model techniques on long-run export demand function, they find that, both in the short run and long run, volatility of exchange rate exerts significant negative effects on exports of India, Pakistan and Sri Lanka. The aforementioned two studies only consider four countries out of eight SAARC members and mostly based on time-series approaches. This empirical paper is different from these previous papers with respect to empirical specification, estimation strategy, scopes and crucial bilateral control factors that have a substantial impact on bilateral trade. Several influential empirical papers in the field of international trade use gravity model intensively to find out the determinants of bilateral trade (such as [Krugman, 1991](#); [Frankel, 1992](#); [Bayoumi and Eichengreen, 1995](#)). Mainly, trade performance between two economies or intraindustry trade flows could be well explained by gravity model, which cannot be resolved by other econometric models and economic theories. In this model, the trade between two countries is proportional to their GDP and inversely related to their geographical distance, which infers countries with higher GDP tend to trade more and more distance between countries (a proxy of transport cost) should discourage bilateral trade.

3. Methodology and data

3.1 Model specification

Extensive body of literature on international economics employs the gravity model to explore the nexus between the macroeconomic variable and bilateral trade performance. Consistent with the previous literature (Dell'Ariccia, 1999; Waugh, 2010; Kang, 2016; Egger and Staub, 2016; Nguyen and Vo, 2017), we also employ a modified gravity model for our panel data set. The stand of the gravity model is that the international trade (bilateral exports, imports or total trade) between two economies is proportional to their size (level of output) and inversely proportional to the distance between them. This model has gained substantial popularity as it allows researchers to account for the bilateral difference in country characteristics such as exchange rate volatility, common border, common language and any other important bilateral characteristics of the countries for which the model is termed as modified gravity model. Therefore, the baseline model can be presented as:

$$\begin{aligned} \text{Bi_Trade}_{ijt} = & \alpha + \gamma_1 \text{ExRate_Vol}_{ijt} \\ & + \gamma_2 \text{Level of Output}_{ijt} + \gamma_3 \text{Output_Vol}_{ijt} + \gamma_4 \text{Level of Income}_{ijt} \\ & + \gamma_5 \text{Bi_Distance}_{ij} + \gamma_6 \text{Language}_{ij} + \gamma_7 \text{Border}_{ij} + \varepsilon_{ijt} \end{aligned}$$

where i and j denote the importer and counterpart country, respectively, and t indicates time. The dependent variable in the aforementioned equation is Bi_Trade_{ijt} , which refers to the log of annual bilateral exports between i and j and vice versa in year t and is measured using the following method (Larraín and Tavares, 2003).

$$\text{Bi_Trade}_{ijt} = \frac{\frac{\text{Export}_{it}}{\text{GDP}_{it}} + \frac{\text{Export}_{jt}}{\text{GDP}_{jt}}}{2}$$

ExRate_Vol_{ijt} denotes exchange rate volatility between the two countries at year t and refers to the unexpected movement in the bilateral trade due to the uncertainty of receipt of the domestic currency. Volatility or fluctuation of the exchange rate is also referred to as exchange rate risk, which is normally measured by the SD. Following Larraín and Tavares (2003), we use the SD of the exchange rate as a measure of exchange rate volatility. We first calculate the bilateral exchange rate and then estimate the SD using the following equations:

$$\text{Exchange Rate}_{ijt} = \text{Nominal Exchange Rate}_{ijt} \times \frac{\text{Consumer Price Index}_{it}}{\text{Consumer Price Index}_{jt}}$$

$$\text{ExRate_Vol}_{ijt} = \text{Standard Deviation} (\text{Exchange Rate}_{ijt})$$

ARCH model has been extensively applied to determine the exchange rate volatility in the area of financial economics (Hasanov *et al.*, 2011). Along with SD, we also use the ARCH model to measure the volatility of the exchange rate as well as to confirm the robustness of the results.

The conditional variance,

$$\sigma_{ijt}^2 = \beta_0 + \beta_1 \varepsilon_{ijt-1}^2 + \beta_2 \varepsilon_{ijt-2}^2 + \dots + \beta_m \varepsilon_{ijt-m}^2$$

where ε_{ijt}^2 is the squared residuals and β are the ARCH estimates.

