

# Impact of exchange rate volatility on green export margins of Vietnam: a gravity approach

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## Abstract

**Purpose** – This study assesses the relationship between real exchange rate volatility and trade margins of Vietnam's green product exports.

**Design/methodology/approach** – Based on the environmentally friendly products listed by the Organization for Economic Co-operation and Development, World Trade Organization and Asia-Pacific Economic Cooperation, this study constructs a green product list comprising 485 goods classified at the six-digit level of the HS2002 system. The Poisson Pseudo-Maximum Likelihood (PPML) estimators are applied to a gravity model covering Vietnam's green exports to 170 partners from 2002 to 2022.

**Findings** – This study discovers that fluctuations in exchange rates between the Vietnamese Dong and currencies of partners have a detrimental influence on Vietnam's green export flows and its market share in total world exports of green products to those importers. Particularly, this negative impact can be attributed to a decrease in both extensive and intensive margins of exports. Therefore, the policies aiming at stabilizing the exchange rates are necessary to boost Vietnam's green exports, ultimately contributing to ensuring Vietnam's sustainable growth.

**Originality/value** – This study posits the necessity for continued scholarly inquiry into mechanisms for enhancing Vietnam's green export performance, specifically through interventions designed to mitigate exchange rate volatility.

**Keywords** Exchange rate volatility, Extensive margin, Intensive margin, Vietnam, Green exports

**Paper type** Research article

## 1. Introduction

The accelerated depletion of natural resources and the emission of harmful gases arising from industrial development have placed increasing burdens on the climate and environment (Wang *et al.*, 2022, 2024). As a rapidly developing nation, industrialization has played a crucial role in Vietnam's economic development by creating jobs, boosting domestic production and promoting exports (Ngo, 2022; Stoffers, 2024). Despite the notable achievements in industrial development, its adverse environmental impacts have been the top concern of Vietnam's government (Nguyen and Nguyen, 2022).

The United Nations Environment Programme has identified green trade as a potential tool for nations to reconcile ecological sustainability with long-term economic prosperity. By promoting the production and exchange of environmentally friendly goods, green trade can catalyze technological innovation, resource efficiency and cleaner production practices. This, in turn, leads to reduced pollution, lower greenhouse gas emissions and improved overall environmental quality (Can *et al.*, 2022; Fabrizi *et al.*, 2024; Huang and Zhao, 2022). Moreover, green products are often subject to lower tariffs and trade barriers than traditional products (Dong *et al.*, 2023). This reduced regulatory burden allows exporters to enter foreign markets more easily and at a lower cost, thereby boosting their competitiveness in the



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international market (Li *et al.*, 2022). Thus, prioritizing the promotion of green exports is crucial for securing a sustainable future for Vietnam.

The exchange rate between currencies is one of the macro variables directly affecting international trade (Lal *et al.*, 2023; Yussif *et al.*, 2024). When exchange rates are volatile, businesses face increased uncertainty and risks, as fluctuations can significantly impact the cost of imports, the price of exports and overall profitability (Hakim, 2024). For instance, a depreciation of a country's currency can make its exports more competitive in foreign markets, but it can also increase the cost of imported goods. Conversely, appreciating a currency can reduce export competitiveness but lower import costs. These fluctuations can lead to unpredictable changes in revenue and expenses, making it difficult for businesses to plan and make decisions. Recent global shocks, such as the US–China trade war, the COVID-19 pandemic and the geopolitical tension between Russia and Ukraine, have led to increased economic uncertainty and volatility, causing significant fluctuations in currency exchange rates (Bossman *et al.*, 2023; Fajgelbaum *et al.*, 2024; Guo and Chen, 2023; Hossain *et al.*, 2024; Prananta and Alexiou, 2024).

Numerous studies have emphasized the importance of extensive and intensive margins in determining trade performance (Adelan and Kakinaka, 2018; Aldan and Çulha, 2016; Amiti and Freund, 2010). Some studies have discovered the relationship between exchange rate fluctuations and trade margins (Dincer *et al.*, 2022; Qiu *et al.*, 2020; Zaki *et al.*, 2019). In Vietnam, there have been several studies examining the influence of exchange rate volatility on Vietnam's exports (Nguyen *et al.*, 2021; Nguyen, 2023; Nguyen and Trinh, 2019; Nguyen and Do, 2020). However, the analysis of the nexus between exchange rate volatility and Vietnam's green trade is still limited. The primary contribution of this study is to explore how exchange rate volatility affects Vietnam's green product exports, considering both extensive and intensive margins of exports. The dataset for empirical analysis of this study covers green product exports from Vietnam to 170 partners over 2002–2022.

The rest of this study is structured as follows. Section 2 reviews the relevant literature. Subsequently, section 3 describes the data and empirical model. Section 4 presents and discusses the results, followed by Section 5 with concluding remarks.

