A New Trade Openness Rate

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ABSTRACT:

This paper proposes a new specification of trade openness providing an explanation which is consistent with other existing options, but with higher explanatory power. The indicator and a new database are proposed and compared with the existing ones, finding that the proposed measure improves on some disadvantages of other proposals. Several empirical confirmations are provided by replicating previous System-GMM estimations with the new variables and applying Granger-causality tests. Additionally, the specification presents the highest coefficient of determination after a new analysis of its influence on economic development by applying Instrumental Variable panel-data models with 36 OECD countries for 1960-2019.

JEL Codes: F17, F14, L16

Key Words: Trade openness, Indicator, System GMM, Explanatory power

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1. Introduction

The accurate use of a trading variable is essential in the science of economics, but also in real practice and for policy, and the specific measurement of the degree of trade openness is also crucial. The most common indicator of this variable is the sum of exports and imports over total GDP. Nonetheless, there are other expressions of trade openness such as the share of exports over GDP. These indicators easily and effectively reflect the trade openness of a country, but there are other easy possibilities for improving this, which are explored in this paper. Concretely, this paper proposes a new theory-based indicator of trade openness that is more explanatory of trade openness using econometric models from the empirical literature.

According to Sakyi et al. (2015, p.4) and referring to how the degree of trade openness is measured, there is "a vast and expanding literature on this topic to the point that trade openness has been defined in many different ways" (e.g. Sachs and Warner, 1995; Harrison, 1996; Alcala and Ciccone, 2004; Rodrik et al., 2004; Ferrieri, 2006; Estrada and Yap, 2006; Squalli and Wilson, 2011). Yanikkaya (2003) and Fenira (2015) indicate the three main groups of trade openness indicators: first, trade measures as exports plus imports over total GDP; second, measures of trade barriers (Dollar and Kraay, 2002); third, trading orientation indicators such as bilateral payment arrangements; fourth, indices of trade orientation such as openness indices (Leamer, 1988), or indices of variability and distortion (Dollar, 1992). The first group is the focus in this paper. This paper is additionally based on more recent developments in commercial trade for proposing the adaptation of an existing theory-based measure of trade development for explaining the degree of trade openness.

Using full-sample panel data on 36 OECD countries for the 1960-2019 period, the paper compares the explanatory power of previous measures and the new proposal by replicating previous econometric models of System-GMM methodology. The proposal and other new alternatives are used as dependent variables instead of using the classical specification of trade openness, already obtained by the authors we replicate. Additionally, the Granger causality of their target variables on the different dependent variables is analyzed by applying a recent panel data test. Finally, we assess the influence of the proposed indicator on the variable of economic development using Instrumental Variables. The suitability of the proposed indicator is confirmed, in addition to a good performance in explanatory power in both replication and influence on economic development compared with other alternatives for measuring trade.

This paper is divided, after this introduction, into Section 2, a brief literature review with theoretical concepts, Section 3, with a descriptive analysis of the data, Section 4, with an empirical illustration showing the predictable power of the proposal, and finally, Section 5, which discusses the results and concludes.

2. Literature Review

This section reviews the main findings of the literature regarding the determinants of trade openness and its relationship with financial VAT, the relationship between commercial trade and development and openness indicators.

2.1 Trade Openness and Financial VAT

Following Guttmann and Richards (2006) and López-Laborda and Peña (2022), it is worth highlighting the scarce literature on the determinants of trade openness —in spite of seminal works such as Alesina and Wacziarg (1998). They include, for explaining trade openness, variables reflecting physical geography, the ratio of taxes and imports, the trade terms, and public spending. Other advances in the study of geographical and commercial variables include Hau (2002), Guttmann and Richards (2006), Ram (2009), and Marjit et al (2014). Additionally, other papers also include financial depth as a determinant, such as Svaleryda and Vlachos (2002) or Aizenman and Noy (2009), or inflation, such as Lartey (2012) and Kurihara (2013), finding a positive and significant association between both variables and a higher sensitivity of non-tradable goods. Finally, some works deal with the influence of the public sector on trade openness (Garen and Trask, 2005; Benarroch and Pandey, 2012; and Jetter and Parmeter, 2015).

Huizinga (2002) theoretically analyzes the influence of VAT reform on VAT revenue and economic welfare, finding a competitive disadvantage in VAT reform. This can also lead to indirect tax competition among countries. Studying data on banking VAT declarations, Moncelli and Pazienza (2007) observe that the current VAT exemption on financial services in force in most countries generates a 'hidden tax burden' on the financial sector. This probably concerns tax cascading.

Exploring data with input-output analysis, the European Commission (2011) simulates the abolition of the financial services exemption under VAT, observing a decrease in the output prices of financial services—but also finding a reduction in the prices of the output of tradable goods. The simulations also illustrate that this last price decrease experiences a pass-through to export prices, provoking a lower value in the terms of trade, thus raising price competitiveness and encouraging greater trade openness. The recent paper by López-Laborda and Peña (2022, p.9) theoretically finds that 'financial VAT reduces the price of traded goods relative to the price of non-traded goods, allowing an increase in the tradable sector'. In addition, they find that financial VAT, and in particular the 'option-to-tax' method applied by some countries in the European Union, are positively correlated with trade openness.

2.2 Openness and Development

The theory provides a basis for several causation patterns between economic and financial development, as in Gries et al. (2009), where finance leads growth (supply-leading hypothesis: e.g., Pagano, 1993), finance follows growth (demand-following hypothesis: see, e.g., Robinson, 1952), or where the real and financial sector influence each other

mutually (bidirectional causality, e.g., Berthelemy & Varoudakis, 1996). Additionally, finance and growth may present no causality between them (insignificant causation: see the discussion in Chandavarkar, 1992). Nonetheless, some authors provide empirical evidence suggesting that certain economies may indeed benefit from well-developed financial systems (e.g., Rousseau & Wachtel, 1998).