Level of Output $_{ijt}$ denotes the output of the economy, measured as the mean of the log of GDP of countries i and j in year t . Following Nguyen and Vo (2017), output level is measured using the following equation:

$$\text{Level of Output}_{ijt} = \frac{\ln(\text{GDP})_{it} + \ln(\text{GDP})_{jt}}{2}$$

We control volatility of output (Output_Vol_{ijt}), which is constructed as the SD of the growth of the log of GDP of between i and j . Moreover, domestic demand is a key factor of international trade. In line with the previous study, we control the level of income ($\text{Level of Income}_{ijt}$) as a proxy of market demand of countries i and j . This can be measured using the following formula:

$$\text{Level of Income}_{ijt} = \frac{\ln(\text{Per Capita GDP})_{it} + \ln(\text{Per Capita GDP})_{jt}}{2}$$

We also control geographical distance between i and j (Distance_{ij}), which refers to the natural logarithm of the distance (in kilometers) between two capital cities of the two trading partner i and j . The higher the increase in distance associated with higher costs of transportation. An increase in the transportation cost leads to increase in the unit price of final goods for selling, thus decreasing its demand. Hence, a negative effect on bilateral trade for this variable is expected. Language_{ij} and Border_{ij} represent the dummy of common language and common border between i and j . Finally, ε_{ijt} is the error term.

3.2 Data sources

Our sample consists of bilateral trade between eight SAARC members – Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan and Sri Lanka over the period 2005–2018. Annual bilateral export data are obtained from the IFS (IMF) database. Volatility of exchange rate, level of output, volatility in output and income level between country i and j are calculated using the SAARC Finance database. The details about the data definition and sources are reported in Table A1. However, Table 2 illustrates the descriptive statistics of the transformed variables. The total number of country-pair groups for the gravity model analysis is 56.

The correlation matrix among the variables is presented in Table 3. Except for the level of output and common language similarities, all other variables are negatively correlated with trade performance of the SAARC country-pair. Most of the correlation coefficients of the variables are found to be lower than 0.6; therefore, multicollinearity is not a significant issue in our analysis. Moreover, we also employ variance inflation factor (VIF) test (Table A2) and find that the mean value of VIF is 1.36 (<10), which also implies that multicollinearity is very low in the OLS model (Kutner *et al.*, 2004).

3.3 Some basic stylized facts

To analyze the potential effects of volatility on bilateral trade performance, we first provide some stylized facts and examples from our country-level annual data to offer a basic

Table 2.
Summary statistics of
the variables

Variable	Obs	Mean	Median	Std. Dev	Min	Max
Bilateral Trade	718	4.369097	4.634518	3.008702	0	9.721754
ExRate_Vol	784	−2.16e-10	−0.3357085	1	−0.3866572	4.510213
Level of output	718	10.41026	10.43137	1.535177	6.570067	13.72588
Output_Vol	680	5.866776	6.140284	1.859783	0.5704427	9.393717
Level of income	718	7.219996	7.217312	0.6387917	5.708571	8.788816
Bilateral distance	784	7.364199	7.628828	0.6733352	5.925998	8.133459
Language	784	0.0114821	0	0.0414679	0	0.2166
Border	784	0.1785714	0	0.3832375	0	1

Variables	Bi_Trade	ExRate_Vol	Level of output	Output_vol	Level of income	Bi_Distance	Language	Border
Bi_Trade	1.0000							
ExRate_Vol	-0.0753*	1.0000						
Level of output	0.5380*	-0.1955*	1.0000					
Output_vol	-0.1349*	-0.0172	-0.1151*	1.0000				
Level of income	-0.1699*	-0.0236	-0.0588	0.1409*	1.0000			
Bi_Distance	-0.6547*	-0.1690*	-0.1322*	0.1968*	0.3549*	1.0000		
Language	0.2585*	0.1449*	-0.1411*	-0.0158	-0.1698*	-0.4351*	1.0000	
Border	0.3486*	0.0403	0.4743*	-0.2178*	-0.2038*	-0.4576*	0.0947*	1.00000
Note(s): * Significant at 10% level								