## 2. Literature review

Several studies have investigated the determinants of green exports. For example, Thanh (2022) relied on data from 25 European countries from 2012 to 2019 and indicated that implementing of digital public services plays a crucial role in promoting green product trade. Employing the 2017 Pilot Zones for Green Finance Reform and Innovations as a quasi-experimental setting and utilizing data from Chinese provinces during 2010–2019, Zhou *et al.* (2023) found that green finance is effective in enhancing total factor productivity, upgrading industrial structure and innovating green technology, thereby promoting the quality of green product exports. Fabrizi *et al.* (2024) analyzed the impact of green innovation and participation in European environmental research networks on green exports across 26 European countries between 2003 and 2015. Their findings suggest that these two factors have a synergistic effect on boosting green exports. Wang *et al.* (2024) used data from 622 Chinese-listed firms to demonstrate how digital technology adoption can stimulate green exports. They argue that digital technology reduces information costs, fosters green research and development and expands market reach, ultimately increasing green exports. This incentive impact is particularly pronounced in firms with lower pollution levels, state ownership and significant environmental investments. Additionally, the positive influence of digital technology on green exports is stronger in cities with stringent environmental regulations, advanced digital technology adoption and effective intellectual property rights.

Existing studies have recognized the significance of both extensive and intensive margins in improving trade performance. Analyzing export data at the product level from 1992 to 2005, Amiti and Freund (2010) delved into the reasons for China's rapid export growth. The study

discovers that a 500% rise in Chinese exports between 1992 and 2005 is predominantly attributable to increased specialization rather than diversification. In other words, China's export growth is primarily driven by selling more of what it has already produced (intensive margin), rather than by introducing new products to the market (extensive margin). [Aldan and Çulha \(2016\)](#) used Turkish export data at the six-digit level from 1995 to 2013 and find that the extensive margin, encompassing both the product market and market expansion, is a significant driver of export growth. Notably, while market expansion is the primary contributor to the Turkish extensive margin, Turkey is more successful than China and India in boosting its extensive margin by expanding both the product basket and export markets. Utilizing trade data at the product level over 1975–2012, [Adelan and Kakinaka \(2018\)](#) assessed the intensive and extensive margin influences on the export growth of the Philippines. The study concludes that the Philippines' weak export performance is primarily due to the underperformance of deepening and survival, which reflects the intensive margin of exports. Additionally, the findings highlight the importance of the extensive margin, especially expanded export markets, in enhancing the Philippines' export performance. However, due to their limited trade volumes and short lifespans, most new trade relationships have a negligible long-term impact on export growth.

Some studies have discussed the effects of exchange rate volatility on trade margins. [Zaki et al. \(2019\)](#) used monthly data at the firm and sectoral levels to investigate the impact of exchange rate fluctuations on extensive and intensive margins of Egypt's exports during 2005–2016. In terms of the extensive margin, the study found that a depreciation in the exchange rate, which lowers the foreign currency price of exports, is positively associated with increased numbers of export markets and products. The response of the intensive margin shows that an exchange rate depreciation leads to increased export value without influencing export quantity. At the sectoral level, the impact of the intensive margin varies across products. Exchange rate depreciations benefit those products for which Egypt holds a comparative advantage, such as apparel and clothing, fruits, vegetables, textiles, minerals and several chemicals. Utilizing Chinese firm-level export data from 2000 to 2007, [Lu et al. \(2020\)](#) found that exchange rate volatility adversely influences export volume (intensive margin) and the firm's export market expansion (extensive margin). Employing Chinese export data to 165 trading partners from 1992 to 2012, [Qiu et al. \(2020\)](#) revealed a negative relationship between real exchange rate volatility and the extensive margin of exports, while simultaneously observing a positive association with the intensive margin. The study posits that uncertainty and risks from exchange rate volatility elevate the expected entry costs into new export markets. As a result, such volatility may impede the entry of small and new firms into new markets and may even compel them to withdraw from current markets. Owing to this extensive margin effect, fewer firms exist in the export markets, resulting in increased export volumes of the remaining firms. [Dincer et al. \(2022\)](#) focused on Turkish firm-level data over 2003–2015 and show that fluctuations in the exchange rate are negatively associated with the intensive margin, especially the quantity of Turkish exports. Notably, this negative effect is more substantial for foreign-owned and services-intensive firms.

Other scholars have paid attention to the influence of exchange rate fluctuations on Vietnam's exports. [Nguyen and Trinh \(2019\)](#) relied on quarterly data of Vietnam's exports over 2000–2014 and document that exchange rate volatility negatively influences export volume in the long run. Additionally, the outcomes show that domestic currency depreciation has a short-term negative impact on exports but a positive long-term effect. Analyzing the relationship between exchange rate devaluation, volatility and Vietnamese manufacturing exports to 26 partners from 2000 to 2015, [Vo et al. \(2019\)](#) found that exchange rate volatility hinders exports in the long run, while a depreciation of the Vietnamese Dong stimulates exports in the short term. Particularly, the negative impact of exchange rate volatility on exports varies across product categories and destination markets. Adopting the Augmented Dickey-Fuller test and the vector error correction model with cointegration analysis on a dataset covering exports of Vietnam during 2009–2018, [Nguyen and Do \(2020\)](#) indicated that

exchange rate shocks have an adverse influence on exports in the long run but no effect in the short run. [Nguyen et al. \(2021\)](#) examined trade flows between Vietnam and the USA over 2010–2020 and conclude that a 10% decline in the value of the Vietnamese Dong relative to the US Dollar induces a 1.91% increase in the long-term trade balance. However, in the short term, the real exchange rate adversely affects the trade balance. Focusing on Vietnam’s agricultural exports to 187 partners from 1996 to 2021, [Nguyen \(2023\)](#) documented that real effective exchange rate volatility hinders the export volume.

