

The impact of trade costs upon gross domestic product: the customs efficiency index as a mediator

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Abstract

Trade costs are important determinants of international trade and economic development. In these relationships customs efficiency plays a critical role. Studies commonly highlight the role of customs efficiency as a significant driver behind the reduction of trade costs. Our study differs from those previously in the sense that our main aim was to explore how and to what extent customs efficiency mediates trade costs and gross domestic product. By utilising hierarchical regression as well as the Baron and Kenny mediation methods, we analysed the dataset of 80 countries for the years 2007, 2010, 2012, 2014 and 2016. The result of the mediation analysis and the Sobel test shows that the customs efficiency index fully mediates trade costs and gross domestic product (GDP). In reducing trade costs to reach a higher level of GDP, the role of customs efficiency is significant.

Keywords: customs efficiency index, GDP, mediation analysis and trade costs

1. Introduction

We aimed to examine the role of the customs efficiency index (CEI) to see how and to what extent it mediates trade costs (TC) and gross domestic product (GDP).

TC have important effects on a country's trade and economic development, and many factors contribute to the costs of trade. Transportation, border-related trade barriers and wholesale and retail distribution account for a large share. In the developed world, they may be as high as 170 per cent of the value of the goods. Considering tariffs that are now down to as low as five per cent of the goods' value, TC remain a major point of concern inhibiting higher levels of economic development (Anderson & van Wincoop, 2004).

Among the many factors playing a role in TC, the level of efficiency of customs processes is critical. Much of the information and documents demanded by different national customs varies widely. These variations increase costs and delays which in turn negatively impact trade and competitiveness. For example, in Vietnam the time to export goods, including document preparation, customs clearance, port and terminal handling as well as inland transport and handling is 24 days at a cost of USD669 per 20-foot container, while in Rwanda, these delays are doubled and the costs are quadrupled (Korinek & Sourdin, 2011, p. 8). In contrast, simplification and facilitation in customs processes increase efficiency and provide a more favourable environment for trade and economic development (Saslavsky & Sheperd, 2014).

Previous studies regard customs efficiency and trade facilitation as one of the main drivers in the reduction of TC (Marti & Puertas, 2017; Staboulis et. al., 2020; Moise et. al., 2011; Memedovic et.al., 2008; Arvis et. al., 2016a). This study, however, explores the role of CEI as a mediator variable and aims to investigate its relationship to TC and GDP. This is because CEI may also have a reverse relationship with TC – analysing this relationship with GDP has been ignored but is considered to be necessary. We contend that exploring the mediator role of the CEI in the relationship between TC and GDP would further contribute to the field. To do this, we developed hypotheses and tested them using secondary data. To analyse and validate the results we used hierarchical regression and mediation analyses.

In the first part of this study, we explain the definitions and background of the concepts in our model. In the second part we develop hypotheses. In the third, we outline the research method, sampling and measurements. In the fourth part, we test the hypotheses and analyse the results. Finally, we draw some conclusions based on our analyses.

2. Background

From an economic perspective, the price of goods is determined at the time and the place of the final delivery to the end user. The goods are valued more where and when they are needed most. To fulfil this objective, the occurrence of TC is inevitable. Apart from the production costs of the goods, TC are made up of various elements, including transportation, policy barriers, information costs, contract enforcements costs, the cost of dealing with different languages, currencies, local legal and regulatory costs and local distribution costs. TC may be as high as 170 per cent of production costs in a typical developed country, the major components being 21 per cent transport costs, 44 per cent border-related trade barriers and 55 per cent local distribution (Staboulis et. al., 2020). Economic policies have considerable effects on the TC especially around physical transport, trade infrastructure and regulation. Their impacts on national welfare are calculated to be around 10 per cent (Anderson & van Wincoop, 2004).

TC vary by income groups and the nature of the trade (Table 1). The costs are higher in trade in agricultural goods than in manufacturing because of higher protectionism in the former. Secondly, TC increase in lower-income countries due to the higher trade barriers (Arvis et al., 2016a), though remain a major concern even for developed countries (Goodwin, 2017).