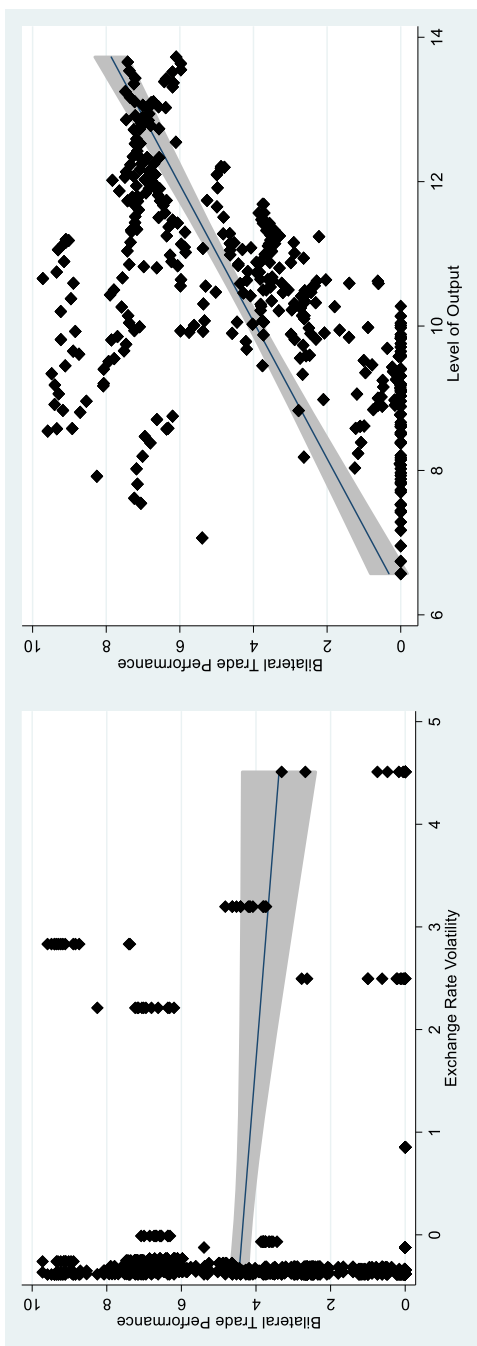
Table 3.
Correlation matrix of
variables

understanding of the SAARC countries that could be adversely influenced by the volatility of the exchange rate. First, for each exporter country and its counterpart country, we calculate the bilateral trade between the economies and annual exchange rate vulnerability (following [Larrain and Tavares, 2003](#)). We then follow [Nguyen and Vo \(2017\)](#) to measure the output level of the exporter and its counterpart country. We plot the bilateral trade performance against volatility and the level of output in [Figure 1](#). We initially find that mutual trade performance is negatively associated with exchange rate fluctuation and positively associated with the countries' level of production, which suggests that SAARC countries with more volatile exchange rates and low output growth export less per destination country.

4. Estimation strategy and results

We first estimate our baseline panel data model using pooled OLS and random effects estimation techniques. While higher exchange rate volatility could affect trade performance between two countries, it is also possible that the bilateral trade could control the exchange rate volatility, which is also termed as reverse causality. Besides, the monetary authority could systematically try to intervene to settle a fixed exchange rate when trade flows between two countries are strong ([Bayoumi and Eichengreen, 1995](#); [Dell'Ariccia, 1999](#)). Thus, exchange rate volatility is not an exogenous variable completely. Due to this unknown form of simultaneous causality and endogeneity, the OLS and RE estimation would provide biased estimates. We employ both OLS and RE estimations with one-year lag of our main explanatory variable (ExRate_Vol) to mitigate the endogeneity problem arising from reverse causality issues ([Reed, 2015](#)). Our primary aim is to use random effects technique as the estimators capture cross-country, within-country differences and cluster standard errors at the country level. While FE estimation is also based on within-country differences, this estimation technique wipes out all time-invariant independent variables (common language, common border and distance). The elimination of all between-group variation in the data set reduces the efficiency of FE estimators, particularly the data set for the gravity model ([Chit et al., 2010](#)). To control the possible economic depression, we introduce year effect dummies in all regressions. Though FE estimation wipes out time-invariant factors, we present the findings in the tables for comparison and robustness purpose. The results of pooled OLS, RE and FE estimators are presented in [Table 4](#).