Exchange rate volatility poses a significant threat to Vietnam’s sustainable development goals by undermining the competitiveness and stability of its green exports. First, fluctuations in the Vietnamese Dong’s value create unpredictable revenue streams for green exporters, discouraging investment in sustainable production and innovation. Second, this uncertainty hinders the expansion of renewable energy technologies and eco-friendly production systems. Last, the diminished green export revenues can reduce the financial resources available for implementing sustainable development initiatives, such as climate change mitigation and adaptation projects, ultimately jeopardizing Vietnam’s sustainability objectives.

Although the existing studies have discussed the impact of exchange rate volatility on the trade margins of several countries worldwide, they have primarily paid attention to gross exports. In Vietnam, the research on green exports, especially the influence of exchange rate fluctuations on green trade margins, is still limited. Fluctuations in exchange rates can lead to increased sunk costs associated with exports, such as market entry, product adaptation and distribution network development. These increased costs can lower profit margins and discourage export activities ([Ethier, 1973](#)). Furthermore, the uncertainty generated by exchange rate volatility can pose various risks to investors, including currency, interest rate and political risks. Such uncertainty can directly influence the expected profitability of investments, making it less attractive for investors to allocate capital to long-term projects, such as those related to green technologies. As a result, the development and export of green products may be hindered. This research aims to contribute to the existing body of knowledge by empirically examining the relationship between exchange rate volatility and Vietnam’s green product exports, considering both extensive and intensive margins.

### 3. Data source and model specification

#### 3.1 Exchange rate volatility measurement

First, monthly nominal exchange rates between the Vietnamese Dong and the currency of each trading partner are calculated by using the exchange rate data for national currencies relative to the US Dollar from the International Financial Statistics (IMF). Then, the nominal rates are adjusted using the Consumer Price Index (CPI) data from the World Bank’s World Development Indicators to derive the real bilateral exchange rates. This study follows [Giofré and Sokolenko \(2023\)](#) to measure annual real bilateral exchange rate volatility, denoted by “ $exvol\_5_{VN,j,t}$ ”, by the standard deviation of the first difference of the logarithm of the monthly real bilateral exchange rate, using a five-year rolling window ( $t-4$  to  $t$ ).

For the robustness check, this study also employs the standard deviation of the first difference of the logarithm of the monthly real bilateral exchange rate, using a two-year rolling window (denoted by “ $exvol\_2_{VN,j,t}$ ”) as another measure of the annual bilateral exchange rate volatility. Higher values of “ $exvol\_5_{VN,j,t}$ ” and “ $exvol\_2_{VN,j,t}$ ” variables imply greater volatility in the real exchange rates between the Vietnamese Dong and the currency of partner  $j$  in year  $t$ .

#### 3.2 Extensive and intensive margins of Vietnam’s green product exports

Green products are characterized by production methods that employ cleaner technologies to minimize pollution, conserve resources and lower environmental risks. They address concerns related to air, water and soil pollution, as well as waste, noise and ecosystem disruption ([Dong et al., 2023](#)). However, technological progress can alter the environmental performance of

various products, making it challenging to establish a fixed list of environmentally beneficial products (Dong *et al.*, 2023; OECD/Eurostat, 1999).

Despite these challenges, substantial efforts have been made to create a comprehensive green product list. On behalf of the Organization for Economic Co-operation and Development (OECD), Sauvage (2014) established a green product list covering 248 commodities to manage wastewater, monitor renewable energy, control air pollution and analyze environmental conditions. In line with the Doha Declaration's objective of reducing tariffs and non-tariff barriers for environmental commodities, the World Trade Organization (WTO) compiled a list of 411 environmentally friendly products (WTO, 2011). Similarly, the Asia-Pacific Economic Cooperation (APEC) proposed a list of 48 green products for which its members committed to lowering tariff rates to a maximum of 5% by the end of 2015 (APEC, 2012).

Using the HS codes associated with the environmentally friendly products listed by the OECD, WTO and APEC, this study aggregates these products into a dataset comprising 485 goods classified at the six-digit level of the HS2002 system. Subsequently, this dataset is merged with the BACI database provided by the Centre d'Etudes Prospective et d'Informations Internationales (CEPII). The combined dataset is then filtered to focus on Vietnam's bilateral green product exports to 170 trading partners between 2002 and 2022. A detailed list of Vietnam's 170 trading partners can be found in Appendix.