The finance-openness nexus allows for more complex paths to economic development (Gries et al., 2009). On one hand, if rising trade openness provokes an increase in financial development, this may stimulate economic growth, where finance enhances growth through allocative and accumulative channels. On the other, if finance fosters openness, this may subsequently promote growth where openness is a growth factor. Openness may encourage economic growth in several different ways, for instance, by raising the level of specialization of a country or by positively influencing innovation and technological dissemination. The empirical findings of some authors suggest that trade openness may indeed be positively associated with economic performance (e.g., Edwards, 1998; Harrison, 1996). Gries et al. (2009, p.1) finds for Sub-Saharan Africa that 'financial deepening and trade openness have swayed economic development rather marginally'. Jalil and Bibi (2021), however, observes that trade openness may promote economic growth, using a sample of 85 countries from 1960 to 2017, while Kim et al. (2011, p.1), observes that 'greater trade openness has a positive effect on capital accumulation, productivity growth, and financial development in high-income countries, but a negative impact in low-income ones.'

As Sakyi et al. (2015) suggests, according to the literature, there are some possible advantages for economic growth and development derived from trade openness. These benefits, from technological progress to increased domestic and international competition, are made explicit through both exogenous and endogenous standard neoclassical economic growth models (e.g. Grossman and Helpman 1990, 1991; Rivera-Batiz and Romer 1991; Spilimbergo 2000; Perera-Tallo 2003). Sakyi et al. (2015) finds a positive bidirectional influence between trade openness and income level in the long term, thereby suggesting that trade openness is both a cause and a consequence of income.

2.3 Openness Indicators

In accordance with the above authors, existing openness measures and indicators can largely be divided into two main groups: nontrade shares (Non-TS) and trade shares (TS) based indicators (Sakyi et al., 2014). Non-TS-based measures incorporate, among others, the following indicators: the use of the discretionary binary (1, 0) measure or the Sachs-Warner index (e.g., Sachs and Warner 1995; Greenaway et al., 1998; Wacziarg and Welch 2008); the exchange rate premium of the black market (Sachs and Warner 1995; Harrison 1996; Rodríguez and Rodrik 2001; Vamvakidis 2002; Lee et al., 2004); the tariff and non-tariff barriers aggregation (Harrison 1996; Dollar and Kraay 2003); and taxes of international trade (Yanikkaya, 2003; Lee et al., 2004).

On the other hand, TS-based openness indicators reflect either the export percentage over GDP (X/GDP)—here called the Export Trade Openness (XTO) indicator, the import

proportion over GDP (M/GDP)—hereinafter, the Import Trade Openness (MTO) indicator, or the share of total commercial trade in GDP ((X + M)/GDP)—here called the Traditional Trade Openness (TTO) indicator (Harrison, 1996; Irwin and Tervio, 2002; Yanikkaya, 2003; Lee et al., 2004; Kim and Lin, 2009; Kim, 2011), as well as some modifications of them (Li et al., 2004; Alcala and Ciccone, 2004; Ferrieri, 2006; Squalli and Wilson, 2011).

Sakyi et al. (2015) considers the TS-indicators more pertinent. Nonetheless, there is still an intense debate and significant disagreement regarding which one of the TS-proposed indicators more adequately takes trade openness into account. For instance, Harrison (1996) considers that the simplest openness indicators are those focused on the TTO—the percentage of trade flows over GDP. Subsequently, most empirical studies use as a standard summary measure of trade openness the indicator (X + M)/GDP (Yanikkaya 2003; Lee et al. 2004; Rodrik et al., 2004; Kim and Lin 2009; Kim 2011; Gries and Redlin 2012).

There is a controversy regarding whether nominal or real measures are better (Alcala and Ciccone, 2004), where the above authors propose 'real international trade openness (RTS)' as exports plus imports as percentage of purchasing power parity (PPP) adjusted GDP. This is relevant since—according to the Balassa–Samuelson hypothesis—productivity gains are of lower magnitude in the non-tradable service sector than in the tradable manufacturing sector. This fact would provoke a rise in the relative price of services of non-tradables and a reduction in the TTO leading to a bias of lower openness influence on income. Squalli and Wilson (2011) also criticized the use of the TTO indicator since it overestimates (underestimates) the openness rate of small (large) trading economies. By using data for 2000 from the Penn World Table (PWT), they observe that several of the world's largest trading economies, such as the USA, Argentina, Brazil, China, and India, are relatively closed economies when the TTO indicator is applied, making this somewhat questionable, especially for cross-country analysis. Subsequently, Squalli and Wilson (2011) propose a new indicator, the 'Composite Trade Shares (CTS)' indicator, including the two dimensions—trading heavily and substantially contributing to global trade—, which better explains trade openness according to them. Sakyi et al. (2014) compares the three previous indicators—TTO, RTS and CTS—and finds no relevant differences.

3. Immediate Indicator Antecedents and Proposal of the PTO rate

3.1 Antecedents

Recently, Peña (2020) proposes a relationship between exports and imports of multilateral trade, concretely:

$$\begin{aligned} \rho \cdot X &= X - PCT \\ \rho \cdot M &= PCT - M \end{aligned} \quad , \qquad (1)$$

where ρ is the marginal productivity of multilateral trade—as supply side—and 'Pure Commerce Trade' is PCT, trade without transport/value added charges—as trade demand. Peña (2020) relates the two previous indicators with trading development. X and M—X>M assumed in this paper—are, respectively, exports and imports. Otherwise, X would represent the greatest trade flow between X and M, and M the smallest. Nonetheless, this fact does not alter the measure which the proposed indicator is based on. The expressions for ρ and PCT are also given in that paper, being for the marginal productivity of trade:

$$\rho = \frac{X - M}{X + M} = \frac{XN}{CT} \quad . \tag{2}$$

This is the same as the net export over total commerce trade, which is considered as a measure of supply in trading development according to Peña (2020). On the other hand, the demand measure of development is given by the pure trade commerce, which has the following expression (Peña, 2020):

$$PCT = \frac{2 \cdot X \cdot M}{X + M} \quad . \tag{3}$$

The previous expression constitutes what Peña (2020) refers to as the Trading Demand Indicator (TDI). This measure can express the midpoint concerning the maximum trade that importer was willing to trade (purchasing) and the minimum trade that the exporter was willing to trade (selling). In contrast to X+M, X or M, the measure of (3) is a weight average between X and M, based on economic theory.