However, studies argue that using the lag of the main explanatory variable might not wholly address the endogeneity issue ([Bellemare et al., 2017](#)). Moreover, the presence of cross-sectional dependency, serial autocorrelation and heteroskedasticity in the data set could lead to bias OLS and RE estimator. Concerning all the aforementioned issues, we develop a dynamic specification of the baseline model, where a one-year lag of the main explanatory variable (bilateral trade) entered as an independent variable in the static model. We employ system GMM (two-step) estimator to estimate the dynamic model suggested by [Blundell and Bond \(1998\)](#). The GMM estimators surmount the limitations of estimators dealing with unobserved variables biases, endogeneity, unobserved country-specific effects, heteroskedasticity and autocorrelation ([Roodman, 2009](#)). The GMM estimators are unbiased for panel data with a limited period and a large number of cross sections ($N > T$). Our analysis includes 56 country-pair cross sections and 14 years of data ($N > T$). These additional estimation techniques would provide further confidence in the results that we obtained from OLS, RE and FE estimators. We perform several diagnostic tests such as Arellano–Bond test of first-order (AR1) and second-order (AR2) serial correlation in the error term, and Sargan and Hansen test of overidentifying restrictions to assess whether system GMM estimator (two-step) is appropriate for estimating the dynamic version of the baseline model. These aforementioned tests are used to ensure the validity and exogeneity of the



Source(s): Authors' calculation

Figure 1.
The stylized facts

Table 4.
OLS, RE and FE
estimations using
standardized value
(standard deviation) of
exchange rate

Variables/approach	(1) OLS	(2) RE	(3) FE	(4) OLS	(5) RE	(6) FE
Exchange rate volatility	-0.282*** (0.0694)	-0.431** (0.182)	-1.167** (0.547)			
Exchange rate volatility (<i>t</i> -1)				-0.290*** (0.0725)	-0.414** (0.182)	-1.163* (0.600)
Level of output	1.281*** (0.0548)	1.055*** (0.146)	1.606* (0.897)	1.275*** (0.0571)	1.066*** (0.146)	1.774* (0.936)
Output volatility	0.0368 (0.0357)	-0.0306 (0.0256)	-0.0471* (0.0261)	0.0432 (0.0369)	-0.0525* (0.0274)	-0.0726*** (0.0280)
Level of income	1.211*** (0.152)	0.223 (0.298)	-1.078 (0.690)	1.152*** (0.158)	0.238 (0.304)	-1.255* (0.726)
Bilateral distance	-3.231*** (0.130)	-2.997*** (0.353)		-3.203*** (0.136)	-2.984*** (0.351)	
Common language	9.226*** (1.746)	7.541 (5.019)		9.219*** (1.821)	7.622 (4.983)	
Common border	-1.812*** (0.216)	-1.443*** (0.603)		-1.767*** (0.224)	-1.448** (0.599)	
Constant	7.911*** (1.345)	15.11*** (3.251)	-3.888 (5.954)	7.729*** (1.415)	14.74*** (3.283)	-4.336 (6.301)
Observations	622	622	622	573	573	573
<i>R</i> -squared						
Overall	0.7274	0.7613	0.2852	0.7266	0.6979	0.2984
Within		0.0312	0.0458		0.0393	0.0560
Between		0.6979	0.2858		0.7625	0.2958
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair	56	56	56	56	56	56

Note(s): S.E. in parentheses. *, ** and ***Significant at 10, 5 and 1% level, respectively

instruments used in the GMM estimation. We also restrict instrument proliferation (number of instruments less than country-pair) as too many instruments may diminish the power of the afore-stated diagnostic tests (Roodman, 2009). System GMM estimation findings are reported in Table 5.

