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RESEARCH PAPER

Revisiting Squalli-Wilson's Measure of Trade Openness in the Context of Services Trade

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Abstract
This study re-examines Squalli-Wilson's measure of trade openness from the perspective of services. An attempt was made to compose all modes of services supply to form a composite measure of service openness that has rarely been used in trade literature. A global sample comprising different regions based on cross-country data was applied to test the reliability of this measure using correlation coefficients, income, and environmental quality models. Ordinary Least Square (OLS) and Two-Stage Least Square (2-SLS) Instrumental Variables approach were applied. Findings from the growth impact of trade are robust and consistent with prevailing literature supporting the positive impact of service trade on economic growth. However, our empirical estimate based on the two measures of environmental pollutants, shows that services openness reduces SO_2 and increases CO_2 emissions. These findings are consistent with most of the existing literature supporting the "gains from trade" hypothesis in the case of SO_2 and the "pollution havens" hypothesis in the case of CO_2 emissions. Nonetheless, the results provide further support in the context of services for the use of composite trade intensity proposed by Squalli-Wilson that not only considered trade/GDP ratio but also the relative importance of the country to the world trade. The inverted U-shaped EKC was also verified in both two measures of environmental pollutions. The policy implications of these findings are that care must be taken while increasing openness in areas of services to increase economic growth and to reduce the phenomenon of pollution haven in the case of CO_2 emissions.
Keywords: Services Trade Openness, Economic Growth, Environmental Pollutants, 2-SLS Instrumental Variable, Global Cross-country Analysis.
JEL Classification: F18, F43, O44, Q56.

Introduction

There is a lack of a clear definition of the words "openness" and so also "trade openness". This is because the concept of trade openness is used in both policy and policy outcomes sense. While in most cases researchers often used trade liberalization to mean trade openness. It is important to know that the two concepts though closely related but are not meant to be the same. Trade liberalization refers to policy measures aimed at promoting trade while trade openness refers to the increase in trade of a given country relative to its national output. Some prevailing definitions of the terms "trade openness" as given by authors include Harrison (1996), who

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defined openness in terms of the differences between saving a unit of foreign exchange via import substitution and earning a unit of foreign exchange by exporting. According to Kyrre (2006), openness is defined precisely concerning the country's barriers to foreign trade. According to Pritchett (1996) openness is the economy's trade intensity. Adzido et al. (2016), define openness as the country's readiness to adopt liberalized foreign policies concerning trade and investment. Yanikkaya (2003) has argued that literature in trade has not been successful in defining openness precisely although recently the definition is similar to the concept of free trade system where all trade obstacles are eliminated.

Many studies have been conducted on the nexus between trade openness and the macroeconomic environment. For instance, studies by Yaya, 2017; Salma et al., 2013; Frankel and Romer, 1999; Greenaway et al., 2002; Mattoo et al., 2006; Alexander, 2012; Karam and Chahir, 2015; Beverelli et al., 2017; Nsiah and Fayissa, 2018, among others have investigated the nexus between trade openness and economic growth. Trade openness and measures of environmental quality have been investigated by Frankel and Rose, 2005; Chintrakarn and Millimet, 2006; Lin, 2017; Shahbaz et al., 2014; Shahbaz et al., 2017; Antweiler et al., 2001; Chintrakarn and Millimet, 2006; Kellenberg, 2008; Tamazian et al., 2009; Meng and Ni, 2011; Cherniwchan, 2017; Rahman, 2017; Hu et al., 2018; Zhang and Zhang, 2018; Zeng et al., 2019. Trade openness and financial development nexus have been investigated by Hazem and Chadi, 2016; Rudra et al., 2017; Chengsi et al., 2015. Trade openness and foreign direct investment (FDI) have been investigated by Neumayer and Soysa, 2005; Aizenman and Noy, 2006. Trade openness and the rate of investment have been investigated by Jacob and Yiheyisb, 2015. Trade openness and poverty have been investigated by Maëlan and Raju, 2014. Trade openness and development aid have been investigated by Rifat, 2012. Trade openness and inflation have been investigated by Romer, 1993; Terra, 1998; Temple, 2002. Trade openness and return in the stock market have been investigated by Li et al., 2004. Trade openness nexus and regional development have been investigated by Pernia and Quising, 2003. Trade openness and corruption have been investigated by Ades and Di Tella, 1999; Treisman, 2000.

Many openness measures have been extensively applied in the literature of trade to measure countries' degree of openness. The most popularly known measure of trade openness used in the literature of international trade has been the use of the ratio of trade value to GDP of a country i.e. (X + M)/GDP. Some recent studies have also researched the use of different measures against (X + M)/GDP utilized in thousands of literature. Alcalá and Ciccone (2004) have suggested openness measures based on purchasing power parity (PPP). Squalli and Wilson (2011) have stated the use of more closely measure of trade openness which was a composite trade intensity comprising the use of a country's trade share relative to its trade level to total world trade. To deal with outliers Frankel and Romer (1999) have worked on an adjusted trade openness measure with a focus on dealing with outliers in (X + M)/GDP. Li et al. (2004) have modified and suggested a new measure based on Frankel and Romer's (1999) openness measure. Lloyd and MacLaren (2002) applied a computable general equilibrium (CGE) model and derived openness measures based on uniform tariff equivalent and with welfare implication and based on the trade volume in scenario of free trade and restricted trade.

It is important to note that all these proposed measures of trade openness were revolved around "trade policy" and "trade outcomes" which would lead us to conclude that there are two main measures of trade openness i.e. "policy-based measure" and "outcome-based measure". These two measures were differentiated by Antonio et al. (2014), and Antonio et al. (1997). Outcome-based trade openness is based on trade outcomes or actual and real trade data (export and import) while a policy-based measure of trade openness is based on tariff incidence, that is, based on tariff data and the country's trade policies.

There has been a long-time debate and argument among trade experts regarding the right measure and statistics of trade openness. Nowadays, the concern of policymakers has been shifted toward the use of trade policy measures (trade-restrictive measures) as an alternative to the trade/GDP ratio. The use of trade policy measures is in itself problematic and controversial as a result, most empirical studies applied outcome-based measures (Squalli and Wilson, 2011). While for the outcome-based measure, data were freely available from various reliable and objective sources of data unlike in the case policy measure. Sabina and Eldin (2018) argued that measuring trade openness-based trade outcomes or trade intensity may result in a false conclusion. Also, Ulasan (2014) contended that openness measures based on trade policy such as tariffs and non-tariff are more ideal measures than trade intensity in capturing the degree of countries' openness. On the contrary, Squalli and Wilson (2011) noted that a measure-based outcome is the best and accurate way to measure trade openness. The measure will lead to a mixture of several economic policy impacts, economic fundamentals resulting from a combination of exogenous and endogenous forces. Antonio et al. (2014) argued that the use of outcome-based measures is a more intuitive and good proxy of policy measures as it depends on trade policy, geography, and structural characteristics. A more liberalized and open economy is expected to trade more and contribute more to global trade. With this in mind measuring trade, openness must be based on the actual trade flow of both exports and imports instead of just relying on potential trade flows which are based on trade policies (Squalli and Wilson, 2011).

In line with the above arguments, we further argued that the use of trade flow or trade outcome in measuring services openness is more ideal than the use of policy and restrictive measures. This is because most services were not subject to import and export duties, in which case services openness if measured using policy-based would lead to an underestimate of a country's degree of openness.