3.2 Proposal of the PTO Rate

Dealing with this TDI measure, and comparing with other trading indicators, this paper proposes the rate of Pure Trade Openness (PTO) as an indicator for trade openness that aims to improve on some aspects of previous trading indicators. Concretely, the following indicator may be adapted to include real measures such as purchasing power parity (PPP) adjusted for GDP (Alcala and Ciccone, 2004). Nonetheless, for being comparable with the most common trade openness indicators, the PTO rate is defined as the PCT as a percentage of GDP:

$$PTO := \frac{PCT}{GDP} = \frac{2 \cdot X \cdot M}{GDP\left(X + M\right)} \quad . \tag{4}$$

The other advantage of the previous indicator compared to others is the lower overestimation (underestimation) of smaller (larger) trading economies (Squalli and Wilson, 2011), thanks to the weighted product between X and M. This result will be confirmed in the next section by a Zipf law. The closest common competitor from this proposed indicator is the Traditional Trade Openness (TTO) indicator, which can be expressed as follows:

$$TTO = \frac{X + M}{GDP} \quad . \tag{5}$$

Additionally, two other indicators can be used as rates of trade openness, regarding exports and imports respectively:

$$XTO = \frac{X}{GDP} \quad . \tag{6}$$

$$MTO = \frac{M}{GDP} \quad . \tag{7}$$

These are the most common TS-based openness indicators according to Sakyi et al. (2014), which also considers the TTO as the most common among them, as we mention above.

3.3 Properties of the Proposed Indicator

The following properties can be drawn. First, the value of the indicator is lower than the traditional trade openness rate, since it is an average—not a sum—between X and M:

$$\frac{2 \cdot X \cdot M}{GDP(X+M)} < \frac{X+M}{GDP} \Rightarrow PTO < TTO, \tag{8}$$

In fact, it can be considered as a weight average between exports and imports. Even more, the proposed indicator is lower than the arithmetic average between exports and imports over GDP:

$$\frac{2 \cdot X \cdot M}{GDP(X+M)} < \frac{X+M}{2 \cdot GDP} \Leftrightarrow 4 \cdot X \cdot M < (X+M)^2 = X^2 + M^2 + 2 \cdot X \cdot M \,. \tag{9}$$

Simplifying:

$$2 \cdot X \cdot M < X^2 + M^2 \Rightarrow PTO < \frac{TTO}{2} \quad . \tag{10}$$

This is true because of (8) that X, M>1 always. Regarding the export over GDP indicator, from (1) we can easily see that XTO>PTO, but it is not so clear in the case of XTO/2, so:

$$\frac{2 \cdot X \cdot M}{GDP(X+M)} < \frac{X}{2 \cdot GDP} \Leftrightarrow 3 \cdot X \cdot M < X^2 \quad . \tag{11}$$

By considering that M=aX, with 1>a>0, we have that:

$$3 \cdot aX^2 < X^2 \Leftrightarrow a < \frac{1}{3} \Rightarrow PTO < \frac{XTO}{2} \Leftrightarrow a < \frac{1}{3} \quad . \tag{12}$$

It is more probable that the relationship was with the other sign, according to the exposed condition, since it seems to be in most cases higher than 1/3. Regarding the MTO indicator, from (1) it can be seen that MTO<PTO always.

3.4 Further Theoretical Issues

Actually, the constant of the gravity equation of (4) could not be exactly 2; this may be an approximation. Nonetheless, the regression models used in this paper apply a logarithm as dependent variable, so, as the logarithm is the approximation of a growth rate, the dependent variable would be the same independently of the value of that constant (K):

$$\frac{PTO_t - PTO_{t-1}}{PTO_{t-1}} = \frac{\frac{K \cdot X_t \cdot M_t}{X_t + M_t} - \frac{K \cdot X_{t-1} \cdot M_{t-1}}{X_{t-1} + M_{t-1}}}{\frac{K \cdot X_{t-1} \cdot M_{t-1}}{X_{t-1} + M_{t-1}}} = \frac{\frac{X_t \cdot M_t}{X_t + M_t} - \frac{X_{t-1} \cdot M_{t-1}}{X_{t-1} + M_{t-1}}}{\frac{X_{t-1} \cdot M_{t-1}}{X_{t-1} + M_{t-1}}}. \quad (13)$$

Because K is taken as common factor in the numerator and is simplified with that of the denominator.

4. Data and Descriptive Analysis

This paper applies a replication of Lopez-Laborda and Peña (2022, hereinafter: LLP) but considering other dependent variables instead of the TTO that they use. The main novelty will be the first empirical use of the proposed trading indicator. A summary of the new variables is collected in Table 1; the rest of the variables used can be found in LLP.

Table 1. Summary of the new variables (in percentage)

Variable	*Observations*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
PTO	1784	26.86397	16.95063	1.479292	91.03955
XTO	1784	26.13426	17.55389	0.8084502	91.6287
MTO	1784	28.57298	16.89334	2.829398	90.50577

Figures 1-3 show particularities of the TTO and PTO indicators. Figure 1 shows the closeness in the growth rates of the PTO and TTO (TO) indicators, a simple correlation by Ordinary Least Squares (OLS) has been made, obtaining a high explanatory power (99.53%), with a relationship close to 1, showing the similarity in the growth of TO and PTO. Finally, as we see in Figure 1 that the PTO follows the trend of the differences between TO and PTO, and as there was a comparative analysis between TTO/2 and PTO in (10) of the previous section, two figures have been developed to show a comparison between the trend of PTO and TTO/2 (Figure 2) and their differences (Figure 3).