5. Discussion on empirical findings

The findings from the static model are reported across the six columns of Table 4, which imply that bilateral trade between SAARC countries is negatively associated with exchange rate volatility (measured by SD of exchange rate). In most instances, the OLS and FE estimators are statistically significant at the 1 and 5% level, respectively. For the model specification with a one-year lag, the estimates of exchange volatility remain identical level of statistical significance (column 4 and 5). The magnitudes of the negative effect of uncertainty measure of exchange rate for OLS and RE models on trade are quite the same (ranges from -0.282 to -0.431). The findings from FE estimators (column 3 and column 6) confirm that the exchange rate volatility has significant, at least 10% level, negative effects on trade of the SAARC countries. We further calculate the conditional variance of exchange rate using ARCH model and employ similar OLS, RE and FE estimation and present the results on Table 6. The findings of these three estimators indicating that exchange rate volatility negatively associated with the trade performance. Though the estimates of OLS model are insignificant, the estimates of RE and FE models (both in case of the current and one-year lag of volatility) are statistically significant at 1% level, which validate the robustness of the findings (Table 4) using SD measure of volatility. But the estimates of volatility measure using ARCH method are relatively show smaller negative effect compared with the volatility using the SD of the exchange rate. Considering Table 5, the system GMM estimators for exchange rate volatility demonstrate a negative and significant (at least the 10 level) effect on bilateral trade. A one-unit increase in the exchange rate volatility using standardized value (using conditional variance) is associated with a 0.10 ($-2.43\text{e-}08$) percentage fall in bilateral trade (% GDP) in the current year and 0.09 ($-3.81\text{e-}08$) percentages in the upcoming year. Compared to the coefficients of static model, the magnitude of the coefficient of GMM estimator correlated with exchange rate volatility is very low, which indicates the absence of stable effect of exchange rate volatility on trade performance. The possible justification of this finding is the capability to hedge against the excessive exchange volatility of the SAARC countries. Thus, the overall estimation findings confirm that the shock of exchange rate volatility on the bilateral trade performance of the SAARC countries is negative and statistically significant for all models (static and dynamic specifications) and estimation techniques although the levels vary depending on volatility measures. The findings demand for the development of sound and innovative monetary policy and stable financial markets to offer future prospects for the hedging of exchange rate risk to counterbalance possible undesirable impact on trade performance. The outcomes are consistent with the findings of the studies that consider sample of Asian economies and also employed gravity model of trade such as Chit *et al.* (2010), Vieira and MacDonald (2016), Nguyen and Vo (2017) and Lin *et al.* (2018).

The results reported in Table 6 reveal that, across columns 1–2, the estimate of the lag-dependent variable is consistently positive and strongly significant at the 1% level, which validates the persistence of trade performance over year in the SAARC countries. The p -values of the AR (1) test is below 5% and for AR (2) test is higher the 10% level of statistical significance. The p -values for Sargan and Hansen tests are higher than 10%. We restrict instrument proliferation in our GMM models, where country-pair is higher than the number of instruments. These all the aforementioned test results suggesting that our set of instruments is exogenous, and using a two-step GMM estimator for our empirical analysis is appropriate and valid.