Traditionally, extensive trade margins are quantified by the number of exported products, whereas intensive margins are proxied by the average export value per product. Yet, these indicators fail to consider the varying significance of different products within the export basket. For example, assume that country  $i$  exports only two products, namely  $k_1$  and  $k_2$ , to country  $j$  with products  $k_1$  and  $k_2$  accounting for 90% and 10% of the total export volume, respectively. In this case, the conventional measure of trade margins will treat the two products equally, which does not accurately capture the dominance of product  $k_1$  in the export flow from country  $i$  to country  $j$ .

Following Abeliansky *et al.* (2021), Cheong *et al.* (2016) and Hummels and Klenow (2005), this study adopt another approach to address this limitation. More specifically, this research uses the following equations to calculate the extensive and intensive margins of bilateral green exports (denoted by  $EM_{VN,j,t}$  and  $IM_{VN,j,t}$ , respectively):

$$EM_{VN,j,t} = \frac{\sum_{k \in K_{VN,j,t}} X_{W,j,t}^k}{\sum_{k \in K_{W,j,t}} X_{W,j,t}^k}, \quad (1)$$

$$IM_{VN,j,t} = \frac{\sum_{k \in K_{VN,j,t}} X_{VN,j,t}^k}{\sum_{k \in K_{VN,j,t}} X_{W,j,t}^k}, \quad (2)$$

where  $X_{W,j,t}^k$  is the value of world exports of green product  $k$  to country  $j$  in year  $t$ .  $X_{VN,j,t}^k$  is the value of the green product  $k$  that Vietnam exports to partner  $j$  in year  $t$ .  $K_{W,j,t}$  is the basket of green products that country  $j$  imports from the world in year  $t$ .  $K_{VN,j,t}$  is the green product list that Vietnam exports to partner  $j$  in year  $t$ .

The bilateral extensive margin of green exports from Vietnam to partner  $j$  is the ratio between the sum of the value that the world exports to  $j$  of the same products that Vietnam exports to  $j$  and the total value of all green products that the world exports to  $j$ . Thus, the bilateral extensive margin reflects the export volume of green products that Vietnam exports to partner  $j$ , weighting Vietnam's set of products by their relative importance in the world green export basket to  $j$ .

The bilateral intensive margin of green exports from Vietnam to partner  $j$  is the ratio between the total value of green products exported from Vietnam to partner  $j$  and the sum of the volume that the world exports to  $j$  of the same green products that Vietnam exports to  $j$ .

Therefore, the bilateral intensive margin captures the market share of Vietnam’s exports over world exports to country  $j$ , within the basket of green products that Vietnam exports to country  $j$ .

The values of both the extensive and intensive margins range from 0 to 1. Partners importing a broader range of green products from Vietnam tend to exhibit a higher extensive margin of Vietnam’s green exports, while those specializing in a few products typically have a lower extensive margin. Conversely, partners that concentrate on a limited range of green products imported from Vietnam tend to experience a higher intensive margin of Vietnam’s green exports, whereas those that import a wide variety of green products generally have a lower intensive margin.

Multiplying the two measures of bilateral green export margins produces the market share of Vietnam in total world exports of green products to partner  $j$  in year  $t$ , denoted by “ $market\_share_{VN,j,t}$ ”:

$$market\_share_{VN,j,t} = EM_{VN,j,t} \times IM_{VN,j,t} = \frac{\sum_{k \in K_{VN,j,t}} X_{VN,j,t}^k}{\sum_{k \in K_{W,j,t}} X_{W,j,t}^k}, \quad (3)$$

### 3.3 Model specification

This study utilizes a gravity model for empirical analysis. The gravity model of trade, which was inspired by Newton’s law of universal gravitation, posits that bilateral trade between countries is positively associated with their economic sizes and negatively correlated with their geographic distance (Yotov *et al.*, 2016).

Two primary challenges in applying the gravity model for bilateral trade analysis are the prevalence of zero trade values and heteroscedasticity across countries. To address these issues, Silva and Tenreyro (2006) suggest using the Poisson Pseudo-Maximum Likelihood (PPML) estimator with a multiplicative trade value specification. In addition, to mitigate the impact of multilateral resistance factors and to obtain unbiased and robust estimators from panel data, Olivero and Yotov (2012) propose using country-time fixed effects in the model specification. Yotov *et al.* (2016) emphasize that incorporating country-time fixed effects into the gravity model effectively accounts for both country size and other time-varying country-specific factors that may be correlated with size variables. Following the previous studies’ suggestions, this study includes Vietnam-year fixed effects (denoted by “ $\mu_{VN,t}$ ”) into the empirical model to account for all time-varying factors of Vietnam. This approach enables us to examine the impact of several factors belonging to Vietnam’s partners as drivers of Vietnam’s green export margins. The empirical model is as follows:

$$green\_trade_{VN,j,t} = \exp \left[ \beta_0 + \beta_1 \ln(exvol)_{VN,j,t} + \beta_2 \ln(gdpc)_{j,t} + \beta_3 \ln(pop)_{j,t} + \beta_4 tradefreedom_{j,t} + \beta_5 \ln(dis)_{VN,j} + \beta_6 FTA_{VN,j,t} + \beta_7 COL_{VN,j} + \mu_{VN,t} \right] * \varepsilon_{VN,j,t}, \quad (4)$$

where  $green\_trade_{VN,j,t}$  represents the margins of green exports from Vietnam to partner  $j$  in year  $t$ , including the extensive margin (denoted by “ $EM_{VN,j,t}$ ”), the intensive margin (denoted by “ $IM_{VN,j,t}$ ”) and the market share of Vietnam in total world exports of green products to country  $j$  in year  $t$  (denoted by “ $market\_share_{VN,j,t}$ ”);  $\ln(exvol)_{VN,j,t}$  is either the logarithm of “ $exvol\_5_{VN,j,t}$ ” or “ $exvol\_2_{VN,j,t}$ ”, which captures the volatility in the real exchange rate between the Vietnamese Dong and the currency of country  $j$  in year  $t$ ;  $\ln(gdpc)_{j,t}$  is the natural logarithm of GDP per capita of country  $j$  in year  $t$ ;  $tradefreedom_{j,t}$  reflects the trade freedom level of country  $j$  in year  $t$ ;  $\ln(pop)_{j,t}$  is the natural logarithm of the total population in country  $j$  in year  $t$ ;  $\ln(dis)_{VN,j}$  is the natural logarithm of the geographical distance between Vietnam and partner  $j$ ;

$FTA_{VN,j,t}$  is a binary variable equaling 1 if Vietnam and partner  $j$  simultaneously participate in a trade agreement in year  $t$  and 0 otherwise;  $COL_{VN,j}$  is a dummy variable that equals 1 if Vietnam and partner  $j$  shared a historical colonial relationship and 0 otherwise;  $\varepsilon_{VN,j,t}$  is the error term.

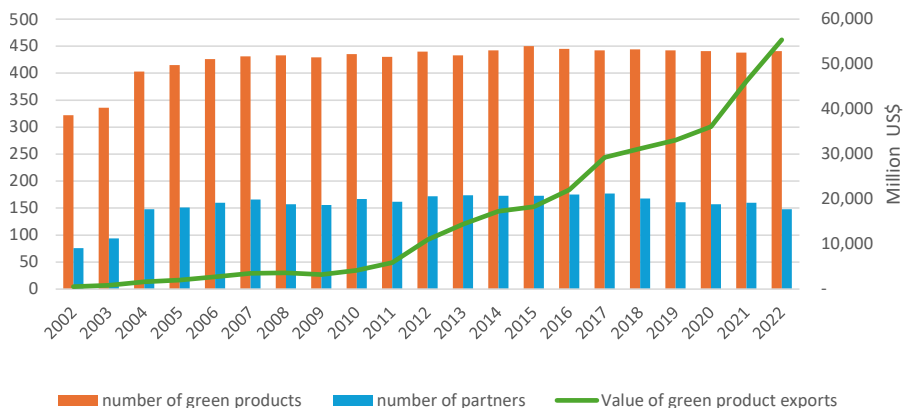
Based on the availability of data, the sample for the baseline model (4) covers green exports from Vietnam to 170 trading partners over 2002–2022. Table 1 summarizes the descriptive statistics, data sources and expected direction of the effects on the dependent variable of the variables used in model (4), while the list of 170 partners of Vietnam's green exports is expressed in Appendix.

### 3.4 Data analysis

Figure 1 displays several indicators of Vietnam's green exports from 2002 to 2022. The line graph illustrates the trend of Vietnam's green export value measured in million US dollars, while the bar graph presents the number of green products exported and the number of countries importing these products. According to Figure 1, Vietnam's green export values exhibited a substantial upward trend during the study period. More specifically, Vietnam's green export value exhibited a gradual upward trend, rising from approximately 544 million