Figure 1. Correlation between the growth rates of TTO (horizontal axis) and PTO (vertical axis).

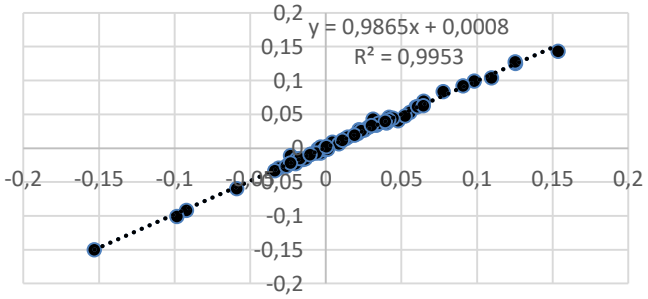


Figure 2. Trend of TTO/2 and PTO

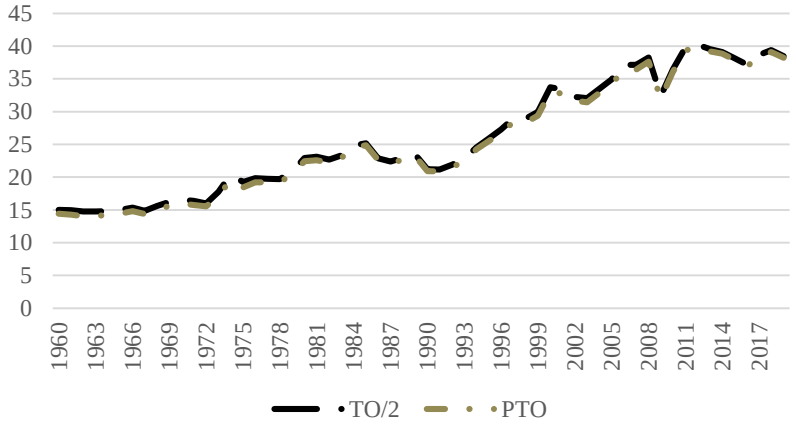


Figure 3. Differences between TTO/2 and PTO

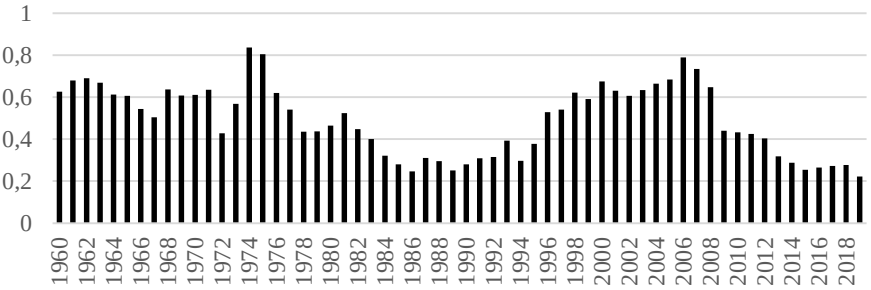
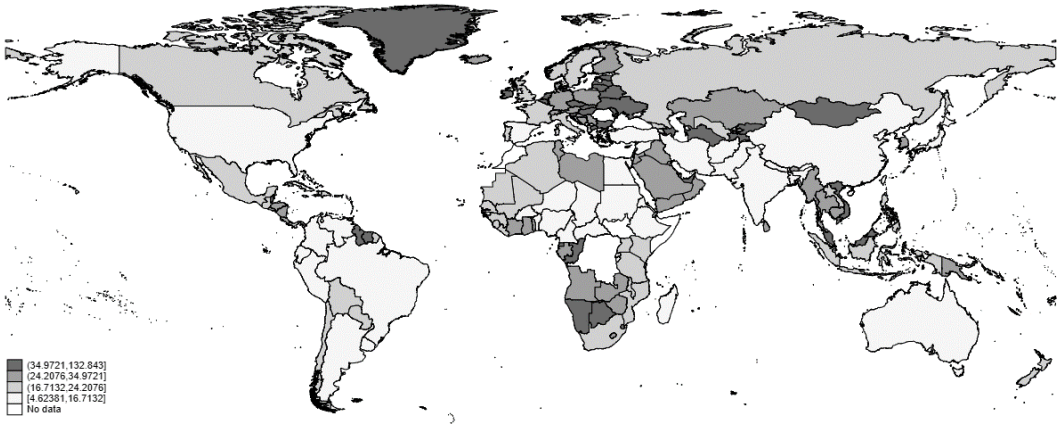


Figure 2 shows that both trends follow very close to each other, rising slowly. Figure 3 highlights the differences between both indicators, with a variation between the valleys around 0.2 for the years 1986, 1989, and 2019, and the peaks of years 1974, 1975, 2006, and 2007, around 0.8. Thus, the highest differences are found during crisis periods (in the mid-1970s with the petrol crisis, or in the Global Financial Crisis).

Map 1 shows the distribution of the values of the proposed PTO around the world. There is a high value of the indicator in ex-URSS countries apart from Russia, some Arab countries, Indochina and South Africa's neighbors.

Map 1. Values of the PTO around the world



The data sample used is in the online Appendix, along with the reason why the PTO has an advantage over the TTO indicator regarding a lower overestimation (underestimation) of smaller (larger) trading economies (Squalli and Wilson, 2011)—true if the distribution of PTO is more equal than TTO. This is seen after applying the standard Zipf equation as follows, considering the correction introduced by Gabaix and Ibragimov (2011):

$$\ln(R-0.5) = \alpha - \beta \ln(S) \quad , \tag{14}$$

where R is the rank of the indicator amount, S is its size, α is a parameter and β is the Pareto exponent, positive by definition. When beta increases (decreases) the distribution becomes more equal (unequal). The TTO presents a higher β, which means a higher equality, than PTO. Additionally, the distribution of TTO is closer to a country's GDP size.