Table 5.
Two-step system
GMM estimation

Variables/approach	Standardized value (SD) of exchange rate		Conditional variance of exchange rate	
	(1) System GMM	(2) System GMM	(3) System GMM	(4) System GMM
Bilateral trade performance (<i>t</i> -1)	0.781*** (0.0550)	0.808*** (0.0542)	0.767*** (0.0577)	0.764*** (0.0578)
Exchange rate volatility	-0.102** (0.0424)		-2.43e-08** (1.13e-08)	
Exchange rate volatility (<i>t</i> -1)		-0.0937** (0.0365)		-3.81e-08* (1.93e-08)
Level of output	0.230*** (0.0616)	0.207*** (0.0615)	0.255*** (0.0666)	0.258*** (0.0671)
Output volatility	-0.0121 (0.0274)	-0.0170 (0.0253)	-0.0112 (0.0284)	-0.0108 (0.0286)
Level of income	-0.0375 (0.0709)	0.0476 (0.0483)	-0.0321 (0.0735)	-0.0336 (0.0733)
Bilateral distance	-0.599*** (0.181)	-0.544*** (0.179)	-0.637*** (0.199)	-0.651*** (0.202)
Common language	1.598 (1.053)	1.487 (0.953)	1.462 (0.882)	1.426 (0.881)
Common border	-0.319** (0.149)	-0.277** (0.136)	-0.359** (0.162)	-0.366** (0.165)
Constant	3.344*** (1.196)	2.470** (1.069)	3.401*** (1.274)	3.508*** (1.287)
Observations	573	573	573	573
Country-pair	56	56	56	56
Year dummy	Yes	Yes	Yes	Yes
Instruments	12	12	12	12
AR(1)	0.041	0.047	0.041	0.041
AR(2)	0.340	0.346	0.337	0.329
Sargan test	0.518	0.490	0.504	0.517
Hansen test	0.180	0.157	0.169	0.181

Note(s): Robust S.E. in parentheses. *, ** and ***Significant at 10, 5 and 1%, respectively. To control instrument proliferation, the lag limits (2 4) are used. SD refers standard deviation

Regarding control variables, higher output growth leads to higher trade, and a more volatile output level negatively affects the bilateral trade performance of the SAARC countries. We find that the estimates of level of output are significant in both static and dynamic model but for the output volatility, the coefficients are statistically significant only in RE model (10% level). These results appear to validate the existing literature such as [Dell'Ariccia \(1999\)](#). The estimated coefficients of the level of income are found to have mixed effect on trade. For OLS and GLS model, the coefficients are positive, and for RE model, the estimates are negative and statistically significant. But while we turned to the dynamic model, GMM estimators for the income variable are found negative, but they fail to obtain any statistical level of significance to interpret the results. The gravity model often incorporates several dummy variable to control for various economic factors that might undermine trade costs, particularly transport and transaction cost. Such variables include distance between countries, common language and common border. In the static model results ([Table 4](#)), the effect of geographical distance is found to be negative and strongly significant in all cases, which indicate that bilateral trade falls due to increase of distance between countries. The GMM estimators for the distance variable are found negative and highly significant at 1% level proves the reliability of results of static estimators. These results are expected and consistent with the theoretical viewpoint. Distance between origin and destination countries for movement of goods is much associated with transportation cost. Higher distance demands higher transportation cost and thus reduces international trade. The effect of common language on trade is found to be positive in all models but only highly significant in OLS and GLS model. This positive effect is primarily expected for the gravity model as existing theories confirm that firms and countries with common language are likely to be more familiar with business and economic environment of each other operating more efficiently compared with firms with uncommon language. Exporters are more likely to search for importers or customers in countries where the trading environment is familiar to them. The common border parameter is found negative in all models and significant almost in all cases. These negative results are inconsistent with our expectation and also the general theory. But our findings are consistent with the findings of [Wang and Badman \(2016\)](#). The potential explanation for the negative effect of common

Variables/approach	(1) OLS	(2) RE	(3) FE	(4) OLS	(5) RE	(6) FE
Exchange rate volatility	-4.01e-08 (3.02e-08)	-6.78e-08*** (2.03e-08)	-6.53e-08*** (2.04e-08)	-6.40e-08 (3.33e-08)	-8.32e-08*** (2.58e-08)	-7.94e-08*** (2.59e-08)
Level of output	1.321*** (0.0548)	1.103*** (0.148)	1.530* (0.891)	1.313*** (0.0570)	1.111*** (0.148)	1.645* (0.929)
Output volatility	0.0328 (0.0362)	-0.0339 (0.0254)	-0.0432* (0.0256)	0.0373 (0.0375)	-0.0567** (0.0272)	-0.0694** (0.0275)
Level of income	1.240*** (0.154)	0.181 (0.302)	-1.139* (0.683)	1.181*** (0.160)	0.190 (0.309)	-1.293* (0.719)
Bilateral distance	-3.208*** (0.132)	-2.946*** (0.364)		-3.181*** (0.138)	-2.930*** (0.362)	
Common language	8.754*** (1.778)	6.591 (5.217)		8.653*** (1.857)	6.664 (5.179)	
Common border	-1.878*** (0.218)	-1.527** (0.625)		-1.831*** (0.226)	-1.528* (0.621)*	
Constant	7.247*** (1.370)	14.67*** (3.326)	-2.672 (5.855)	7.118*** (1.440)	14.36*** (3.357)	-2.717 (6.173)
Observations	622	622	622	573	573	573
<i>R</i> -squared						
Overall	0.721	0.6900	0.3241	0.720	0.6897	0.3315
Within		0.0452	0.0555		0.0541	0.0665
Between		0.7522	0.3306		0.7531	0.3345
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Country-pair	56	56	56	56	56	56