Most empirical studies applied the trade/GDP ratio despite its flaws. Squalli & Wilson (2011), have argued on the inappropriateness of the use of trade/GDP ratio as it may not only be lacking some empirical support but may exaggerate the effect on the aggregate macroeconomic environment. The trade/GDP ratio considered only current prices, economic size, resources endowment, and other determinants of comparative advantage and that because of price movement, changes in the exchange rate and prices of goods and services in the both domestic and international market may converge and country with small economic size and preference of foreign goods may have a high ratio of trade to GDP signifying a high degree of trade openness (Lloyd and MacLaren, 2002). Despite its shortcomings, the trade/GDP ratio has the advantage over policy measures as it is based on trade outcomes. One of the advantages of using the trade/GDP ratio is that the measure is not artificial as it is the spontaneous measure of the degree of openness (Squalli and Wilson, 2011).

In line with this argument Squalli and Wilson (2011), have suggested an alternative measure that captured two dimensions of openness based on trade outcomes. To them, an economy is considered open, if it has a relatively high trade share to overall GDP and considerable trade integration with the rest of the world. Their measure is defined as;

$$CTSi = \frac{(X+M)i}{1/n\sum_{j=1}^{n}(X+M)j} * \frac{(X+M)i}{GDPi} \quad (1)$$

where: $_i$ = denotes a country subscript; CTS_i = country *i*'s composite trade share which is an adjusted country's trade share to GDP relative to the rest of the world; $(X+M)_i$ = country *i*'s sum of exports and imports; n = number of countries; $1/n$ = mean of the world trade share *(WTS)* of all countries involved; $_j$ = rest of the world; $(X+M)_j$ = sum of exports and imports of the rest of the world; GDP_i = country $_i$'s *GDP*.

Off all the outcome-based openness measures used in previous literature, we argued that Squalli & Wilson (2011)'s openness measure as shown in equation (1), is much more closely a measure of trade openness which is a measure of composite trade intensity comprising the use of country's trade relative to its trade level to total world trade. Based on the trade/GDP ratio, an increase in trade indicates an increase in trade openness. Squalli & Wilson (2011), have argued that in a cross-sectional study it may be wrong to draw such a conclusion that higher trade share means higher openness. This is because, across countries, higher trade share may indicate that a given country's openness is small relative to others and this does not in any way indicate a given country's actual degree of trade openness. In this regard, it is suitable to apply a given country's trade level relative to the rest of the world which will account for its contribution to world trade and also measure its trade intensity. To them, openness to trade is a two-dimensional concept as stated in equation (1), and each concept measures a different way with which an economy is connected to the rest of the world.

Based on the above, the main purpose of this study is to revisit the trade openness measure proposed by Squalli and Wilson (2011) in the context of services and apply it to the income and environmental quality equation as means of testing its reliability. The need to focus on services arises because of difficulty in measuring international services transactions. This has posed many researchers in using the wrong proxy of services trade openness owing to the use of only cross border services and relying on trade/GDP ratio. This has resulted in miscalculating the role of services and the clear-cut measure of its openness. Another reason is the lack of empirical studies focusing on services trade as more attention was given to the goods trade. In trade literature, most trade openness measures were extensively put to test using goods trade while measuring the impact of openness on economic activities ignoring the significant role of services in reshaping the macroeconomic environment. As indicated earlier in this study, economists have demonstrated empirically the impact of trade openness on economic growth, environmental quality, financial development, inflation, and many more. Most of these studies were based on goods trade openness with little or no emphasis on services. This has been the main rationale behind revisiting Squalli and Wilson's (2011) openness measure in the context of services and augmenting it into income and environmental quality equation as means of testing its robustness using a global cross-country sample. This would enable us to investigate the impact of services trade on income and environmental quality. In doing so, we obtained a robust estimate of services trade impact on economic growth as our findings show a positive and significant effect of trade on growth which is in line with most of the existing literature. We also found services trade to reduce sulfur dioxide by a significant amount and increase carbon emissions. These two prevailing results were in support of the "gain from trade" hypothesis in the case of sulfur dioxide and "pollution havens" or the "race to the bottom" hypothesis in the case of carbon emissions. Consistent with Squalli and Wilson (2011), in comparing STI and CSTI in correlation analysis, income, and environmental quality models we found CSTI to be a reliable measure of services openness better than STI. This also provides further empirical support for the need to use CSTI as a proxy of services trade openness. Our result also validated the existence of the so-called EKC hypothesis, which asserts that an increase in income may be companied by decrease pollution after reaching a threshold point.

To this end, the present study is structured into five sections. Section 2 deals with the conceptual issues related to services trade and its openness. Section 3 deals with the methodology of measuring services openness and data sources. Section 4 presents a different battery of robustness tests to our constructed CSTI using correlation coefficients, income, and environmental quality models. Finally, section 5 offers a concluding remark.

Conceptual Issues in Services Trade and Its Openness

The complexity of measuring services trade openness is a result of a limited number of services that can be traded across the border. For services trade to take place for a large number of services, interaction (physical contact) is required between producers and consumers. With this in mind, services trade can broadly be defined based on the mode via which services trade can occur at a global level. The founders of the General Agreement on Trade in Services (GATS) have recognized and identified four channels or modes of services supply. In addition to the commonly known cross-border supply of services i.e. mode 1 (e.g. architectural and banking services transmitted through email or telecommunications). In mode 1, neither the services supplier nor the consumer move, and of course the services is traded. The definition of services trade also includes mobility of buyers or consumers to the countries where the services are produced or provided i.e. consumption abroad or mode 2 (e.g. tourists or patients travel to another country to obtain services), the existence of services provider or enterprises in the country where the services are consumed and required via foreign ownership and foreign direct investment i.e. commercial presence or mode 3 (e.g. hotel chains or domestic subsidiaries of foreign insurance companies), and the temporal movement of services providers or workers i.e. the presence of natural or physical person entering the territory of another country to supply the services i.e. mode 4 (e.g. teachers, accountants, and doctors). These were the framework adopted for present multilateral services negotiations under regional agreements and GATS. Therefore in measuring services trade openness, we adopt the definition of services trade proposed by GATS as it will provide a broader look at services trade and services trade openness.

Now a question arises regarding the applicability of most of the outcome-based measures of trade openness to measure services openness. Going by GATS definition of services trade. We argued that these measures were mainly restricted to trade in goods with little or no emphasis on services trade. The reason is that the measures have failed to account for modes 3 and 4. While scholars have also suggested the use of FDI (mode 3) and trade-based indicators, to measure services openness (Assem and Jefferey, 2000). Previous studies have substantially used the trade/GDP ratio to measure the degree of countries' openness to the world markets. Care must be taken in using any of the outcome-based openness measures while measuring services trade openness. This is because critiques of the measurement and methodology applied to goods trade liberalization are likely to be increased in measuring services trade openness (Nicolette, 2011).

In quantifying services trade openness using outcome-based measures the scope and scale of services openness may be narrowed down by overlooking two main important modes of services supply which also constitutes a greater part of services. The significant role of services and services openness is to a large extent miscalculated when considering only Balance of Payment (BOP) gross term cross border services supply which does not account for an important component of services mode 3 and 4 and services value addition “hidden in goods trade” (Martin, 2019). To this end, we further argued that cross-border services trade does not fully reflect actual or total services flows, and measuring openness based only on cross services will underestimate the degree of countries' openness.