5. Empirical illustration

5.1 Empirical Strategy

The empirical strategy and specification are also the same as in LLP. For the dynamic panel data model in two steps with System GMM, the specification follows Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998):

$$TOM_{it} = TOM_{it-1}\gamma + X_{it}\beta + \alpha + c_t + u_{it} \quad , \tag{15}$$

Where TOM is the trade openness measure (PTO, XTO or MTO), X is the set of explanatory control variables, β is the set of coefficients of their respective control variables, α_i is the constant or intercept, γ is the coefficient of the first lag of the dependent variable and u_{it} is the error. All the control variables are taken from the LLP database, where some of the variables were at the same time taken from the World Bank.

Among the control variables, two alternative specifications are formulated using the variables of interest of LLP. The first specification takes as interest variables *fvat*fr* and *separate*fr* variables. The first one is the interaction of *fvat*, a dummy variable taking the value 1 if VAT is levied on financial services—financial VAT—, and 0 otherwise; with *fr*, the financial services tax rate applied, in percentage. The second variable is the combination of *fr* with *separate*, the latter being a binary variable with value 1 if a separate tax is levied on financial services, and 0 otherwise. As LLP shows, a country with financial VAT in force would present greater trade openness than with the exemption. The reason is that the exemption discourages traded goods compared to non-traded goods such as financial services. Furthermore, the expected influence is higher when the financial VAT rate is closer to the standard VAT rate.

The second specification focuses on obtaining the influence on the trade openness of the financial VAT method most used by the economies in the sample—i.e. the 'option-to-tax' method implemented by the European Union (EU). Article 137(1)(a) of the VAT Directive currently in force allows countries of the European Union (EU) to include an

option to tax financial services. EU Member States generally apply the exemption, but since 1978 some countries—Austria, Belgium, Estonia, France, Germany and Lithuania—have implemented the option-to-tax system. The 'option-to-tax' (O2T) approach allows financial institutions to opt to apply VAT on financial services. Thereby, if an institution chooses not to apply VAT, the exemption is in force. Otherwise, VAT is levied on financial services using the VAT method set by the government where the provider of financial services is based. This means that each financial institution decides the most preferable option depending on its profits. This alternative specification uses *O2T*fr*, *alter*fr* and *separate*fr* as interest variables. The first is the combination of the financial tax rate—*fr*—and *O2T*, a binary variable showing whether an economy implements (value 1) or not (value 0) the O2T method. The *alter* variable is binary, reflecting whether an economy levies (value 1) or not (value 0) VAT on financial services with a method other than the O2T.

The variables are taken from the World Bank database, with the exceptions of the spatial and tax variables, from LLP. The *gdppc* variable is the logarithm of per capita GDP lagged one year, the *psize* variable is the size of the public sector measured as the share of general public expenditure as a percentage of GDP, investment is the gross capital formation, *density* is measured as the population over the total area of the country in km^2, *spatial* is a geographical variable of localization between 0 and 1, with 0 if it is an island and otherwise 1 over the total of countries with a common border, *surplus* is the public surplus when positive or deficit when negative, *stability* is an index of political stability, *secondary* is the percentage of gross secondary school/high school enrolment, *inflation* is the annual growth rate of the Consumer Price Index, TOT reflects the terms of trade adjustment measured as imports minus exports, and *fvat*fr* and *separate*fr* represent, respectively, the tax rate of VAT applied to financial services and the tax rate on consumption of financial services by taxes others than VAT.

5.2 Regression results

Tables 2-5 show the results, where in the static fixed effects models, the model with the proposed indicator PTO has the highest explanatory power, also reflecting the main trade determinants. The term 'Std. e.' refers to Standard errors and 'Coeff.' to the coefficients.

Table 2. Results for the static panel models of Fixed Effects

	R^2	**Model I**	**Model II**	**Model III**	**Model IV**
Method	**Target variable/Dependent variable**	**PTO**	XTO	MTO	TTO
FE	*Full Financial vat rate*	0.393	0.377	0.35	0.379
	Rate of Opt to tax/ Alter	0.393	0.374	0.352	0.378
RE	*Full Financial vat rate*	0.0022	0.0237	0.0137	0.0007
	Rate of Opt to tax/ Alter	0.0053	0.0224	0.0008	0.0007
OLS (pool)	*Full Financial vat rate*	0.559	0.522	0.572	0.561
	Rate of Opt to tax/Alter	0.559	0.522	0.573	0.561
Total Score		**17**	14	15	14
Average R^2		**0.319**	0.307	0.310	0.313

Table 3. Results for the dynamic panel models of GMM System for the logarithm of PTO

Dependent variable: *lnpto*		**Model Ia**			**Model Ib**	
Explanatory variables	Coeff.	Std. e.	p-value	Coeff.	Std. e.	p-value
lnpto t-1	0.588	0.076	0.000	0.581	0.089	0.000
trend	0.010	0.003	0.001	0.010	0.003	0.002
*fvat*fr*	0.018	0.007	0.008			
*O2T*fr*				0.025	0.015	0.089
*alter*fr*				-0.005	0.021	0.823
*separate*fr*	0.009	0.015	0.531	0.004	0.021	0.829
gdppc	-0.092	0.050	0.067	-0.102	0.049	0.038
investment	1.27E-13	7.86E-14	0.108	1.04E-13	1.15E-13	0.363
psize	0.021	0.007	0.002	0.017	0.005	0.002
surplus	0.018	0.007	0.009	0.015	0.005	0.006
stability	0.073	0.043	0.092	0.040	0.043	0.347
secondary	-0.004	0.002	0.060	-0.003	0.002	0.109
local	0.000	0.001	0.659	0.000	0.001	0.787
density	-0.556	0.644	0.388			
inflation	0.010	0.004	0.011	0.013	0.005	0.008
TOT	-2.57E-15	1.55E-15	0.098	-3.14E-15	8.84E-16	0
constant	1.503	0.455	0.001	1.624	0.551	0.003
Sargan (p-value)		0.653			0.581	
Arellano-Bond (p-value 1st, 2nd Order)	0	0.46		0	0.515	
No Observations/Instruments		592/49			587/49	

