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Effects of the Tax Transition Reform on the Real Exchange Rate through the Trade Openness Channel in Developing Countries

Sèna Kimm Gnangnon+
World Trade Organization, Switzerland

Abstract International financial institutions have advised developing countries to implement a reform of their tax revenue structure to reduce their dependence on international trade tax revenue, for the benefit of domestic tax revenue. This study examines the effect of this type of tax reform on the real exchange rate through the trade openness channel. It defines tax reform (also known as "tax transition reform") as a process that involves the convergence of developing countries' tax structures toward the tax structure of developed countries (given the weak dependence of the latter's tax structure on international trade tax revenue). The analysis is conducted using an unbalanced panel dataset of 107 countries from 1980-2019, and the two-step system-generalized method of moments approach. The findings show that tax reform causes real exchange rate depreciation, with the magnitude of this effect being higher in developed countries than in developing countries. Furthermore, the real exchange rate depreciation effect of the tax reform is higher in countries with greater trade openness and a tax structure that is less dependent on international trade tax revenue.

Keywords: tax transition reform, real exchange rate, trade openness, developing countries

JEL Classifications: H20, O11, F14

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I. Introduction

Public and particularly tax revenues in developing countries may be vulnerable to higher trade openness (or trade policy liberalization), particularly given the significant challenges these countries face in mobilizing domestic tax revenue (e.g., Cagé and Gadenne, 2018; Khattry, 2003; Khattry and Rao, 2002) in the context of unavoidable higher trade openness. The International Monetary Fund (IMF) and World Bank have recommended that these countries implement tax reform, to reduce their tax revenue's dependence on international trade tax revenue and ensure a sustainable stream of public revenue. This recommendation from the IMF and World Bank is key for reducing

+Corresponding Author: Sèna Kimm Gnangnon
Economist, World Trade Organization, Rue de Lausanne 154, CH-1211 Geneva 21, Switzerland.
E-mail: kgnangnon@yahoo.fr
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developing countries' dependence on development aid, which will help these developing countries realize their development objectives. The reform proposal of the IMF and World Bank includes a proportional tariff reduction combined with a point-by-point consumption tax increase, meaning that a one-unit tariff reduction is associated with the same unit rise in consumption. Different expressions have been used in the literature to refer to this type of tax reform, which include "proportional tariff-tax reform," "point-for-point reforms," and "revenue-neutral tariff-tax reform" or "tax transition reform." Some empirical studies (e.g., Baunsgaard and Keen, 2010; Waglé, 2011; and Crivelli, 2016; Moller, 2016) have demonstrated that the foregone trade tax revenue further to trade liberalization in developing countries has successfully been replaced with public revenue from other sources, including domestic tax revenue in developing countries. However, many theoretical studies[1] have been conducted on the implications of point-for-point reforms for public revenue, welfare, economic growth, and market access.

Recently, some empirical studies have examined the effect of tax reform on fiscal space (Gnangnon and Brun, 2019a), tax revenue (Gnangnon and Brun, 2019b), tax revenue instability (Gnangnon and Brun, 2019c), and trade openness (Gnangnon, 2019). In addition, Gnangnon (2020) examined the effect of development aid on tax reform when countries further open-up to international trade. These studies have used a definition of tax reform that is similar to the type of tax reform recommended by the IMF and World Bank. In these studies, tax reform (also known as "tax transition reform") is defined as the process of convergence of a developing country's tax structure toward the tax structure of developed countries. The application of this tax reform's definition rests on the fact that, in contrast with developing countries, the structure of tax revenue in developed countries is highly dependent on domestic tax revenue, and international trade tax revenue represents a low share of total tax revenue. Only a few theoretical and empirical studies on the macroeconomic effects of tax reform (for example, point-for-point reforms) have considered the effect of tax reform (e.g., Fujiwara, 2013; Kreickemeier and Raimondos-Møller, 2008; Gnangnon, 2019) on market access (or trade openness). Additionally, to the best of our knowledge, less attention has been placed on the issue concerning the effect of tax reform on the real exchange rate in developing countries, which is a relevant policy tool for countries' competitiveness in the international trade market, including the area of production and export product diversification (e.g., Guzman et al., 2018; Freund and Pierola, 2012; Nouira et al., 2011; Rodrik, 2008, 2009; Sekkat, 2016; Sekkat and Varoudakis, 2000). It is of less importance that; most existing studies on the effects of tax policy on the real exchange rate had majorly focused on the effect of tax reform on the real exchange rate in developed countries (e.g., Auray et al. 2018; de Mooij, and Keen, 2012; Feldstein and Krugman, 1990; Freund and Gagnon, 2017; Nicholson, 2010), with

1) These studies include for example Abe (1995); Anderson and Neary (2016); Boadway and Sato (2009); Emran and Stiglitz (2005); Fujiwara (2013); Ganelli and Tervala (2015); Karakosta and Tsakiris (2014); Keen and Ligthart (2002, 2005); Kreickemeier and Raimondos-Møller (2008); Lahiri and Nasim (2005); Michael et al. (1993); Munk (2008); Naito (2006); and Naito and Abe (2008).

less focus on developing countries. As stated, this article considers the issue of "tax reform" from a perspective that varies from that of developed countries. Auray et al. (2018), for example, examined the effect of the Ramsey-optimal tax reforms on the real exchange rate dynamics in small open economies, where the Ramsey-optimal taxation requires that the capital income tax rate not be raised both in the short and long term bases (e.g., Correia, 1996).