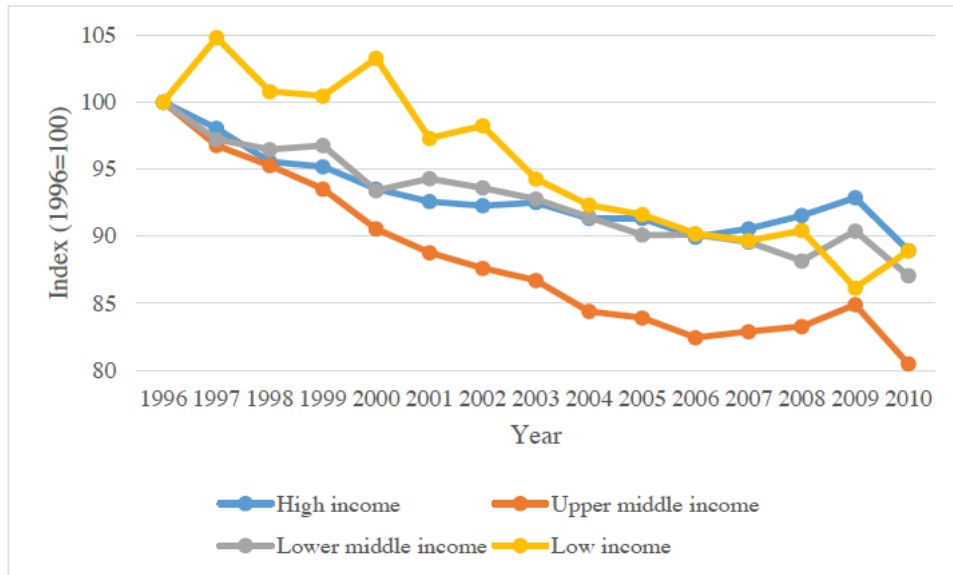
Table 1: TC as a percentage of goods' value by sector and income group

Income group	Manufacturing %	Agriculture %
High income	82.39	141.11
Upper middle income	98.09	166.57
Lower middle income	125.08	187.67
Low income	227.08	310.63

Source: Arvis et.al. (2016a), p. 19

As far as trade in manufacturing goods is concerned, TC have been reducing over the years for all income groups (Figure 1). The rate of decline is higher in richer countries due to the higher rate of liberalisation and facilitation (Arvis et al., 2016a).

Figure 1: World TC (manufactured goods)



Source: Arvis et.al. (2016a), p. 23

The Organisation for Economic Co-operation and Development (OECD) developed Trade Facilitation Indicators (TFI) to assist policy makers to improve border procedures, reduce trade costs and increase world trade. They are based on specific measures designed to bring simplification, standardisation and automation to customs and border processes providing opportunities for significant savings. The decrease of TC is estimated to be 13.2 per cent in the upper income group, 14.4 per cent for low-income countries and 15.5 per cent for middle-income countries (Moise & Sorescu, 2013). In another study, the overall savings are estimated to be almost 10 per cent of overall TC (Moise et.al., 2011) with speed and timeliness being key factors. In this regard, efficient processes in Customs prevent delays and secure delivery times in the global supply chain. A one-day reduction in the time spent in Customs corresponds to a 0.6 per cent decrease in customs tariffs. Assuming that all trade facilitation measures are implemented, a 0.9 per cent decrease in import costs and a 1.2 per cent decrease in export costs may be achieved. In terms of global welfare, as much as USD210 billion may be saved by preventing delays in customs processes. Table 2 gives an estimation of the global welfare gains, noting that China alone accounts for almost one-quarter of the total global gains. (Hilberly & Zhang, 2015).

Table 2: Potential benefits of trade facilitation

Import gains			
Country	Reduction in days	Welfare gain (billions of USD)	Share of global total
China	2.12	24.60	0.24
Mexico	2.70	7.16	0.07
Russia	3.35	7.01	0.07
Italy	1.93	5.56	0.06
Indonesia	3.63	4.63	0.05
Export gains			
Country	Reduction in days	Welfare gains (billions of USD)	Share of global total
China	2.48	32.76	0.30
Mexico	1.54	3.60	0.03
Russia	3.98	14.03	0.13
Saudi Arabia	1.96	4.56	0.04
Indonesia	3.21	4.01	0.04

Source: Hilberry and Zhang (2015), p. 36

One of the indicators of trade facilitation is cited as the CEI (Saslavsky & Sheperd, 2013). It is defined as speed, simplicity and predictability of formalities shown in the clearance process (The World Bank, 2014). With more efficient clearance processes at the border, reduced delays and costs may be achieved. In contrast, unpredictable delays at the border cause significant harm, exceeding the negative effects of traditional tariff measures (OECD, World Trade Organization [WTO] and The World Bank, 2014). Traders rate the speed, simplicity and predictability of the customs clearance process as critical success factors in their international competitiveness. Countries on the other hand see customs efficiency as an important driver in boosting trade, investment and national welfare. This also makes the role of customs authorities more like a trade facilitator than a mere protector of public interest (The World Bank, 2016).