Table 4. Results for the dynamic panel models of GMM System for the logarithm of XTO

Dependent variable: *lnxto*		**Model IIa**			**Model Iib**	
Explanatory variables	Coeff.	Std. e.	p-value	Coeff.	Std. e.	p-value
lnxto t-1	0.616	0.113	0.000	0.578	0.145	0.000
trend	0.008	0.005	0.113	0.007	0.006	0.279
*fvat*fr*	0.035	0.022	0.117			
*O2T*fr*				0.049	0.031	0.120
*alter*fr*				0.035	0.047	0.448
*separate*fr*	0.001	0.019	0.977	-0.007	0.023	0.775
gdppc	-0.083	0.042	0.052	-0.065	0.063	0.305
investment	1.51E-13	8.56E-14	0.077	1.27E-13	9.61E-14	0.187
psize	0.012	0.006	0.037	0.010	0.007	0.156
surplus	0.011	0.007	0.118	0.010	0.008	0.207
stability	0.061	0.039	0.120	0.046	0.048	0.342
secondary	-0.002	0.002	0.230	-0.002	0.002	0.317
local	0.002	0.002	0.212	0.002	0.002	0.226
density	-0.333	1.092	0.760			
inflation	0.008	0.006	0.172	0.008	0.007	0.264
TOT	-1.25E-15	1.55E-15	0.421	-9.54E-16	2.12E-15	0.652
constant	1.214	0.668	0.069	1.319	0.768	0.086
Sargan (p-value)		0.656			0.588	
Arellano-Bond (p-value 1st, 2nd Order)	0	0.91		0	0.913	
No Observations/Instruments		592/49			587/49	

Table 5. Results for the dynamic panel models of GMM System for the logarithm of MTO

Dependent variable: *lnmto*		**Model IIIa**			**Model IIIb**	
Explanatory variables	Coeff.	Std. e.	p-value	Coeff.	Std. e.	p-value
lnmto t-1	0.581	0.106	0.000	0.511	0.131	0.000
trend	0.010	0.003	0.001	0.009	0.003	0.003
*fvat*fr*	0.013	0.006	0.043			
*O2T*fr*				0.021	0.013	0.112
*alter*fr*				-0.019	0.027	0.472
*separate*fr*	0.017	0.015	0.229	0.018	0.013	0.181
gdppc	-0.083	0.047	0.080	-0.056	0.066	0.399
investment	1.82E-13	1.06E-13	0.086	1.43E-13	1.26E-13	0.257
psize	0.018	0.007	0.015	0.014	0.008	0.088
surplus	0.018	0.007	0.012	0.016	0.008	0.053
stability	0.036	0.043	0.408	0.029	0.046	0.527
secondary	-0.004	0.002	0.025	-0.003	0.001	0.060
local	0.000	0.001	0.661	-0.001	0.001	0.120
density	-0.683	0.696	0.326			
inflation	0.011	0.005	0.041	0.013	0.005	0.017
TOT	-3.00E-15	1.85E-15	0.104	-4.68E-15	1.49E-15	0.002
constant	1.762	0.526	0.001	1.792	0.554	0.001
Sargan (p-value)		0.719			0.69	
Arellano-Bond (p-value 1st, 2nd Order)	0	0.235		0	0.151	
No Observations/Instruments		592/49			593/35	

Table 2 shows the explanatory power of the static panel data models of Fixed Effects (FE), Random Effects (RE) and Ordinary Least Squares (OLS) with the same control and dependent variables as the next models of Tables 3-5. Below the R^2, a 'score' is included reflecting the scores 1-4, for the models with the lowest R^2 taking a 1, 2 for the second lowest, 3 points for the third one and the dependent variable associated with a model with the highest R^2 obtains a 4. There is a ranking for each kind of model, sorting all the dependent variables analyzed. Finally, it shows their average for each model I-IV corresponding to, respectively, Tables 3-5 of the present paper and Table 4 of LLP. It is observed that the PTO models achieve the greatest average R^2 and score, without achieving the lowest R^2 on the ranking in any case, in contrast to the others. Additionally, as models I-III show in Tables 2-5—with '*a*' showing financial VAT and '*b*' *O2T* and *alter* methods—, the PTO variable is the only one that reflects the statistical significance of the coefficients of the *fvat*fr* and *O2T*fr* variables—in addition to other control variables—as it appears in the TTO model shown in Table 4 of LLP.

5.3 Granger-causality test results

Finally, we use an extremely novel technique for testing whether one variable Granger-causes (GC) another in panel data: proposed by Juodis et al. (2021), it is developed in Xiao et al. (2023), and solves the so-called 'Neville bias'. It can only be applied to balanced panels, so we have reduced the sample to the same number of countries but since 1999 in order to achieve a balanced panel. Table 6 shows the description of the main variables of this new balanced sample. The null hypothesis checks whether the variable in the left of Table 7—where the results are shown—does not GC the right-hand variable showing the p-value.