**Table 1.** Description of regression variables

Variable	Obs.	Mean	Std. dev.	Min	Max	Expected sign	Reference	Sources
<i>Dependent variable</i>								
$market\_share_{VN,j,t}$	2,836	0.004	0.012	0	0.147		Abeliansky <i>et al.</i> (2021),	The BACI-CEPII database, Sauvage (2014), WTO (2011), APEC (2012), Abeliansky <i>et al.</i> (2021), Cheong <i>et al.</i> (2016) and Hummels and Klenow (2005)
$EM_{VN,j,t}$	2,836	0.24	0.225	0	0.936		Cheong <i>et al.</i> (2016), Hummels and Klenow (2005)	
$IM_{VN,j,t}$	2,836	0.027	0.096	0	1		Hummels and Klenow (2005)	
<i>Independent variable</i>								
$\ln(exvol\_5_{VN,j,t})$	2,836	-3.7	0.703	-5.938	0.307	-	Dincer <i>et al.</i> (2022), Qiu <i>et al.</i> (2020), Zaki <i>et al.</i> (2019)	Author's calculation using data from IMF and the method developed by Giofré and Sokolenko (2023)
$\ln(exvol\_2_{VN,j,t})$	2,836	-3.898	0.734	-6.91	0.188	-		Giofré and Sokolenko (2023)
$\ln(gdp)_{j,t}$	2,836	8.779	1.417	5.569	11.63	+	Qiu <i>et al.</i> (2020)	World Development Indicator – World Bank
$\ln(pop)_{j,t}$	2,836	16.093	1.769	11.138	21.072	+	Nguyen (2023)	
$tradefreedom_{j,t}$	2,836	74.613	11.874	0	95	+	Gnangnon (2019)	The Heritage Foundation database
$\ln(dis)_{VN,j}$	2,836	8.99	0.709	5.352	9.883	-	Nguyen (2023), Zaki <i>et al.</i> (2019)	The CEPII gravity dataset
$FTA_{VN,j,t}$	2,836	0.111	0.314	0	1	+	Nguyen (2023)	
$COL_{VN,j}$	2,836	0.128	0.334	0	1	+	Zaki <i>et al.</i> (2019)	
<b>Source(s):</b> Author's own work								



**Figure 1.** Summary of Vietnam's green exports during 2002–2022 **Source(s):** Author's elaboration by employing data from the BACI-CEPII, Author's own work

US dollars in 2002 to a peak of around 3,634 million US dollars in 2008. Subsequently, due to the impact of the global financial crisis, the value experienced a slight decrease to around 3,215 million US dollars in 2009. Following the [WTO's 2011](#) compilation of 411 environmentally friendly products and subsequent tariff and non-tariff barrier reductions for those commodities ([WTO, 2011](#)), Vietnam's green export value exhibited a sharp upward trajectory, culminating in a value of approximately 55,400 million US dollars by 2022. The number of green products exported remained relatively stable throughout the study period, ranging from 328 to 449. Moreover, these products constituted over 93% of the total list sourced from the OECD, APEC and WTO. Although there were variations in the number of Vietnam's green product export partners from year to year, the overall trend remained relatively stable. During the research period, Vietnam's green products were exported to 170 countries.

## 4. Empirical results

### 4.1 Baseline regression

To assess the impact of exchange rate volatility on Vietnam's green export margins, this study utilizes PPML estimators to estimate [Equation \(4\)](#). The dependent variable is either "market\_share", "EM", or "IM", which respectively represents Vietnam's market share in total world exports of green products to an importer, the extensive margin or the intensive margin of green products exported from Vietnam to that country.

The results are reported in [Table 2](#). Columns (1), (3) and (5) of [Table 2](#) display the regression results utilizing "exvol\_5" to quantify the volatility of the bilateral exchange rate between the Vietnam Dong and the currencies of Vietnam's trading partners, while columns (2), (4) and (6) display the outcomes adopting "exvol\_2" to measure the exchange rate volatility.

As evidenced by [Table 2](#), the coefficients associated with the real exchange rate volatility variables, "exvol\_5" and "exvol\_2", are negative and statistically significant across all columns. These empirical results suggest that increased real exchange rate volatility has a detrimental effect on the market share, extensive margin and intensive margin of Vietnam's green exports. To facilitate a more detailed interpretation of the empirical results, this study will focus on the findings with "exvol\_5" as the key independent variable. More specifically, the estimated coefficient of  $-0.341$  for the "exvol\_5" variable suggests that a 10% increase in the volatility of the bilateral exchange rate between the Vietnam Dong and the currency of a partner leads to a 3.41% decrease in Vietnam's share of the total world green exports to that

**Table 2.** Impact of exchange rate volatility on trade margins of Vietnam's green exports (2002–2022)

Variables	(1) market_ share	(2) market_ share	(3) EM	(4) EM	(5) IM	(6) IM
$\ln(exvol\_5)_{VNj,t}$	-0.341*** (0.0639)		-0.136*** (0.0293)		-0.451*** (0.169)	
$\ln(exvol\_2)_{VNj,t}$		-0.191*** (0.0464)		-0.0912*** (0.0248)		-0.914*** (0.136)
$\ln(gdpc)_{j,t}$	-0.163*** (0.0617)	-0.162*** (0.0624)	0.275*** (0.0120)	0.276*** (0.0120)	-0.589*** (0.0624)	-0.602*** (0.0639)
$\ln(pop)_{j,t}$	0.0527*** (0.0200)	0.0491** (0.0206)	0.248*** (0.00730)	0.248*** (0.00731)	-0.373*** (0.0464)	-0.354*** (0.0449)
$tradefreedom_{j,t}$	0.00505 (0.00373)	0.00470 (0.00369)	0.00970*** (0.00183)	0.00952*** (0.00185)	0.00267 (0.00508)	0.00463 (0.00472)
$\ln(dis)_{VNj}$	-0.439*** (0.0447)	-0.465*** (0.0452)	-0.344*** (0.0192)	-0.350*** (0.0191)	0.00303 (0.114)	0.0741 (0.104)
$FTA_{VNj,t}$	0.941*** (0.0866)	0.941*** (0.0851)	0.0938*** (0.0341)	0.0996*** (0.0343)	0.528* (0.303)	0.520* (0.306)
$COL_{VNj}$	0.828*** (0.139)	0.844*** (0.140)	0.181*** (0.0497)	0.187*** (0.0495)	0.300** (0.144)	0.452*** (0.147)
Constant	-3.222*** (0.597)	-2.373*** (0.669)	-6.194*** (0.254)	-5.989*** (0.250)	5.145*** (1.491)	2.058 (1.371)
Vietnam-year fixed effects	YES	YES	YES	YES	YES	YES
Observations	2,836	2,836	2,836	2,836	2,836	2,836