World production and trade increasingly takes place within global value chains (GVCs). In these chains trade is based on the intermediate goods flow for import, process and finally export. This makes multiple border crossings a necessity and passing across borders each and every time requires a high degree of customs efficiency (Memedovic et. al., 2008; Baldwin & Lopez-Gonzalez, 2015; Baskol, 2016; Kowalski et. al., 2015). The CEI is one of the six dimensions of trade in the logistics performance index (LPI), published bi-annually by the World Bank. The LPI provides qualitative evaluations of a country by its trading partners – logistics professionals working outside the country. The CEI indicates the efficiency of customs and border clearance. It rates the countries from very low

(1) to very high (5). It is one of the main inputs required for a country to reach a higher level of supply chain and logistics performance (OECD/International Transport Forum [ITF], 2016).

Nations ultimately strive to reach a higher GDP per capita level for their economic development and exploring the effect of TC and the CEI on GDP per capita is therefore necessary. GDP per capita is one of the indicators of economic health and wellbeing of countries. It refers to the value in the products and services produced in a country per capita: GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products (The World Bank, 2022a). Against this background we now develop the hypotheses.

3. Hypotheses development

The hypotheses were developed to reflect the dual relationship of the variables as follows.

3.1 The effect of TC on the CEI

While inefficiency of customs is a driver of higher levels of TC, the reverse may also be at play: various direct and indirect costs of trade, such as trade and transport infrastructure, may well be negatively impacting the efficiency of Customs (Korinek & Sourdin, 2009). For example, the lack of efficient and effective transport and port infrastructure has a negative impact on the functioning of border administrations (Keçeli, 2011) and poor infrastructure often explains the lengthy waiting times and congestion and accounts for 40 to 60 per cent of a country's transport cost (Limao & Venebles, 2001). An insufficient level of information communication technology (ICT) infrastructure is cited as another area in increasing the cost of trade and transport, resulting in customs inefficiency. Customs automation, prearrival clearance, risk analysis, electronic submission of custom documents, information management and terminal operations and electronic single windows all heavily depend on well-functioning ICT systems (Korinek & Sourdin, 2011, Ojala & Çelebi, 2015).

Against this background the following hypothesis was developed:

H_1 : TC have a negative effect on the CEI.

3.2 The effect of the CEI on GDP

TFI measure simplification, standardisation and digitalisation of customs processes required to reach higher levels of efficiency in Customs (OECD, WTO and The World Bank, 2014). Higher levels of efficiency in Customs and border management processes have a strong positive impact on competitiveness and economic development (Korinek & Sourdin, 2011). The CEI – being an important driver of logistics performance – is closely related to economic growth (Memedovic et. al., 2008). In contrast, cumbersome customs processes cause delays and act as significant barriers to trade and economic development (Hummels & Schaur, 2013). Sanchez et. al. (2014) find that the rise in logistics performance positively impacts a nation's level of economic development, and timely delivery of goods and a high quality of logistics services necessitate efficiency in customs. Çelebi et. al. (2015) and Çelebi (2018, 2021) find that logistics performance has a significant impact on GDP.

In light of the existing literature the following hypothesis was developed:

H_2 : The CEI has a positive effect on GDP.

3.3 The effect of TC on GDP

Easier, faster and cheaper access to products and services from around the world through a reduction in TC stimulates a nation's level of economic development (ITF, 2015). In this relationship, the high quality of trade and transport infrastructure and administrative procedures are particularly critical (Duranton et. al., 2014; Korinek & Sourdin, 2011). Poor trade and transport infrastructure and cumbersome regulations, in contrast, increase the cost of trade, inhibiting economic development (Togan, 2016). In light of the existing literature the following hypothesis was developed:

H₃: TC have a negative effect on GDP.

3.4 CEI mediates TC and GDP

Countries ultimately aim to reach higher levels of GDP per capita for their citizens. One way to achieve this depends significantly on how competitive their trade is in manufacturing products globally. To be competitive on a global scale requires countries in turn to simultaneously achieve lower levels of TC and higher CEI (Hoekman, 2014). In this interplay, the quality of trade and transport infrastructure and policies is especially important as it helps improve both indicators to reach higher level of GDP per capita (Arvis et.al., 2016a; Togan, 2016).

In light of the existing literature the following hypothesis was developed:

H₄: The CEI mediates TC and GDP.