Note(s): S.E. in parentheses. *, ** and ***Significant at 10, 5 and 1 % level, respectively

Table 6.
OLS, RE and FE
estimations using
conditional variance of
exchange rate

border on trade is that Sri Lanka and Maldives do not have any physical common border with other SAARC countries. Besides, SAARC countries are operating on outdated and poor corridor management system. Studies found that modernization of cross-border facilities such as implementation of paperless trade, one-stop customs procedures and single window system could reduce trade cost and time between countries (Roy and Xiaoling, 2020). Additionally, political interest as well as national benefits might be the main consideration for bilateral trade among SAARC nations.

6. Conclusion

This study investigates the effect of uncertainty arising from exchange rate volatility on bilateral trade using annual data from 2005 to 2018 on eight SAARC countries. Our model specification is modified gravity model of trade, and we initially employ pooled OLS, RE and FE estimation techniques to obtain the estimate of exchange rate uncertainty. We find that there exists a negative and significant relationship between uncertainty and trade performance, which implies that excessive volatility reduces trade flows between SAARC countries. We use one-year lag of main explanatory variable in all models and two-step system GMM estimation techniques to control the problem of a potential simultaneity bias, heteroskedasticity and autocorrelation. The empirical findings from the GMM estimation also confirm the adverse effect of exchange rate uncertainty on trade flows and point out that this negative relationship is not driven by simultaneous causality bias.

Future direction of the research in this area should look at more industry-level and sector-wise disaggregated data. Exchange rate volatility might have a different shock across different sectors and industries. Policy initiatives to hedge against unpredicted volatility of the exchange rate are required to encourage the bilateral trade flow in SAARC region. The member countries should step forward to set up a transparent exchange rate system so that the stability of the exchange can be maintained over a longer period. Moreover, trade growth could be driven by external economic factors, such as external development and relative prices. Local policymakers should consider these factors to retain a competitive and stable exchange rate for the overall trade and economic growth of the region. Identifying financial instruments to minimize this volatility for longer period is beyond the scope of this study and will be investigated in future work.

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Table A1.
Sources of data

Appendix		
Variables	Definitions	Source
Trade	Goods, value of exports, free on board (FOB), US dollars (to counterpart SAARC country)	Directions of Trade Statistics, IMF
Nominal Exchange Rate	Exchange rates, National currency per US dollar, period average, national currency per US dollar, rate	International Financial Statistics, IMF
Consumer Price Index (CPI)	Annual CPI data: average of monthly CPI data	SAARCFINANCE Database
GDP	Gross domestic products at market prices (USD million)	SAARCFINANCE Database
Total Population	Population (no. in millions)	SAARCFINANCE Database
Common Language	Common native language	Geography Database of CEPII
Common Border	1 for contiguity	
Bilateral Distance	Simple distance between capitals (capitals, km)	

Table A2.
Multicollinearity test

Variable	VIF	1/VIF
Bilateral distance	1.75	0.571008
Common border	1.64	0.610143
Level of output	1.45	0.691415
Common language	1.32	0.757116
Level of income	1.18	0.844329
Output volatility	1.1	0.911331
Exchange rate volatility	1.09	0.915359
Mean VIF	1.36	

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