**Note(s):** Robust standard errors are in parentheses. \*, \*\* and \*\*\* indicate statistical significance at 10%, 5% and 1%, respectively

**Source(s):** Author's own work

country. A comparative analysis of the exchange rate fluctuation's influence on extensive and intensive margins of Vietnam's green exports reveals that the former is more susceptible to such volatility. The estimated coefficients of the "exvol\_5" variable on "EM" and "IM" are -0.136 and -0.451, respectively. Given that other factors remain unchanged, if the fluctuation in the bilateral exchange rate between the Vietnamese Dong and the currency of a partner increases by 10%, the extensive and intensive margins of Vietnam's green exports to that country will decline by 1.36% and 4.51%, respectively. The results suggest that the intensive margins of Vietnam's green exports, representing the volume of existing green products traded with established partners, are more susceptible to real exchange rate volatility than the extensive margins, which refer to the introduction of new green products or entry into new markets. Existing trade flows are highly sensitive to short-term price fluctuations. When the real exchange rate fluctuates, exporters face immediate challenges in maintaining profitability and competitiveness in existing markets, leading to adjustments in export volumes. Conversely, the extensive margins, involving market entry or product diversification, are often driven by longer-term strategic considerations, such as technological innovation or market access agreements and are less directly influenced by short-term currency swings.

The results of this study generally confirm the adverse influence of exchange rate volatility on the extensive and intensive margins of Vietnam's green exports. The findings imply that the uncertainties and risks associated with exchange rate fluctuations significantly hinder Vietnam exporters' ability to expand their green product basket for exports. Additionally, the unexpected risks arising from exchange rate volatility can lead to a decline in export volumes for existing green products. The susceptibility to exchange rate volatility may vary significantly across sectors, primarily determined by their reliance on imported inputs and export orientation. Industries characterized by high import dependence on specialized

equipment or raw materials, such as the burgeoning renewable energy sector, are particularly vulnerable. Often sourced internationally, solar panels and wind turbine components experience fluctuating costs directly tied to exchange rates. Similarly, the sustainable agricultural sectors highly depend on imported organic fertilizers or specialized machinery, making them sensitive to currency fluctuations that affect both input costs and export competitiveness. Conversely, industries with a higher degree of localized production and less reliance on international supply chains may experience comparatively lower impacts from exchange rate fluctuations. The outcomes complement the conclusion of [Nguyen \(2023\)](#), who finds a negative relationship between exchange rate volatility and Vietnam's agricultural exports. Moreover, the results of this study are in line with those of [Lu et al. \(2020\)](#), who argue that exchange rate risks are negatively associated with both extensive and intensive margins of Chinese exports.

Given the crucial role of green exports in the sustainable development path of Vietnam, the findings of this study have several implications. First, to foster a predictable and conducive environment for green trade, the State Bank of Vietnam should strengthen its coordination with partner central banks to manage exchange rate fluctuations, potentially through currency swap agreements or targeted interventions. Second, promoting the use of hedging instruments and providing accessible information on exchange rate risk management to green exporters can mitigate the adverse effects of volatility. Third, long-term strategies should focus on diversifying Vietnam's green export markets to reduce reliance on volatile foreign exchange markets. Last, policies that encourage foreign direct investment in green sectors, particularly those that utilize local currency for transactions, can create a more stable trade environment to boost Vietnam's green exports.

Considering some factors belonging to Vietnam's trading partners, the outcomes reveal that the GDP per capita of a partner country is negatively correlated with Vietnam's market share in total world exports of green products to that country. Such an adverse effect on Vietnam's market share of green products is primarily driven by a decrease in the intensive margin rather than the extensive margin. Additionally, the result indicates that the population size of an importer boosts Vietnam's market share in total world exports of green products to that country. This result is due to the positive impact on the extensive margin rather than the intensive margin. Trade freedom in partner countries is found to have a positive impact on extensive margin of Vietnam's green exports.