Determined to provide a complete measure of services openness, in addition, to cross-border services supply we included mode 3 and mode 4 to measure services openness based on equation (1). The outcome-based measure of openness applied to goods trade was not premeditated to properly capture some elements of services supply. Apart from the policy-based measure of services trade openness like services trade restrictiveness index (STRI), outcome-based measures were only designed to account for cross-border services supply (mode 1 and 2). And it remains for the researcher to properly look into and account for other modes of services supply in measuring services openness. Our study does not assert to provide a new measure of services openness but rather, it aimed to measure services trade openness based on

Squalli and Wilson (2011)'s openness measure by incorporating other modes of services supply which are mostly ignored in measuring services openness and testing for its soundness in income and environmental quality equation. This will provide further support and validate the reliability of Squalli and Wilson (2011)'s openness measure in the context of services.

Data and Methodology

Method

Following Squalli and Wilson (2011), measure in which there are two dimensions to measuring trade openness which is trade intensity (TI) or simply [(Xi + Mi)/GDPi] and world trade intensity (WTI) or [(Xi + Mi)/Total world trade)]. We construct a measure of service openness based on these two dimensions. In the case of services, exports and imports include all modes of services exports and imports. The incorporation of all services mode into the openness measure is not going to change the insinuations and basic assumptions of Squalli and Wilson's measure. Based on equation (1), country i's services trade intensity can be given as;

$$STIi = (SX + SM)i \,/\, GDPi \tag{2}$$

where: STI_i = country i's services trade intensity; GDP_i = country *i*'s GDP; $(SX + SM)_i$ = sum of country $_i$'s services export and import. Given that services can be supplied and provided via cross-border trade, foreign establishment, and movement of workers. We suggest that in the case of services, services trade intensity (STI) should incorporate both cross-border services supply, foreign establishment, and services provided by the movement of professional workers. In this regards the complete and enriched measure of services openness would be the use of the ratio of the sum of services exports and imports (through all modes of services) to GDP. Therefore, SX and SM include all modes of services supply i.e. cross services trade modes 1 and 2, FDI i.e. mode 3, and the movement of professional workers i.e. mode 4. We used remittance received and paid by reporting country as a proxy of services supplied via the movement of professional workers. According to Squalli & Wilson (2011), using trade/GDP ratio as in equation (2) ignores the relative benefits arising from trade with the rest of the world by country i which is measured as;

$$WSTIi = \frac{(SX + SM)i}{\sum_{j=1}^{n}(SX+SM)j} \tag{3}$$

where $WSTI_i$ is country i's services trade intensity relative to the rest of the world. $\sum_{j=1}^{n}(SX + SM)j$ is the sum of the world services exports and imports all modes included. *(SX+SM)* are is as defined in equation (2).

To form a composite measure of services trade openness using *STI* and *WSTI* we followed the approach adopted by Squalli and Wilson (2011) which was based on the methodology and principles used by the Organization for Economic Cooperation and Development (OECD) (2008), for forming composite indicators. For detail on how to compose STI and WSTI see OECD, 2008: 30; Squalli and Wilson, 2011: 13.

Thus the composite services trade intensity can be given as;

$$CSTIi = \frac{(SX + SM)i}{1/n\sum_{j=1}^{n}(SX+SM)j} * \frac{(SX + SM)i}{GDPi} \tag{4}$$

where all variables are as defined in equations (2) and (3).

It is important to note that most of the outcome-based measures of trade openness are designed only to accommodate for goods trade, as they are all based on only export and import flow or simply cross border trade. Given that services can be provided via cross-border trade, foreign direct investment, and movement of professional workers. Our approach to measuring services trade includes all the modes of services supply and came up with a complete measure of services trade openness using equation (4). In the context of this study, services openness is a broad term that includes all modes of services supply such as cross-border trade, consumption abroad, commercial presence, and movement of professional workers. To this end, SX and SM are broad services exports and imports that incorporate all modes of services supply.

Based on equations 2 and 4 we computed two different measures of services trade openness which are STI and CSTI and augments these in growth and environmental quality equations to test the reliability and robustness of CSTI in comparison to the conventional measure of services openness (STI). As a trade openness measure that has not been widely used in many empirical studies and has not gained much popularity in hypothesis testing, there is a need to test how robust it is in explaining different macroeconomic variables under different conditions. To this end following Squalli and Wilson (2011), we resort to using correlation coefficients to determine the degree of association between STI, CSTI, and other macroeconomics, trade policy, and environmental pollutant measures. While regressions analysis for income and environment would be used to determine the direction and the extent to which CSTI explained income and environmental outcomes.

Data

The data set used in this study is a cross-section for a large set of countries worldwide for 2005, 2014, and 2017. The data for the services trade flows of all modes (services exports, imports, FDI net inflows and net outflows, remittance received and paid by reporting countries) were all obtained from WDI. Real GDP per capita which is in constant 2010 US$ was also obtained from WDI. Data for environmental quality measures like carbon dioxide (CO_2) emissions measured in metric tons per capita come from WDI while sulfur dioxide (SO_2) data comes from National Aeronautics and Space Administration (NASA) and Socioeconomic Data and Applications Center (SEDAC). Population and land area data were obtained from WDI while polity data was obtained from the Polity IV Project at the University of Maryland. The definition, short names used in the subsequent analysis, and data sources are presented in Table 1.

Table 1. Data Sources and Definition of Variables Used in the Study

Variable	Description	Source
EQL	The environmental quality indicator which may be any of the CO_2, SO_2	WDI, NASA-SEDAC
CO_2	Carbon dioxide emissions in metric tons per capita	WDI
SO_2	Sulphur dioxide emissions	NASA-SEDAC
RGDP	Real GDP per capita in constant 2010 US$	WDI
$RGDP^2$	Real GDP per capita squared	Author construct based on WDI data
STI	Services trade intensity measured as the ratio of all models of services trade to GDP	Author construct based on WDI data
CSTI	Composite services trade intensity; constructed based (Squalli and Wilson, 2011) trade openness measure	Author construct based on WDI data
Pop	Pollution total	WDI
Area	Land area per capita is measured as land area divided by population	Author construct based on WDI data
Polity	Polity index which measures the level of the country's	Polity IV Project at the

Variable	Description	Source
	democracy	University of Maryland
	Variables used to construct CSTI	
	Cross border services exports and imports (i.e. mode 1 and 2 services supply)	WDI
	FDI net inflows and outflows BoP, current US$ (i.e. mode 3 services supply)	WDI
	Remittance received and paid by reporting country (i.e. mode 4 services supply)	WDI
	Other variables used to test the robustness of CSTI in the correlation analysis	
	Custom duties as % of tax revenue	WDI
	Employment in the services sector as % of total employment	WDI
	Official exchange rate per US$, period average	WDI
	Net financial flows bilateral current US$	WDI
	New business density new registrations per 1,000 people ages 15-64	WDI
	New business registered in the number	WDI
	Taxes on international trade as % of revenue	WDI

Note: *WDI = Word Development Indicators, NASA-SEDAC = National Aeronautics and Space Administration and Socioeconomic Data and Applications Center (SEDAC)

Augmenting CSTI in Income and Environmental Quality Equations

As a measure that has not been used in many empirical studies and has not gained more popularity, there is a need to test how robust this openness measure is, in explaining different macroeconomic variables under different conditions. Following Squalli and Wilson (2011) we test how robust our constructed service trade intensity is using correlation coefficients, and running regressions analysis for income and environment to determine the direction and the extent to which services openness explained income and environmental outcomes.

