

The asymmetric impact of trade openness on output volatility

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Abstract Studies show that the relationship between openness and output volatility is theoretically ambiguous, but most of these studies provide an empirical estimation for this relationship. This paper investigates the impact of trade openness on output volatility, and how this impact may be affected by the country's level of development. We use a panel dataset for 33 countries for the years of 1980 through 2009. A standard deviation of quarterly real GDP over a 5-year span is used as the dependent variable. Controlling for the country and period-specific effects, the main results are as follows: trade openness increases the output volatility. And, the output volatility of countries with a higher level of development is less affected by trade openness.

Keywords Panel data · Output volatility · Trade openness

JEL Classification C32 · E32 · F41

1 Introduction

Output volatility affects the aggregate economic growth, the stock market, and economic forecasting. This paper examines the impact of trade openness on output volatility. In addition, the paper investigates whether this impact is asymmetric or not. Recent empirical papers on the impact of trade openness on output volatility argue that this relationship is theoretically ambiguous, but empirically testable.

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The literature that is relevant to discussing the relationship between openness and business cycle volatility is rapidly growing. However, many studies failed to use the right methodology, which can lead to an incorrect outcome. [Karras \(2006\)](#) finds that trade openness has a significant negative impact on output volatility. Karras calculates the average of trade openness and the standard deviation of output from 1951 to 1998, a time span that is too wide to yield accurate results. In contrast, this analysis uses a panel data for 33 countries. Time is divided into 5-year periods, as this was seen as a more appropriate measure for business cycle volatility.

[Calderón and Schmidt-Hebbel \(2008\)](#) employ an annual panel data for 82 countries from 1975 to 2005. In relying on annual data and by accounting for year- and country-fixed effects, the authors find that trade openness reduces the standard deviation of real GDP growth rate. However, unlike Calderón and Schmidt-Hebbel and other papers in the literature that use annual data on output, our research uses quarterly data on log of real GDP, as this allows for a more precise estimation for output variability.

Studies such as those conducted by [Calderón and Schmidt-Hebbel \(2008\)](#) and [Bekaert et al. \(2006\)](#) focus on the standard deviation of output or consumption over a 5-year period. Splitting the series into 5-year periods is better suited for this type of analysis for two reasons: First, it gives more distance for output variability. Second, it is more consistent with the NBER recessions.

[Giovanni and Levchenko \(2009\)](#) argue that sectors more open to international trade are more volatile. While [Yanikkaya \(2003\)](#) argues that trade barriers and regulations affect the openness–economic growth relationship. Examples of these barriers include: taxes, methods of payment, and tariffs.

The paper contributes to the existing literature the following: We use quarterly data on real GDP to account for the output volatility, in which more observations are included in each of the 5-year periods. In addition, this paper includes country- and time-fixed effect, and control variables such as size of the economy, financial openness, real exchange rate, inflation rate, and nominal short-term interest rate. Finally, and most importantly, this research shows how the country's level of development determines the degree of the impact of trade openness on output volatility. The remainder of this paper is organized as follows: Sect. 2 describes the data. Section 3 provides empirical models; and Sect. 4 presents the results and the conclusion of our research.

2 Data

Our data are a panel for 33 countries from 1980 to 2009. Data on real GDP, real exchange rate, inflation rate, and nominal short-term interest rate is quarterly. While data on trade openness, financial openness, country size, and human development index are annual, the following variables are extracted from [Smith and Galesi \(2011\)](#): real GDP, real exchange rate, inflation rate, and nominal short-term interest rate. Trade openness and country size variables are taken from Penn World Table 7.1, while financial openness is taken from Chinn-Ito Financial Openness Index (2011) and the human

development index is drawn from the United Nations Development Programme.¹ Table 1 in the “Appendix” provides the list of countries used in the sample. And Table 2 provides the data source.