Turning to the gravity control variables, the results provide overall support for the core principles of the gravity model. The negative and statistically significant coefficients associated with the geographic distance variable in columns (1)–(4) of [Table 2](#) consistently reveal its adverse influence on Vietnam's market share for green products, especially the extensive margin. The FTA dummy variables are positive in all columns of [Table 2](#) and statistically significant in columns (1)–(4). The results suggest that simultaneous participation in trade agreements boosts Vietnam's market share of green products in partner countries by promoting the extensive margin of exports. Consistent with common wisdom, colonial ties (COL) exhibit a significant positive relationship with both extensive and intensive margins of Vietnam's green exports.

#### 4.2 Other robustness check

To further validate the robustness of the baseline findings, this study utilizes alternative measures of trade margins. Specifically, the number of green products exported (denoted by “*num\_product*”) is employed as a proxy for the extensive margin, while the average export value per product (denoted by “*value\_per\_product*”) is used to capture the intensive margin. The model (4) is re-estimated with the dependent variable being the total value of green exports (denoted by “*total\_value*”), the number of green products exported and the average export value per product, respectively. The results are shown in [Table 3](#). Columns (1), (3) and (5) display the results with “*exvol\_5*” being the key independent variable presenting exchange

**Table 3.** Robustness check

Variables	(1) total_value	(2) total_value	(3) num_ product	(4) num_ product	(5) value_per_ product	(6) value_per_ product
$\ln(exvol_5)_{VNj,t}$	-0.446*** (0.0932)		-0.165*** (0.0415)		-0.383*** (0.0774)	
$\ln(exvol_2)_{VNj,t}$		-0.303*** (0.0754)		-0.115*** (0.0341)		-0.283*** (0.0595)
$\ln(gdpc)_{j,t}$	0.996*** (0.0520)	1.029*** (0.0597)	0.381*** (0.0147)	0.383*** (0.0147)	0.578*** (0.0355)	0.591*** (0.0398)
$\ln(pop)_{j,t}$	0.815*** (0.0215)	0.827*** (0.0219)	0.302*** (0.00964)	0.303*** (0.00959)	0.611*** (0.0139)	0.615*** (0.0147)
$tradefreedom_{j,t}$	0.0186** (0.00774)	0.0166* (0.00849)	0.00843*** (0.00221)	0.00825*** (0.00223)	0.0173*** (0.00436)	0.0163*** (0.00473)
$\ln(dis)_{VNj}$	-0.430*** (0.0676)	-0.430*** (0.0779)	-0.378*** (0.0211)	-0.383*** (0.0208)	-0.120** (0.0558)	-0.119** (0.0608)
$FTA_{VNj,t}$	0.480*** (0.116)	0.505*** (0.133)	0.252*** (0.0369)	0.259*** (0.0371)	0.312*** (0.0946)	0.340*** (0.103)
$COL_{VNj}$	1.168*** (0.131)	1.276*** (0.143)	0.268*** (0.0589)	0.277*** (0.0584)	0.929*** (0.138)	0.967*** (0.139)
Constant	-11.25*** (0.849)	-11.11*** (0.925)	-2.239*** (0.289)	-2.029*** (0.276)	-10.98*** (0.833)	-10.78*** (0.866)
Vietnam-year fixed effects	YES	YES	YES	YES	YES	YES
Observations	2,836	2,836	2,836	2,836	2,836	2,836

**Note(s):** Robust standard errors are in parentheses. \*, \*\* and \*\*\* indicate statistical significance at 10%, 5% and 1%, respectively

**Source(s):** Author's own work

rate volatility. Columns (2), (4) and (6) show the results when “*exvol\_5*” is replaced by “*exvol\_2*”.

The outcomes support the findings from [Table 2](#). That is, fluctuations in the exchange rate between the Vietnamese Dong and the currencies of trading partners exert a detrimental impact on Vietnam's green exports. This negative influence is evident in both the extensive and intensive trade margins.

## 5. Conclusion

This study empirically examines the bilateral effects of real exchange rate volatility on trade margins using a dataset covering Vietnam's green exports to 170 trading partners during 2002–2022. By adopting the PPML estimators for a gravity model, this study indicates that greater volatility in the real exchange rate between the Vietnamese Dong and the partners' currencies adversely influences Vietnam's green exports. Notably, this negative impact is contributed by a decline in both extensive and intensive trade margins. Being among the initial investigations into the determinants of Vietnam's green exports, this study offers policymakers a foundational empirical basis for enhancing Vietnam's green trade via macroeconomic strategies focusing on exchange rate stabilization. Such a policy framework would provide a favorable environment for the expansion of Vietnam's green exports, thereby contributing to the country's economic growth and environmental sustainability.

While this study provides significant contributions to the understanding of factors influencing Vietnam's green exports, it is not without limitations. Although this study sheds light on the extensive and intensive margins of export flows, it does not delve into the export quality. As [Hausmann et al. \(2007\)](#) emphasized, a nation's economic growth prospects depend

not only on the quantity but also on the quality of its exports. High-quality products facilitate technological advancement, upward mobility in global value chains and enhanced export performance. Thus, future research exploring the impact of exchange rate shocks on green export quality would be a valuable extension of this study.

### Supplementary material

The supplementary material for this article can be found online.

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