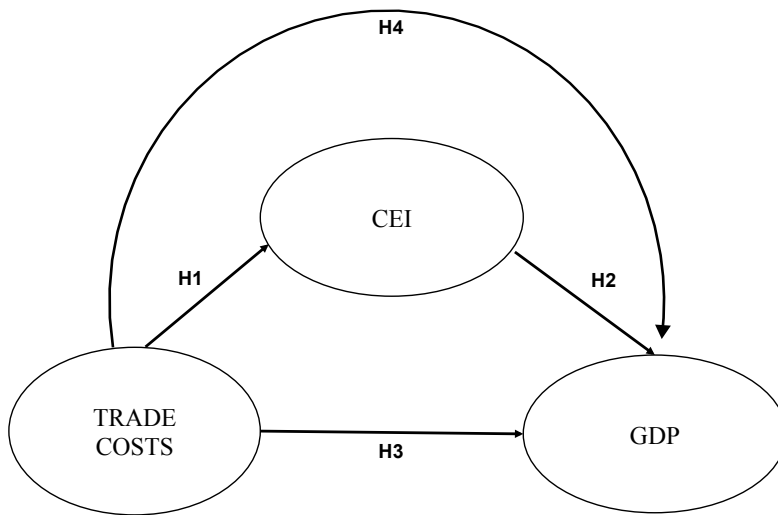
4. Research methods

We conducted a mediator analysis using the Baron and Kenny (1986) method. This method of analysis explores to what extent the effect of the independent variable on the dependent variable occurs through the effect of another variable –a mediator variable. This variable – according to Baron and Kenny – plays a mediator role in the interplay between independent and dependent variables when the following conditions are met:

- a change in the independent variable causes the mediator variable to change
- a change in the mediator variable causes the dependent variable to change
- when the mediator and the independent variables are included in the analysis together, the influence of the independent variable on the dependent variable decreases or completely disappears.

Figure 2 shows a conceptual model of the research. To test the hypotheses, we used hierarchical multiple regression.

Figure 2: Conceptual model



Source: Authors

CEI, TC and GDP are the variables of the research model and the three regression equations are designed to test the interrelationships. Model 1 is based on the third hypothesis (H3) testing the effect of TC (the independent variable) on GDP (the dependent variable). Model 2 is based on the first hypothesis testing the effect of TC (the independent variable) on CEI (the mediator variable). Model 3 is based on the second and fourth hypotheses testing the effects of both TC (the independent variable and CEI (the mediator variable) on GDP (the dependent variable). In the following equations β_0 denotes the intercept of the regression line, β_1 denotes the slope of the regression line and ε denotes the error term.

Model 1: $GDP = \beta_0 + \beta_1 \cdot TC + \varepsilon$ (H₃)

Model 2: $CEI = \beta_0 + \beta_1 \cdot TC + \varepsilon$ (H₁)

Model 3: $GDP = \beta_0 + \beta_1 \cdot TC + \beta_2 \cdot CEI + \varepsilon$ (H₂ and H₄)

5. Measurements and sampling

We used the datasets of TC, CEI and GDP per capita. We took the CEI and GDP per capita dataset from the World Bank world development indicators (World Bank, 2022b) and TC data from the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP, 2021). Since secondary data were used there was no need to determine the validity and reliability of the scales. Therefore, confirmatory factor analysis was not conducted. This was not an analysis of comparison or of changes in time. Instead, the main motivation was to explore the linear relationships in the selected period. The period used was thus deemed sufficient for the purpose and the scope of the study.

We analysed data for the years 2007, 2010, 2012, 2014 and 2016 for a total of 80 countries. We used 2007 as the first year, because it was the year when the CEI was first published. After 2007, the World Bank continued to publish it bi-annually, in 2010, 2012, 2014 and 2016. We limited our analysis of TC to trade in manufacturing goods and excluded TC to trade in agricultural goods. For bilateral TC, we used Turkey as a reporting country and the other countries as partners. To fill the data row for Turkey as a partner country, we used Germany's bilateral costs with Turkey.

TC are bilateral trading costs among country pairs. There are several measurements attempting to measure trade costs: some are only concerned with cost components directly related to TC, such as the cost of moving standard containers internationally or the costs of delivering goods to the next seaport from a factory including the cost of processing paperwork, customs clearance, transport and handling. The dataset published by UN-ESCAP on the other hand offers a comprehensive measure for TC. It consists of all costs related to trading goods with international partners. This bilateral measurement nature of TC includes all costs involved in trading goods internationally with another partner (that is, bilaterally) relative to those involved in trading goods domestically (that is, intranationally). It captures TC in a broader sense, including not only international transport costs and tariffs but also other trade cost components associated with differences in languages and currencies, as well as cumbersome import or export procedures (Anderson & van Wincoop, 2004).