Correlation between CSTI with Trade Policy, Macroeconomic and Environmental Quality Measures

Following Squalli and Wilson (2011), we test how reliable are our constructed STI and CSTI, by comparing the correlation coefficients of different indicators of capital flows, opened trade policies, macroeconomic and environmental outcomes with STI, and CSTI. The indicators used include custom and other duties (as % of tax revenue), employment in the services sector (% of total employment), FDI net inflows and outflows (current USD), GDP (constant USD), net financial flows bilateral (current USD), New business density (new registration per 1,000 people ages 15-64), Number of new business registered, official exchange rate per US$ period average, customs duties as % of tax revenue and taxes on international trade as % of revenue, carbon emissions in metric tons per capita, sulfur dioxide. Customs duties and taxes on international though not much relevant to international trade in services, because barriers to services trade are informed of rules and regulations. But we compute correlations of these two indicators for more robustness tests to STI and CSTI. We may expect a negative association between custom duties, taxes on international trade with both STI and CSTI because some services like trade in intellectual property and services if traded across the border by way of goods, are subject to customs duties.

Another important indicator of trade policy that we considered is the official exchange rate. An exchange rate or exchange rate distortion is used as an indicator of countries' trade liberalization policy. This is because the exchange rate serves as a good indicator of measuring the degree to which an economy is toward the domestic or foreign market. Therefore, in international trade literature, the degree of trade liberation and exchange rate policy are used interchangeably. Though Rodriguez and Dani (2001) have argued that the exchange rate and its fluctuations are more of a macroeconomic imbalance rather than trade policy barriers.

Moreover, Warner, 2003; Sachs and Warner, 1995 claim that a high exchange rate causes an increase in imports prices relative to local prices and thereby discourages imports and encourages exports. In this case, we expect the correlation coefficient between the openness index and the exchange rate to be negative. We also expect the sign of the correlation coefficient of the remaining indicators to be positively associated with STI and CSTI.

Table 2. Correlations

Indicators	STI	CSTI
Custom duties	0.0067	-0.4163***
Employment in the services sector	0.2311***	0.3307***
Official exchange rate	-0.1774**	-0.2079***
FDI Net inflows	0.0665	0.6076***
FDI Net outflows	0.0801	0.5954***
GDP Constant USD	0.3142***	0.5425***
Net financial flows bilateral	-0.0828	0.2552***
New business density	0.4338***	0.3148***
New business registered	-0.1132	0.6116***
Taxes on international trade	0.0743	-0.3463***
Carbon dioxide emissions CO_2	0.0666	0.4940***
Sulfur dioxide SO_2	-0.0840	-0.0121

Source: Authors' computation based on World Bank, World Development Indicators (WDI) and NASA-SEDAC = National Aeronautics and Space Administration and Socioeconomic Data and Applications Center (SEDAC) data dated 16/04/2020.

Table 2 shows the pairwise correlation between some important variables considered to be associated with services trade openness. The estimated correlation coefficients between STI and CSTI are positive (0.5446) and significant at less than a 1% significance level. As expected GDP is positively correlated with both CSTI and STI at a less 1% level of significance. Correlation coefficients in the case of STI are only significant with expected signs in variables like employment in the services sector, official exchange rate, GDP, and new business density. While for the remaining variables, the coefficients were not significant accompanied by a lack of support for the theoretically expected sign. The CSTI correlation coefficients were all significant at less than 1% level with the expected sign except for sulfur dioxide. This result supports the robustness of CSTI. The correlations between CSTI and all indicators are high and more robust compared to STI and are in line with the theoretical expectations. These results support the fact that STI is not the best measure of openness and this result is also consistent with Squalli and Wilson (2011), and further supports the need to use CSTI instead of STI as a measure of services trade openness.

Services Trade Openness Impact on Income

One of the broadest and earliest literature of trade gains have been devoted to welfare gains from foreign trade. Recently trade gains have been more broadened to include its role in generating economic growth. Various empirical studies have reported an association between trade and economic growth and yet the nexus is far from identical among countries (Marcelo, 2016). Some studies cast doubt on this association and revealed that the statistical significance of the association depends on the proxy variable of openness as well as an empirical model specification (Edwards, 1998; Vamvakidis, 2002). According to Halit (2003), studies on the impact of trade openness on economic growth are still on the rise and therefore the relationship between the two remained unconvincing. But despite this mis-consensus, it remained a well-known fact that countries that are more open to trade can have higher economic growth. Trade openness has been found to positively affect growth in studies by Gorgi and Alipourian (2008), in the case of selected OPEC member countries, Fakhr and Sheikhbahaie (2008). in case of 10 East Asian countries, Yaya (2017), in the case of Cote d'Ivoire, Salma, et al. (2013), in the case of Pakistan, Hosseini (2014), in case of India; Mishra et al. (2010), in the case of Pacific Island countries; Frankel and Romer (1999) in a cross-country study; Greenaway et al. (2002), in a sample of 73 developing countries. Studies that report a negative effect of trade openness on economic growth include Hyun and Nanak (2008), in a panel sample of 80 countries; Mahdavi and Shamsiev (2005), in a panel of Former Soviet Union (FSU) countries after the union collapse. Therefore, there are mixed findings on the nexus between trade openness and income and precluding the acceptance of the positive effect of trade on income.

As can be observed from the foregoing literature, openness-growth links have received considerable attention but very little attention has been devoted to investigating the impact of services openness on economic growth. Services trade openness is more growth-inducing than goods trade but despite this firm belief investigating the role of services to growth has been silent in most trade empirical studies. The few available studies that investigate the impact of services trade on growth, including Nsiah and Fayissa (2018), examined the impact of services trade on economic growth in 28 samples of African countries. They found services import to exhibit short-run positive impact on economic growth and export to have a long-run positive impact on growth. Using the VAR model Karam & Chahir (2015), in the case of MENA has shown services trade to increase GDP. Mattoo et al. (2006) used cross-country regression for a sample of 60 countries over the period 1990-1999 and found services trade liberalization to positively influence long-run growth performance. Another study done by Beverelli et al. (2017) used cross-country regression to examine the effect of services trade restriction on productivity and found that decreased services trade restrictiveness has a positive impact on manufacturing productivity. A cross-country study, Aaditya et al. (2006), revealed that services trade liberalization increases long-run growth performance in a sample of 60 countries. Alexander (2012) confirmed that industries experienced higher productivity if use services to a greater extent from a more liberalized service sector than others. These studies focusing on services trade impact on growth were not free from shortcomings as they are only based on cross border services trade. Our study will provide a complete measure of services openness and apply it to investigate the impact of services trade on economic growth using a global sample.

The lack of empirical studies on services trade impact on growth is largely attributed to many methodological and measurement problems associated with services trade. It is against this background that this study aimed to revisit the trade-growth nexus using broader services trade openness measures.

To investigate the impact of services trade on GDP we estimate a model based on original Frankel and Romer, 1999 and augmented CSTI which was built based on Squalli and Wilson, 2011's composite openness measure. Our model is a log-log model given as;

$$InRGDP_i = ɣ_0 + ɣ_1 lnSTO_i + ɣ_2 InPop_i + ɣ_3 InArea_i + \mu_i \quad (5)$$

where: *$InRGDP_i$* is the log of country *i*'s real GDP per capita, *$InSTO_i$* is the log of country $_i$'s services trade intensity, *$InPop_i$* is the log of country $_i$'s population, *$InArea_i$* is the log of country $_i$'s land area per capita. $ɣ_0$ $ɣ_1$ $ɣ_2$ and $ɣ_3$ are the parameters to be estimated.