Table 6. Descriptive statistics of the employed variables for the balanced GC panel

Variable	*Observations*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
TTO	756	72.54426	38.34626	15.949	182.085
PTO		35.78367	19.26523	7.80005	91.0396
XTO		35.44886	19.99413	6.32532	91.6287
MTO		37.10062	19.16034	6.79504	90.5058
eca		0.7222222	0.4481997	0	1
*fvat*fr*		3.72365	7.412833	0	21
*separate*fr*		0.1256614	0.3316868	0	1
*O2T*fr*		3.04326	7.117306	0	21
*NO2T*fr*		0.6746032	2.890027	0	15

The results show that the null hypothesis of whether a financial tax rate does not GC another is in most cases rejected, with the exceptions of the separate tax rates on MTO and financial VAT rate and NO2T tax rate on XTO when the sample excludes European and Central Asian countries according to the World Bank classification. This means that separate tax rates do not precede the imports ratio in general and that financial VAT rates, in particular NO2T rates, do not precede shifts in the export ratio. The Granger-causality for the opposite direction cannot be obtained due to the properties of the tax rates. As summary, these results show that the target variables of López-Laborda and Peña (2022) are not only associated with trade openness, but also usually *lead* to trade openness.

Table 7. Results of the GC with the balanced panel data

H0: Left variable does not GC the one on the right		*Region*	*p-value*	*H0: Left variable does not GC the one on the right*		*Region*	*p-value*
*fvat*fr*	TTO	TOTAL	0	O2T*fr	TTO	ECA	0
*fvat*fr*	TTO	ECA	0	O2T*fr	PTO	ECA	0
*fvat*fr*	TTO	NO ECA	0	O2T*fr	XTO	ECA	0
*fvat*fr*	PTO	TOTAL	0	O2T*fr	MTO	ECA	0
*fvat*fr*	PTO	ECA	0	NO2T*fr	TTO	NO ECA	0
*fvat*fr*	PTO	NO ECA	0	NO2T*fr	PTO	NO ECA	0
*fvat*fr*	XTO	TOTAL	0	NO2T*fr	XTO	NO ECA	0.952
*fvat*fr*	XTO	ECA	0	NO2T*fr	MTO	NO ECA	0.002
*fvat*fr*	XTO	NO ECA	0.952	separate*fr	TTO	TOTAL	0
*fvat*fr*	MTO	TOTAL	0	separate*fr	PTO	TOTAL	0
*fvat*fr*	MTO	ECA	0	separate*fr	XTO	TOTAL	0
*fvat*fr*	MTO	NO ECA	0.002	separate*fr	MTO	TOTAL	0.817

6. Relationship with Economic Development and Policy Implications

Peña (2020) states that the PCT indicator—basis of the PTO since it is the PCT divided by the GDP—can be considered a measure of trading development. In this section we are going to see whether this is true and the degree of explanation of the indicator as a measure of economic development compared with the other indicators. Table 8 shows the descriptive statistics of the chosen variable, *rdexp*, as indicator of economic development for the two samples. The first one is the full sample for the regressions and the second one is used for the GC tests.

Table 8. Descriptive statistics for the new variable for the two samples

Variable	*Sample*	*Observations*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
rdexp	Initial, Full, not balanced, sample for regressions	807	1.707	0.990	0.251	5.140
	New, Reduced, balanced, sample for GC	670	1.706	1.004	0.251	5.140

The *rdexp* variable is taken from the World Bank Indicators and measures research and development expenditure as a percentage of GDP. Before starting with the regressions, Table 9 shows the direction of the causality between the indicators of trade openness and the development indicator, showing a double direction of causality in all cases with the exceptions of when the development indicator does not GC trade openness, where the null hypothesis is non-rejected for countries outside the European and Central Asia (ECA) region—according to the classification of the World Bank—, and for the case where *MTO* does not GC *rdexp* for all countries of the sample, where the null hypothesis is also non-rejected. After studying the Granger-causality of the variables, Table 10 shows the correlations of the different expressions of trade openness with the development measure, for Fixed Effects (FE), Random Effects (RE) and Ordinary Least Squares (OLS) methodologies, for all the countries and the ECA and non-ECA countries. The results show a statistically significant and robust positive impact of trade openness on economic development. Nonetheless, possible endogeneity may appear, and a Durbin-Wu-Hausman test is performed, showing for all the trade indicators the need to apply Instrumental Variables (IV) models—collected in Table 11 and using the independent variables of models I-III of Tables 3-5 as instruments.

Table 9. New results of the GC between the rdexp *variable and trade openness*

H0: Left variable does not GC the one on the right		*Region*	*p-value*	*H0: Left variable does not GC the one on the right*		*Region*	*p-value*
rdexp	*PTO*	ALL	0	*PTO*	*rdexp*	ALL	0.025
rdexp	*PTO*	NO ECA	0.562	*PTO*	*rdexp*	NO ECA	0
rdexp	*PTO*	ECA	0	*PTO*	*rdexp*	ECA	0
rdexp	*TTO*	ALL	0	*TTO*	*rdexp*	ALL	0.041
rdexp	*TTO*	NO ECA	0.607	*TTO*	*rdexp*	NO ECA	0
rdexp	*TTO*	ECA	0	*TTO*	*rdexp*	ECA	0.001
rdexp	*XTO*	ALL	0	*XTO*	*rdexp*	ALL	0.011
rdexp	*XTO*	NO ECA	0.644	*XTO*	*rdexp*	NO ECA	0.001
rdexp	*XTO*	ECA	0	*XTO*	*rdexp*	ECA	0
rdexp	*MTO*	ALL	0	*MTO*	*rdexp*	ALL	0.23
rdexp	*MTO*	NO ECA	0.346	*MTO*	*rdexp*	NO ECA	0.001
rdexp	*MTO*	ECA	0	*MTO*	*rdexp*	ECA	0.016

The results of Table 11 show an elastic effect of the trading indicators on the development variable—coefficient of the indicators statistically significant, robust, positive and higher than 1—for all the cases. In addition, taking into account that there is no R^2 for the IV FE of model (7), the highest R^2 of a model passing the Hausman test with RE as null hypothesis—all of them are FE models—corresponds to that of the PTO variable, model (1), with the highest explanatory power.