The CEI is based on survey participants consisting of logistics experts around the world that are requested to evaluate the eight countries with the highest business flow with their home country (Arvis et al., 2016b).

GDP per capita is an indicator of national economic output published by the World Bank, which describes it as “gross domestic product divided by midyear population. GDP at purchaser’s prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2010 US dollars” (World Bank, 2022a, ‘Long definition’ section).

We used this dataset to test our hypotheses and the SPSS program to apply hierarchical regression. The Baron and Kenny (1986) mediation methods and Sobel (1982) tests were used for analysis and validation of the results. The results of the analysis are described below.

6. Analysis of results

Baron and Kenny’s (1986) method requires a relationship among the variables shown in the models as a first step (Civelek, 2018). We calculated the correlation coefficients accordingly. Table 3 shows that the relationships among the variables were statistically significant:

Table 3: Correlation coefficients

	CEI	TC	GDP
CEI	1		
TC	-0.391*	1	
GDP	0.784*	0.331*	1

*Correlation is significant at the 0.01 level

We developed three models to test the mediator effect. Table 4 shows the R and R² values of these models, while Table 5 outlines the results of the analysis of variance (ANOVA).

Table 4: Model summaries

Models	R	R ²	Adjusted R ²	Standard error of the estimate
Model 1	0.331	0.110	0.108	19644.0463
Model 2	0.391	0.153	0.151	0.55744
Model 3	0.784	0.615	0.613	12933.2906

Table 5: ANOVA tables

Models		Sum of squares	Degrees of freedom	Mean square	F	Significance level (p)
1	Regression	1.893E+10	1	1.893E+10	49.068	0.000
	Residual	1.536E+11	398	385888554		
	Total	1.725E+11	399			
2	Regression	22.348	1	22.348	71.919	0.000
	Residual	123.675	398	,311		
	Total	146.023	399			
3	Regression	1.061E+11	2	5.306E+10	317.188	0.000
	Residual	6.641E+10	397	167270006		
	Total	1.725E+11	399			

We found that the ANOVA results of the models are statistically significant, as shown in Table 6.

Table 6: ANOVA results of the models

Relationship	Model 1	Model 2	Model 3
TC → GDP	-0.331*		-0.029
TC → CEI		-0.391*	
CEI → GDP			0.772*

Note: Regression coefficients are standardised. *p<0.01.

→ (arrows) indicates the direction of relations and effect.

We conducted the Sobel test (Sobel, 1982) to validate the results reached by the Baron and Kenny (1986) method. We note that the Sobel test is significant, as shown in Table 7.

Table 7: Sobel test results

	Sobel Test statistic	Significance level (p)
TC → CEI → GDP	-22.82933165	0.00*

*p<0.01

→ (arrows) indicates the direction of relations and effect.

7. Conclusion

Table 6 shows that the test results are statistically significant and supported all the hypotheses, as follows:

- H₁: TC have a significant negative effect on the CEI ($\beta_{\text{model2}} = -0.391, p < 0.01$)
- H₂: The CEI has a positive effect on GDP ($\beta_{\text{model3}} = 0.772, p < 0.01$)
- H₃: TC have a negative effect on the GDP ($\beta_{\text{model1}} = -0.331, p < 0.01$)
- H₄: The CEI has a mediator role in the relationship between TC and GDP ($\beta_{\text{model3}} = -0.029, p < 0.39$).

When we included the CEI as a mediator variable in the model we found that the effect of TC on GDP dropped, with the value of the β coefficient decreasing greatly and becoming statistically insignificant. We thus concluded that the CEI fully mediates the relationship between TC and GDP.

The motivation behind this research was to explore the mediating effect of the CEI in the relationships between TC and GDP. TC affect both the CEI and GDP. When TC decrease, GDP and the CEI increase. The results of this research support these relationships. The results also show that the CEI plays a role in this relationship and this role is of a full mediator nature. By including customs efficiency in the relationship, the previous effect of TC on GDP falls and becomes insignificant.

These results lead to the following policy implications: efforts to reduce TC are crucial in gaining a higher level of GDP per capita. At the same time, policies to improve the CEI are also important and should concurrently be implemented. Further research using different income groups of countries and time periods would extend the contribution to the field.

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