Equation (5) is estimated using OLS and 2-stage least square (2SLS) instrumental variable (IV) approach. The use of an IV estimate is important because OLS may lead to bias estimates of trade effect on income and as such, it cannot be relied upon because of the endogeneity problem. The way to solve this is by using an IV associated with trade but not correlated with the error term μ_i. Therefore, the idea of using IV is to control for the endogeneity problem and to compare IV and OLS results, and determine whether OLS overestimates the effect of trade on income. If using an IV approach is suitable for our model. Then other additional factors that are prominent in influencing income like human capital, physical capital may not necessarily be controlled in our model but are included in the error term. Using IV estimate, trade impact on income include the effect of other factors operating through it to influence income and that, including these factors would leave its effect operating through trade. The reverse effect of income on trade that may lead to a biased estimate of model (5) parameters can be eliminated by using IV.

Following Squalli and Wilson (2011), we estimated three models each using OLS and IV approach by augmenting STI, CSTI, and the log of CSTI in the model (5). Based on the test of endogeneity conducted. The trade variables used to estimate model (5) were proven to be endogenous as p-values of both Durbin and Wu-Hausman were less than 5% significance level and hence calling for the need to use IV estimate. The test statistic and the corresponding p-values are reported in Table 3 under the OLS estimate. We instrumented our trade variables with the total population, real GDP, and land area both at level form. These variables were found to be good instruments in all the three estimated IV models in table 3. The Sargan and Basman tests of over-identifying restriction also show that our models are correctly specified as shown in table 3. To deal with heteroskedasticity of the residual, OLS models were estimated using robust standard errors.

Table 3. OLS and IV estimates of the Income Growth Equation

Explanatory Variables	**Model 1 OLS**	**Model 2 OLS**	**Model 3 OLS**	**Model 4 IV**	**Model 5 IV**	**Model 6 IV**
Intercept	8.718*** (0.711)	10.23*** (0.647)	12.11*** (0.634)	-7.753 (6.896)	13.18*** (1.586)	14.84*** (0.993)
STI	0.00992*** (0.00310)			0.205*** (0.0726)		
CSTI		3.17e-05** (1.35e-05)			0.000171*** (2.75e-05)	
lnCSTI			0.380*** (0.0563)			0.786*** (0.0761)
lnPop	-0.0372 (0.0437)	-0.116*** (0.0383)	-0.334*** (0.0499)	0.979** (0.421)	-0.234*** (0.0894)	-0.595*** (0.0699)
lnArea	-0.0206 (0.0721)	-0.00715 (0.0647)	0.105* (0.0592)	1.361** (0.588)	0.362** (0.152)	0.314*** (0.0861)
Test of endogeneity						
Durbin	111.636 (0.0000)	117.692 (0.0000)	81.3311 (0.0000)			
Wu-Hausman	308.844 (0.0000)	361.909 (0.0000)	149.801 (0.0000)			
Test instruments validity						
Sargan test				0.34733 (0.8406)	0..4119 (0.9378)	5.85603 (0.1188)
Basman test				0.33589 (0.8454)	0.3961 (0.9410)	5.8157 (0.1209)
Observations	172	172	172	172	172	172
R^2	0.061	0.143	0.434	---	---	---
F-Statistic	7.71	4.35	17.68	---	---	---
Wald chi2 stat.				8.28	40.41	111.01
Overall p-value	0.0001	0.0056	0.0000	0.0407	0.0000	0.0000
Root MSE	1.3246	1.2656	1.0282	5.0421	2.3767	1.37

Source: Research finding.

Note: The statistical significance of the estimates at < 1%, < 5% and < 10% are denoted by ***, **, and * respectively. Robust standard errors were in parenthesis except for the Durbin and Wu-Hausman test of endogeneity, Sargan and Basman test of instrument validity which are p-values.

Table 3 reports six estimated regression models. Models 1-3 are OLS models estimate of real GDP per capita, services trade intensity, population, and per capita land area. The model indicates a statistically and positive significant impact of services trade openness on income. The point estimate indicated that an increase in STI by 1 percent point will result in a 0.00992 percent increase in real GDP per capita. The estimate based on CSTI and lnCSTI results in GDP per capita increase by 0.0000317 and 0.380 percent respectively all statistically significant at less than 1%. Unlike in the case of model (3), the use of CSTI in place of STI in model (2) has resulted in the decreased estimated effect of services openness on income. However, despite this decrease, in the model (2) and (3) as compared to model (1) there is a considerable increase in the explanatory power of services openness when we use CSTI and lnCSTI in place of STI because of the value of R^2 increases from 0.061 in the model (1) to 0.143 in the model (2) and 0.434 in the model (3). Statically and based on the reported value of R^2 the effect of services trade openness on GDP growth is better explained when CSTI is used in log form and these results are also consistent with (Squalli & Wilson, 2011). The differences in the coefficients estimated imply that when CSTI is used in place of STI, it may underestimate the effect of services trade openness on GDP growth and that when CSTI is used in log form it better explained the effect of openness on GDP growth. Therefore, from three estimated OLS models and based on the reported R^2 by using CSTI the explanatory power of the independent variables increased and even more increased by using lnCSTI.

In the IV models estimate trade openness variables are instrumented because they are all endogenous as confirmed by the test of endogeneity. In all the three IV estimated models the coefficients of the trade variables suddenly increase and were all statistically significant further supporting the reliability of CSTI. Consistent with Frankel and Romer (1999), in all the three estimated IV models, the results provide no support that OLS overestimates the effect of trade on income. This is because the IV estimates in all three models are higher than the OLS estimate. This finding contradicts Squalli and Wilson's (2011) findings while comparing OLS and IV estimates. The results further revealed that service openness has a positive and statically significant impact on GDP growth. When CSTI is in logs, the IV estimate substantially exceeds the OLS estimate by a statistically significant amount. Consistent with Squalli and Wilson (2011), our findings based on OLS and IV estimates, provide empirical support for the use of composite services trade intensity (CSTI) in place of services trade intensity (STI) in measuring the effect of services trade openness on income. Our finding is also consistent with (Nsiah and Fayissa, 2018; Karam and Chahir, 2015; Mattoo et al., 2006; Beverelli et al., 2017; Aaditya et al., 2006; Alexander, 2012) that found services trade to positively impact on economic growth. But contradicts studies by (Hyun and Nanak, 2008; Mahdavi and Shamsiev, 2005) that report a negative effect of goods trade openness on economic growth.

Using OLS estimate we found that the population has a negative effect on economic growth and this effect is significant only when CSTI and its log are used in place of STI. The result shows that a 1 percent point increase in population will lead to a 0.334 percent decrease in GDP per capita in the model (3). The effect of increased population on income as found in this study contradicts, the one found in the original Frankel and Romer (1999), equation but is consistent with Squalli and Wilson (2011), that applied the equation and verified the hypothesis. In using the IV estimate, population positively and significantly affect growth in model 4 and negatively affect growth in models 5 and 6. There is no consensus on the theoretical ground on the nexus between income and population growth. Population growth encourages technological innovation as stated by endogenous growth theory. In the classical and neoclassical view proliferating population growth can probably deteriorate GDP per capita. Based on economic theory, the population can be favorable or harmful to economic growth. Empirical literature using different growth models has also reported mixed findings on the relationship between population and economic growth. By controlling for international trade, the results in the OLS estimate report a positive and significant impact of an area on income only when lnCSTI is used in the model estimate. In model 3, a 1 percent point increase in areas is associated with a GDP per capita increase of about 0.105 percent and this estimate is economically and statistically significant. In IV estimate the coefficients of area are positive and statistically significant when all services openness measures are used in the model.