3 Empirical model

The output volatility is represented by the standard deviation of $\log(\text{RGDP})$,² and the 5-year standard deviation of output is defined as follows:

$$\sigma_{yit} = \sqrt{\frac{1}{20} \sum_{q=1}^{20} (y_{qit} - \bar{y}_{it})^2} \tag{1}$$

The variable σ_{yit} is the standard deviation of the log of real GDP for country i in period t , where $i = 1,2,3,\dots,33$ and $t = 1,2,\dots,6$. Because there are 30 years, time is divided into six periods, with each being 5 years in length. We divide the sum of squared deviations by $\frac{1}{20}$ because we have 20 quarters in a period of 5 years. y_{qit} is the output for quarter q in country i within the period t . And \bar{y}_{it} is the average of 5 year output for that particular country i .

The trade openness is the sum of exports, EX, and imports, IM, as a fraction of GDP:

$$\text{OPEN}_{it} = \frac{\text{EX}_{it} + \text{IM}_{it}}{\text{GDP}_{it}} \times 100 \tag{2}$$

The country size is defined as the aggregate Gross Domestic Product of a country i at time t relative to the USA.³

$$\text{Size}_{it} = \frac{\text{GDP}_{i,t}}{\text{GDP}_{US,t}} \tag{3}$$

Baseline regression

$$\sigma_{yit} = \mu_i + \tau_t + \beta_{it}\text{OPEN}_{it} + \Psi_{it}Z_{it} + \varepsilon_{it} \tag{4}$$

where σ_{yit} is the standard deviation of the log of real GDP for country i in period t , μ_i , and τ_t are country- and time-fixed effects, respectively, and OPEN_{it} is the log of openness as defined in (2).⁴ Z_{it} is a vector of control variables: country size, financial openness, real exchange rate, inflation rate, and nominal short-term interest rate. ε_{it} is an error term.

$$\sigma_{yit} = \mu_i + \tau_t + \beta_{it}\text{OPEN}_{it} + \gamma_{it}\text{HDI}_{it} + \chi_{it}(\text{HDI} \times \text{OPEN})_{it} + \Psi_{it}Z_{it} + \varepsilon_{it} \tag{5}$$

¹ See UNDP 2014 Human Development Report.

² $\text{Log}(\text{RGDP}_{it}) = \text{Log}(\frac{\text{GDP}_{it}}{\text{CPI}_{it}})$, where CPI_{it} is the Consumer Price Index for country i in time t .

³ Total PPP Converted GDP, G-K method, at current prices (in millions \$).

⁴ Since t represents a period of 5 years and the openness is given by annual data, first, we take the logs of openness, and then, we calculate the average of logs over 5 years, that is, the average of the logs, not the log of the averages.

Equation (5) has the same variables as Eq. (4), except we add a development variable and an interaction term. The variable HDI_{it} refers to the human development index, and the interaction term $(HDI \times OPEN)_{it}$ counts for investigating if there is asymmetric impact of trade openness on output volatility.⁵

4 Results and conclusion

Table 3 reports the results of the baseline regression. These results show a positive impact of log of trade openness on output volatility, with a coefficient of 0.029814 and significant at a 1 % level. These results differ from Calderón and Schmidt-Hebbel (2008) and Karras (2006), where both studies find a negative significant impact of trade openness on output variability.

Our results are robust because of the inclusion of controls and country characteristics. In Karras's paper (2006), the results change dramatically when country size is added to the simple linear regression. This alters the sign of the openness coefficient from insignificant positive to significant negative.

Table 3 shows that the larger the size of the economy, the less the output volatility. The coefficient equals -0.03331 and significant at a 1 % level. None of the other control variables are significant. Additionally, the adjusted R-squared is sufficiently large: 0.708. Taking into consideration the country- and time-fixed effects, our main result as indicated in Table 3 shows that trade openness increases the output volatility.

Table 4 includes the human development index and a continuous interaction term between this variable and the log of trade openness. The coefficient of the log of trade openness is positive and significant. The developed countries experience higher jumps and drops in output than developing countries, but this coefficient is insignificant. However, the coefficients of the inflation rate and the nominal short-term interest rate are both significant.