Table 10. Results of the correlation of trade openness and the rdexp *variable*

Methodology	*FE*			*RE*			*OLS (pool)*		
Sample	ALL	NO ECA	ECA	ALL	NO ECA	ECA	ALL	NO ECA	ECA
Model	1	2	3	4	5	6	7	8	9
PTO	0.015***	0.025*	0.014***	0.015***	0.024**	0.013***	0.033***	0.056***	0.029***
	0.004	0.011	0.003	0.004	0.011	0.003	0.001	0.005	0.001
constant	1.151***	1.693***	0.956***	1.185***	1.741***	0.977***			
	0.14	0.311	0.138	0.229	0.648	0.198			
N	588	147	441	588	147	441	588	147	441
R^2*adjusted*	0.1352	0.1413	0.1493	0.0869	0.1592	0.0141	0.5063	0.4693	0.612
Model	10	11	12	13	14	15	16	17	18
TTO	0.008***	0.013*	0.007***	0.007***	0.012**	0.006***	0.016***	0.028***	0.014***
	0.002	0.005	0.002	0.002	0.005	0.002	0.001	0.002	0
constant	1.150***	1.689***	0.959***	1.186***	1.737***	0.982***			
	0.146	0.313	0.144	0.232	0.647	0.202			
N	588	147	441	588	147	441	588	147	441
R^2*adjusted*	0.1302	0.1422	0.1409	0.0935	0.1589	0.0177	0.5062	0.4727	0.6114
Model	19	20	21	22	23	24	25	26	27
XTO	0.015***	0.024**	0.013***	0.014***	0.022**	0.013***	0.033***	0.054***	0.029***
	0.003	0.009	0.003	0.003	0.009	0.003	0.001	0.005	0.001
constant	1.179***	1.744***	0.980***	1.202***	1.781***	0.993***			
	0.124	0.269	0.125	0.218	0.605	0.189			
N	588	147	441	588	147	441	588	147	441
R^2*adjusted*	0.1582	0.1509	0.1764	0.0532	0.1509	0.0007	0.5132	0.4534	0.6267
Model	28	29	30	31	32	33	34	35	36
MTO	0.014***	0.026*	0.012**	0.013***	0.024*	0.011***	0.032***	0.058***	0.028***
	0.005	0.013	0.004	0.004	0.013	0.004	0.001	0.005	0.001
constant	1.195***	1.679***	1.017***	1.247***	1.738**	1.051***			
	0.18	0.372	0.187	0.253	0.705	0.231			
N	588	147	441	588	147	441	588	147	441
R^2*adjusted*	0.0891	0.115	0.0911	0.1391	0.1667	0.0566	0.4913	0.4904	0.5862

Table 11. Results of the correlation of trade openness and the rdexp variable with IV

Model	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Method	**IV FE**	**IV RE**	**IV FE**	**IV RE**	**IV FE**	**IV RE**	**IV FE**	**IV RE**
VARIABLES	**PTO**	**PTO**	**TTO**	**TTO**	**XTO**	**XTO**	**MTO**	**MTO**
lnpto	1.233***	1.581***						
	(0.358)	(0.411)						
lntto			1.294***	1.682***				
			(0.382)	(0.441)				
lnxto					1.106***	1.356***		
					(0.319)	(0.377)		
lnmto							1.341***	1.869***
							(0.418)	(0.448)
Constant	-2.606**	-3.824***	-3.741**	-5.371***	-2.129*	-3.000**	-3.047**	-4.915***
	(1.257)	(1.366)	(1.613)	(1.774)	(1.111)	(1.238)	(1.486)	(1.518)
Observations	557	557	557	557	557	557	557	557
Number of countries	35	35	35	35	35	35	35	35
R^2	0.0476	0.0364	0.0017	0.0408	0.0316	0.0157	NA	0.0740
Hausman test	0.0003		0.0002		0.0029		0	

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The policy implications of this paper are as follows. First, a new indicator with higher explanatory power can be used for policy analysis and policymaking, in addition to proposing a new database based on the previous measure that can be useful for comparing countries internationally and for future research in commercial trade and international economics. Additionally, it is shown that indirect taxes on financial services lead to trade openness, rather than merely being associated with it as previously found. Finally, we find that the proposed measure for the degree of trade openness is a good explanatory variable of economic development.

7. Concluding remarks

This paper proposes an indicator of trade openness, the Pure Trade Openness (PTO) measure, which is useful for explaining commercial trade, achieving the highest explanatory power among its immediate competitors. Furthermore, it can improve on the main disadvantages of most of the current measures in a unique indicator. Finally, it is also the measure with the highest explanatory power for expenditure in Research and Development (R&D).

The empirical estimates apply the data and models of López-Laborda and Peña (2022: LLP) to check whether the proposed indicator is reliable for explaining trade, confirming it with 36 OECD countries for the 1960-2019 period and using the System-Generalized Method of Moments system (GMM). Moreover, estimating the correspondent static models for obtaining the explanatory power, we obtain that the PTO is never the indicator with the lowest R^2, and indeed, it benefits from the highest average of the coefficient among the most-common alternative measures. After the previous exercises, two complementary reduced samples are employed, which are balanced to allow the use of a recently-found Granger-causality test for panel data, checking whether the target variables of LLP Granger-cause (GC) the trade openness measures, and confirming this, in addition to the double direction of the Granger-causality of openness and R&D expenditure. Instrumental Variables models for panel data also show the influence of the PTO on that expenditure.

The results of this paper show a robust estimation of the trading determinants, with significance and sign similar to other specifications of trade openness, but with the highest explanatory power, as Table 2 shows. This article additionally presents the behavior of several countries regarding different indicators of trade openness. Together with the new indicator, a new database with data for the new indicator is attached in the online Appendix. This paper can be useful for academics, policymakers, and international and development economists.

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