Services Openness Impact on the Environmental Quality

Examining the impact of trade on the environment is motivated because of the recent attention from both researchers and policymakers on this issue. Many theoretical links through which openness to trade can influence environmental outcomes have been identified but the empirical validation of these theories remained unresolved. This is because existing empirical studies have failed to provide genuine and conclusive evidence on the association between trade and environmental outcomes (Asghari, 2014). Some studies report that trade has a beneficial impact on the environment among these studies include; Hu et al., (2018), who is a sample of 25 developing countries explored the role of commercial services trade in generating carbon emissions and found that carbon emissions decrease with increase in commercial services trade. Zhang and Zhang (2018) used the ARDL bound testing approach to co-integration and found services trade to decrease CO_2 emissions in China. Another panel study of 128 countries by Kellenberg (2008), reports a small but negative effect of trade on measures of environmental quality. Chintrakarn and Millimet (2006) investigate the impact of inter-regional trade on different measures of environmental quality. Their findings show no evidence of the detrimental effect of trade on the environment. Using cross-country regression Frankel & Rose (2005), revealed a negative association between trade openness and environmental outcomes measure as nitrogen dioxide (NO_2), SO_2, and particulate matter (PM_{10}). Antweiler et al. (2001) developed a theoretical model and applied real data to verify the theory; they found to trade to be goods in improving the environmental quality of sulfur dioxide. Cherniwchan (2017) analyzed the effect of the North Atlantic Free Trade Area (NAFTA) on SO_2 and PM_{10} in the U.S and revealed that trade decrease SO_2 and PM_{10}. Meng and Ni (2011) found a beneficial effect of ordinary and intra-product trade on the environmental quality measure of SO_2 and CO_2 emission in 12 Chinese provinces. Findings from these studies support the gains from trade theory and contradict the race to the bottom theory.

Other studies that revealed trade to have a detrimental effect on environmental quality include; Tamazian et al. (2009), who examined the effect of financial services trade openness on CO_2 emissions in BRIC member countries. Findings revealed that the financial services trade increase CO_2 emissions in all countries. Rahman (2017) who is a panel of 11 Asian most populous countries while using fully modified least square (FMOLS) and dynamic ordinary least square (DOLS) shows that trade increases CO_2 emissions and degraded the environment. Lin (2017) has also revealed trade to degrade the environment as it increases SO_2 NO_2 and Aerosols concentration in China. Zeng et al. (2019) while using a fixed-effect model has found interprovincial trade to increase SO_2 in China. Shahbaz et al. (2014) while using the ARDL bound test to co-integration confirmed that trade increases CO_2 emission in Tunisia. In a panel of 105 low, middle and high-income countries Shahbaz, et. al. (2017), revealed that trade openness reduces environmental quality as it increases CO_2 emissions in all countries. Asghari (2010) while using fixed and random effect models show that trade increases CO_2 emissions in the case of the EU, the Persian Gulf, and North-South regions. Tayebi and Younespour (2012) in the context of Iran's trade with East Asia, the Middle East, and OECD countries have shown that Iran’s trade with these regions increases CO_2 emissions in Iran. Shahabadi et al. (2016)

show that trade negatively affects the environmental performance of OPEC member countries. A study was done by Sharifi and Azarbaiejani (2016) reported no statistical evidence of trade impact on the environmental quality measure of CO_2 emissions in OPEC member countries.

To verify the impact of services on the environment we estimate the following regression equation based on the original (Frankel & Rose, 2005):

$$InEQL_i = \Upsilon_0 + \Upsilon_1 lnRGDP_i + \Upsilon_2 lnRGDP_i^{\ 2} + \Upsilon_3 lnSTO_i + \Upsilon_4 lnPolity_i + \Upsilon_5 lnArea_i + \mu_i \quad (6)$$

where *lnEQL* stands for a measure of environmental quality in log form (which may be any of the two measures we adopted which are SO_2 (measured in milligram mg) and CO_2 emissions (measured in metric tons per capita), *lnRGDP* is real per capita GDP introduced in log form, *lnSTO* is the log of services trade intensity, *lnPolity* is the log of polity index, which a measure of democratic governance believed to influence the environmental quality and *lnArea* is per capita land area introduced in log form and μ_i is the error term. The non-linear component of GDP per capita replicates the famous environmental Kuznets curve (EKC) hypothesis. The hypothesis is that the coefficient of real GDP square is negative and that the pollution curve finally goes down. We will verify the existence of an environmental Kuznets curve hypothesis though is not the main focus of this study. The incorporation of land areas is to allow for the influence of population density on environmental damages. Υ_3 is the measure of the average effect of greater trade openness on environmental quality, and it is our variable of interest. The two measures of environmental quality used were estimated as separate equations.

Going by the EKC hypothesis, the expected sign of Υ_1 is positive and negative for Υ_2. A statistically significant and negative Υ_2 is an indication of a turning point in which the pollution curve turns down. The hypotheses and expected sign of Υ_3 is mixed as its signs depend on a countries level of economic development. The sign of Υ_3 is an indicator of testing and validating the race to the bottom theory or the pollution haven hypothesis and the gains from trade theory in the sample countries. If the sign is positive and significant it validates the pollution haven hypothesis and vice versa. For developed countries, the sign of Υ_3 is expected to be negative, this is because production in these countries is less polluting. Again developed countries are even accused of shifting their pollution-intensive industries to less developed countries. In which case they will start to import pollution-intensive goods from developing and less developed countries with less environmental standards. This is what has resulted in the emergence of the race to the bottom, or pollution haven hypothesis in developing and less developed countries.

In this part of the analysis, we augmented services trade openness measures into the environmental quality equation based on the original Frankel and Rose (2005), environment equation. This is done to further verify the reliability of using CSTI in place of STI in empirical studies. Because of the endogeneity of trade and income and to avoid the problem of spurious regression we estimate equation (6) using both OLS and IV approaches. Table 4 and 5report models estimate sulfur dioxide and carbon emissions. In each case, we conduct Durbin and Wu-Hausman tests of endogeneity and the Sargan and Basman tests of over-identifying restrictions. In both sulfur dioxide and carbon emissions equations, the Durbin and Wu-Hausman tests show that the variables income and trade are endogenous and that we correct in treating them as endogenous. This is because the p-values from these tests are all less than the 5 percent significance level and hence rejecting the null hypothesis that variables trade and income are exogenous. In estimating equation (6) many variables were used to instrument trade and GDP per capita and the required test of instrument validity has proven that these variables were exogenous. The Sargan and Basman tests also show that our models are correctly specified. The test results corresponding to each model are reported in Tables 4 and 5.