The coefficient of the interaction term between human development and trade openness is significant negative: -0.084158 . This indicates that output volatility in more developed countries is less affected by trade openness than countries that are less developed. Table 4 demonstrates that the output volatility coming from trade openness is weaker in developed countries than that in developing countries. These results are reasonable. Because developed countries have more complicated economic structures and different output volatility sources, while developing countries depend more on international trade.

Appendix

See Tables 1, 2, 3 and 4.

⁵ Note that the interaction term here is a continuous variable.

Table 1 Countries in the sample and the average Human Development Index HDI

Country	Average HDI*	Country	Average HDI
Argentina	0.7221	Mexico	0.6720
Australia	0.8801	Netherlands	0.8460
Austria	0.8043	Norway	0.8705
Belgium	0.8290	New Zealand	0.8474
Brazil	0.6416	Peru	0.6492
Canada	0.8551	Philippines	0.6048
China	0.5456	South Africa	0.6142
Chile	0.7222	Saudi Arabia	0.6959
Finland	0.8157	Singapore	0.8024
France	0.8066	Spain	0.7865
Germany	0.8188	Sweden	0.8406
India	0.4581	Switzerland	0.8528
Indonesia	0.5671	Thailand	0.6076
Italy	0.7922	Turkey	0.6081
Japan	0.8331	United Kingdom	0.8154
Korea	0.7656	USA	0.8686
Malaysia	0.6770		

* Average HDI is the simple average of Human Development Index over the years of 1980–2009

Table 2 Data Sources, 1980–2009

Variable	Frequency	Source
Real GDP	Quarterly	Smith and Galesi (2011)
Real exchange rate	Quarterly	Smith and Galesi (2011)
Inflation rate	Quarterly	Smith and Galesi (2011)
Nominal short-term interest rate	Quarterly	Smith and Galesi (2011)
Trade openness	Annual	Penn World Table 7.1 (PWT 7.1)
Financial openness	Annual	Chinn-Ito Financial Openness Index (2011)
Country size	Annual	Penn World Table 7.1 (PWT 7.1)
Human Development Index	Annual	United Nations Development Programme Human Development Report, 2014

Table 3 Least-squares baseline regression

Variable	Coefficient
Log (trade openness)	0.029814*** (0.010086)
Log (country size)	-0.03331*** (0.00959)

Table 3 continued

	Variable	Coefficient
	Financial openness	0.001701 (0.00222)
Dependent variable: standard deviation of the log of real GDP sample of 33 countries, 1980–2009 (5-year period observations) counting for country- and time-fixed effects Robust standard errors in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10% Numbers in bold are the resulting coefficients	Real exchange rate	0.012857 (0.00955)
	Inflation rate	0.07084 (0.09607)
	Nominal short-term interest rate	-0.10171 (0.10797)
	Number of observations	189
	Adjusted R ²	0.708
	F	11.85***

Table 4 Least-squares regression including the level of development

	Variable	Coefficient
Dependent variable: standard deviation of the log of real GDP sample of 33 countries, 1980–2009 (5-year period observations) counting for country- and time-fixed effects Robust standard errors in parentheses. *** significant at 1%; ** significant at 5%; * significant at 10% Numbers in bold are the resulting coefficients	Log (trade openness)	0.08231 *** (0.0183147)
	Human Development Index	0.05445 (0.14547)
	Human Development Index × Log (trade openness)	-0.084158 *** (0.02784)
	Log (country size)	-0.02354 ** (0.01095)
	Financial openness	0.00203 (0.00213)
	Real exchange rate	0.00592 (0.00934)
	Inflation rate	0.16938 * (0.09470)
	Nominal short-term interest rate	-0.19557 * (0.10547)
	Number of observations	189
	Adjusted R ²	0.7244
	F	12.11***

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