Table 4. OLS and IV Estimate of Sulphur Dioxide (SO_2) Equation

Explanatory Variables	Model 1 OLS	Model 2 OLS	Model 3 OLS	Model 4 IV	Model 5 IV	Model 6 IV
Constant	-12.82*** (4.870)	-13.15** (5.056)	-11.01** (4.741)	-19.83* (11.07)	-22.47** (9.534)	-30.23* (17.74)
lnRGDP	4.254*** (1.040)	4.408*** (1.090)	4.069*** (1.009)	5.667** (2.223)	7.054*** (2.037)	5.404*** (1.831)
$LnRGDP^2$	-0.226*** (0.0600)	-0.239*** (0.0632)	-0.233*** (0.0580)	-0.330** (0.129)	-0.418*** (0.121)	-0.263** (0.107)
STI	-0.0234*** (0.00593)			0.0717** (0.0319)		
CSTI		4.15e-07 (5.23e-06)			6.75e-05*** (2.48e-05)	
lnCSTI			0.220*** (0.0744)			-0.581** (0.289)
lnPolity	-0.485** (0.205)	-0.538** (0.252)	-0.678** (0.286)	-0.119 (1.158)	-0.434 (0.973)	2.321 (4.100)
lnArea	-0.222** (0.106)	-0.113 (0.105)	0.0116 (0.107)	0.197 (0.269)	0.0638 (0.200)	-0.480** (0.237)
Test of endogeneity						
Durbin	30.568 (0.0000)	17.3989 (0.0002)	27.018 (0.0000)			
Wu-Hausman	21.9905 (0.0000)	9.96515 (0.0001)	17.5244 (0.0000)			
Test instruments validity						
Sargan test				0.187545 (0.6650)	0.033289 (0.03046)	0.66073 (0.7187)
Basman test				0.171929 (0.6784)	0.03046 (0.8615)	0.607051 (0.7382)
Observations	118	118	117	82	82	91
R^2	0.266	0.183	0.240	---	---	---
F-Statistic	13.06	7.85	10.93			
Wald chi2 stat.				10.66	15.31	1578
p-value	0.0000	0.0000	0.0000	0.0052	0.0091	0.0075
Root MSE	1.4409	1.52	1.4713	2.3982	2.0161	2.041

Source: Research finding.

Note: The statistical significance of the estimates at < 1%, < 5% and < 10% are denoted by ***, **, and * respectively. Robust standard errors were in parenthesis except for Durbin and Wu-Hausman test of endogeneity, Sargan and Basman test of instrument validity which is p-values.

Table 5. OLS and IV Estimate of Carbon Dioxide Emissions (CO_2) Equation

Explanatory Variables	Model 1 OLS	Model 2 OLS	Model 3 OLS	Model 4 IV	Model 5 IV	Model 6 IV
Constant	-8.192** (3.744)	-7.647* (3.973)	-6.891* (3.744)	-10.02*** (3.455)	-13.42 (9.600)	-7.835** (3.483)
lnRGDP	3.649*** (0.317)	3.563*** (0.331)	3.677*** (0.314)	3.989*** (0.393)	4.584*** (1.757)	3.979*** (0.399)
$lnRGDP^2$	-0.160*** (0.0185)	-0.156*** (0.0195)	-0.165*** (0.0183)	-0.181*** (0.0230)	-0.218** (0.104)	-0.186*** (0.0239)
STI	0.00648** (0.00303)			0.00965*** (0.00259)		
CSTI		2.12e-06 (2.13e-06)			1.60e-05** (6.74e-06)	
lnCSTI			0.0697*** (0.0223)			0.120*** (0.0344)
lnPolity	-2.691***	-2.581***	-2.855***	-2.672***	-2.227***	-2.922***

	(0.725)	(0.762)	(0.745)	(0.639)	(0.799)	(0.660)
lnArea	0.117***	0.0767***	0.0588**	0.137***	0.0892***	0.0476*
	(0.0324)	(0.0253)	(0.0236)	(0.0293)	(0.0264)	(0.0254)
Test of endogeneity						
Durbin	6.50424	12.3063	6.50243			
	(0.0387)	(0.0021)	(0.0387)			
Wu-Hausman	3.21774	6.34843	3.21656			
	(0.0430)	(0.0023)	(0.0431)			
Test instruments validity						
Sargan test				3.5486	4.02605	4.86592
				(0.3087)	(0.2587)	(0.3013)
Basman test				3.46031	3.88696	4.69016
				(0.3259)	(0.2739)	(0.3206)
Observations	149	149	148	148	148	147
R^2	0.872	0.864	0.870	0.869	0.848	0.866
F-statistic	225.61	220.25	226.02			
Wald chi2 stat.				974.03	757.09	948.78
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Root MSE	0.52552	0.54033	0.52963	0.52128	0.56108	0.52729

Source: Research finding.

Note: The statistical significance of the estimates at < 1%, < 5% and < 10% are denoted by ***, **, and * respectively. Robust standard errors were in parenthesis except for the Durbin and Wu-Hausman test of endogeneity, Sargan and Basman test of instrument validity which is p-values.

Tables 4 and 5 provide an estimate of SO_2 and CO_2 emissions equations using both OLS and IV approaches. Following Squalli and Wilson (2011), we introduced CSTI in both the level and log form to check for the reliability of using CSTI. In the OLS estimate except for CSTI, the STI and lnCSTI as measures of services trade openness were all statistically significant determinants of SO_2 and CO_2 emissions. Composite trade intensity at a level is not a significant determinant of the pollutants but when introduced in log form it becomes significant at less than 1% level. Using STI as a measure of services trade openness reduces SO_2 and when we control for endogeneity it increases SO_2. In table 5 trade intensity increases CO_2 emissions in OLS and even after controlling for endogeneity. This implies that services trade is detrimental to the environment as it increases carbon emissions. When CSTI is used in both SO_2 and CO_2 OLS equations it is not statistically significant but after controlling for endogeneity and using IV estimate it becomes statistically significant at less than 1 and 5% level of significance. Models 6 in table 4 and 5 which are our final models show that services trade reduce SO_2 and increase CO_2 emissions. In IV estimate we obtained robust evidence of the harmful effect of trade on carbon emissions. This is because both the coefficients of trade intensity and composite trade intensity are positive and significant. CSTI coefficients are much higher than that of STI in both OLS and IV, implying that CSTI better explains the effect of trade on income. The beneficial effect of trade on the environment in the case of SO_2 in model 6 of Table 4 supported the gains from the trade hypothesis. This finding is also consistent with Antweiler et al., 2001; Frankel and Rose, 2005; Meng and Ni, 2011; Cherniwchan, 2017, who found trade to decrease SO_2 emissions. But contradicts Lin, 2017; Zeng et al., 2019, who found trade to increase SO_2 in China.

The damaging effect of trade on the environment as shown in table 5 implied the existence of the “race to the bottom” or “pollution havens hypothesis” in the sample countries. This finding is also consistent with Tamazian, et. al. (2009), who found financial services trade openness to increasing CO_2 emissions in BRIC countries, Rahman, 2017; Lin, 2017; Shahbaz et al., 2014; Shahbaz et al., 2017; Asghari, 2010; Tayebi and Younespour, 2012; Shahabadi et al., 2016, who all found trade to increase CO_2 emission in the context of different countries, regions and global sample. This finding also contradicts Hu et al. (2018), who found commercial services trade to decrease CO_2 emissions in 25 developing countries, Zhang and Zhang (2018), who found services trade to decrease CO_2 emissions in China, Kellenberg, 2008; Chintrakarn and Millimet, 2006; Meng and Ni, 2011, who has found trade to be beneficial to the environment and decrease CO_2 emissions. Democratic governance as measured by the polity index is found to reduce CO_2 emissions and this finding is robust across different models estimated in table 5. While there is no robust evidence for the role of democracy in reducing SO_2 emissions. We also obtained robust evidence of the positive and increasing impact of the area on carbon emissions. Model 6 in Table 4 shows a beneficial impact of the area on the environment as it reduces sulfur dioxide. This estimate is not robust across different models estimate. The EKC hypothesis is also validated in both equations and across different estimated models of both OLS and IV.

The IV estimates of income and SO_2 equations report missing R^2. The reason is just that IV estimate normally reports missing or negative R^2 if the sum of squares in the model is negative because the Residual Sum of Squares (RSS) is greater than the Total Sum of Squares (TSS). In the framework of IV estimate, missing or negative R^2 has no statistical meaning. This is because in 2-SLS while estimating the model parameters some explanatory variables do enter the model as instruments. Therefore, missing or negative R^2 is not a problem in the 2-SLS model. The most important thing, which will be of much concern to the researcher is the parameters estimated with standard errors that are acceptable.

Conclusion

It is believed that there is no consensus among trade experts regarding the definition of trade openness. This has also given rise to the lack of a reliable measure of trade openness. While trade literature had for long been using the ratio of trade to GDP as a proxy of trade openness as well as of trade liberalization. It has been found that the use of the trade/GDP ratio is problematic. Despite its shortcomings, it has been considered by researchers as a more reliable measure and proxy of trade goods and services openness and liberalization. Owing to the distinctive nature of goods and services, a measure of openness applicable to goods trade must be applied with caution in the case of services. This is because the traditional measure if apply to measure services openness can only account for cross border services supply which is recorded in countries' BOP and ignore other important modes of services supply. Though literature in trade was more focussed on goods trade with little emphasis on services. This may be attributed to the complexity of measuring services trade and its openness due to the limited number of services that can be traded across national boundaries. However, cross-border services trade does not fully reflect actual or total services flows, and measuring openness based on only cross-border services trade will underestimate the degree of countries' openness. Determined to provide a complete measure of services openness and in addition, to cross border services supply, we included mode 3 (foreign ownership) and mode 4 (presence of a person in a country to supply services) to measure services openness based on Squalli and Wilson, 2011's openness measure and testing its robustness using correlation coefficients, income, and environmental quality equations.

With this in mind, the study provides an attempt to compose all modes of services supply to measure services trade openness using an alternative openness measure proposed by Squalli and Wilson, 2011. By focusing on only services trade which in most cases were neglected in trade literature we provided further support for the use of new composite trade intensity measures that not only considered trade share to overall GDP but also the relative importance of the country to the world trade. The different battery of robustness tests ranging from correlations to the estimate of income and environmental quality equations augmenting CSTI was conducted and has proven the reliability and the need to use CSTI in place of STI. Our result also provides further empirical support for the need to use CSTI while measuring the impact of services trade on trade policy indicators and the macroeconomic environment. Our study findings are not only consistent with Squalli and Wilson (2011), but also with other empirical studies that predominantly used the trade/GDP ratio. The approach adopted in measuring services trade openness in this study provides a significant improvement over the use of only cross-border services trade while measuring services openness. The study further provides comprehensive support for the need to use CSTI as a proxy of services trade openness and liberalization while using the actual flow of all modes of services supply. This is because the use of services trade flow or outcome in measuring services openness is more ideal than the use of policy measures as most services were not subject to import and export duties.

Based on our built composite services trade intensity (CSTI), we modeled the effect of services trade on income and environmental quality while controlling for endogeneity using the IV approach. Our results indicate a positive and statistically significant effect of services trade on economic growth. This effect is also robust to different estimation and different openness measures in both OLS and IV estimates. These results provide empirical evidence in support of the openness-led-growth hypothesis, which asserts that countries with higher services trade openness may experience higher per capita income growth. Furthermore, in the trade environment nexus, we found a negative and statistically significant effect of services trade on SO_2 measures of environmental quality. This result shows a beneficial effect of trade on the environment as it reduces SO_2. This result supports the gains from the trade hypothesis that asserts trade to have a gainful effect on the environment. In the case of CO_2 emission, we found trade, to degrade the environment as it increases CO_2 emissions. This finding is also robust across different openness measures and in both OLS and IV estimates. The finding is also consistent with the prominent hypotheses of “pollution haven” or the "race to the bottom" hypothesis that assets trade to make countries dirtier. The inverted U-shaped EKC for the relationship between growth and pollution was also verified in both two measures of environmental quality and found robust to different estimations in all the two pollutants. The policy implications of these findings are that care must be taken while increasing openness in areas of services to increase economic growth and to reduce the phenomenon of pollution haven in the case of CO_2 emissions.

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Appendix A

A1: Acronyms and Abbreviations used in the Study

BOP	Balance of Payment
CGE	Computable General Equilibrium
CO_2	Carbon dioxide emissions
CSTI	Composite Services Trade Intensity
EKC	Environmental Kuznets Curve
FDI	Foreign Direct Investment
FSU	Former Soviet Union
GATS	General Agreement on Trade in Services
GDP	Gross Domestic Product
IV	Instrumental Variable
MSE	Mean Standard Error
NASA	National Aeronautics and Space Administration
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
OPEC	Organization of Petroleum Exporting Countries
PM_{10}	Particulate Matter
PPP	Purchasing Power Parity
RSS	Residual Sum of Square
SEDAC	Socioeconomic Data and Applications Center
SO_2	Sulphur Dioxide
STRI	Services Trade Restrictiveness Index
STI	Services Trade Intensity
TSS	Total Sum of Squares
UK	United Kingdom
US	United States
WDI	World Development Indicators
WTS	World Trade Share
2-SLS	Two-Stage Least Square

A2: List of Sample Countries Used in the Study

Afghanistan	Congo, Rep.	Iraq	Morocco	Solomon Islands
Albania	Costa Rica	Ireland	Mozambique	South Africa
Algeria	Cote d'Ivoire	Israel	Myanmar	Spain
Angola	Croatia	Italy	Namibia	Sri Lanka
Antigua	Cyprus	Jamaica	Nepal	St. Kitts
Argentina	Czech Republic	Japan	Netherlands	St. Lucia
Armenia	Denmark	Jordan	New Zealand	St. Vincent
Aruba	Dominica	Kazakhstan	Nicaragua	Suriname
Austria	Dominican Rep.	Kenya	Niger	Sweden
Azerbaijan	Ecuador	Kiribati	Nigeria	Switzerland
Bahamas	Egypt Arab Rep	Korea, Rep.	N/Macedonia	Tajikistan
Bahrain	El Salvador	Kosovo	Norway	Tanzania
Bangladesh	Equator. Guinea	Kuwait	Oman	Thailand
Barbados	Estonia	Kyrgyz Rep.	Pakistan	Timor-Leste

Belarus	Eswatini	Lao PDR	Palau	Togo
Belgium	Ethiopia	Latvia	Panama	Tonga
Belize	Fiji	Lebanon	Papua N Guinea	Trinidad
Benin	Finland	Lesotho	Paraguay	Tunisia
Bhutan	France	Liberia	Peru	Turkey
Bolivia	Gabon	Libya	Philippines	Turkmenistan
Bosnia & Herz	Gambia	Lithuania	Poland	Tuvalu
Botswana	Georgia	Madagascar	Portugal	Uganda
Brazil	Germany	Malawi	Qatar	Ukraine
Brunei Darussalam.	Ghana	Malaysia	Romania	UK
Bulgaria	Guatemala	Maldives	Russian Fed.	Uruguay
Burkina Faso	Guinea	Mali	Rwanda	Uzbekistan
Cabo Verde	Guinea-Bissau	Malta	Samoa	Vanuatu
Cambodia	Guyana	Marshal Islands	Sao Tome Prin.	Vietnam
Cameroon	Haiti	Mauritania	Saudi Arabia	W/Bank& Gaza
Chad	Honduras	Mauritius	Senegal	Yemen, Rep.
Chile	Hong Kong	Mexico	Serbia	Zambia
China	Hungary	Micronesia	Seychelles	Zimbabwe
Colombia	India	Moldova	Sierra Leone	
Comoros	Indonesia	Mongolia	Slovak Repub.	
Congo D. Rep.	Iran.	Montenegro	Slovenia	