This study[2] bridges the gap in the literature by examining the effect of tax reform on the real exchange rate in developing countries, especially through the trade openness channel. Empirical studies were conducted using a sample of 107 countries from 1980-2019, and the two-step system-Generalized Method of Moments approach. The findings show that tax reform exerts a real exchange rate depreciation effect, in particular, in countries with higher trade openness. However, tax reform is related to the appreciation of the real exchange rate in countries whose tax structures are highly dependent on international trade tax revenue.

This article is structured as follows: Section 2 provides a theoretical discussion on the effect of tax reform (as defined above) on the real exchange rate, Section 3 specifies the model that will be used to examine the current problem, Section 4 presents the econometric approach to perform the empirical studies, Section 5 interprets the results of the findings, and Section 6 concludes.

II. Theoretical Discussion on the Effect of Tax Reform on the Real Exchange Rate

We hypothesize that tax reform could have an effect on the real exchange rate through the trade openness channel. However, before laying out the arguments supporting the effect of the tax reform through the trade openness channel, it is important to note that tax reform (particularly a revenue-neutral tariff-tax reform) could also have an effect on the real exchange through other channels,[3] such as the domestic output (e.g., Ganelli and Tervala, 2015; Michael et al., 1993; Keen and Ligthart, 2002, 2005; Karakosta and Tsakiris, 2014; Kreickemeier and Raimondos-Møller, 2008; Naito, 2006), which include the Keynesian expenditure-switching effect of a nominal exchange rate change when prices are stagnant (Ganelli and Tervala, 2015). Then, we discussed how the effect of tax reform on the real exchange rate could materialize through this channel.

According to Kreickemeier and Raimondos-Møller (2008), the proportional tariff-tax reform would make resources in the production sector more efficient as it would leave consumer prices unchanged but have an effect on only the production sector of the economy, including the form

2) Some few works (e.g., Beck and Coskuner, 2007; Freund and Gagnon, 2017) have investigated the effects of domestic taxes on real exchange rate in developed countries. This is not only the main objective of the current article, but these studies have focused on developed countries.

3) See Ganelli and Tervala (2015) for a literature survey.

of lower implicit production subsidies (because of declining tariffs) (as consumption taxes are less distortionary than tariffs, with tariffs acting as an equivalent to a net subsidy to producers). This effect of proportional tariff-tax reform is a direct application of the Diamond and Mirrlees (1971) theory[4] on the desirability of production efficiency (see also Dixit, 1985). According to this theory, when a small economy cannot implement lump-sum taxation, the optimal policy entails the implementation of taxes on the net demand of households instead of border taxes to finance its resource requirements. Thus, many studies (e.g., De Long and Summers, 1991; Lee, 1993; Eaton and Kortum, 2001) have provided empirical evidence that changes in trade barriers have an effect on the relative price of imported capital goods to consumption goods, and discourage investment. Kreickemeier and Raimondos-Møller (2008) used a static general equilibrium model to prove theoretically that under perfectly competitive conditions (i.e., at constant marginal costs), the point-for-point reform does not necessarily result in higher market access (i.e., higher import value, at world market prices). Simultaneously, the authors have discovered that there exists a (non-linear) tariff-tax reform that unambiguously promotes trade through market access, despite the resulting level of trade being lower than the one that would have arisen from the implementation of only tariff reform. Fujiwara (2013) conducted a study on the impact of point-by-point policy reform on market access (among other outcomes) in the context of imperfect competition (in particular decreasing marginal costs). In contrast to Kreickemeier and Raimondos-Møller (2008) (whose findings are based on the perfect competition assumption), Fujiwara (2013) discovered theoretically that while the point-by-point policy reform is not easy to implement, it improves market access in a competitive small open economy. On the empirical aspect, Gnangnon (2019) examined the effect of tax reform on trade openness, where tax reform (according to the proposed reform by the World Bank and the IMF) captures the convergence of a developing country's tax structure toward the developed countries' tax structure[5]. Gnangnon (2019) discovered that tax reform promotes trade openness in developing countries, with Least Developed Countries (LDCs) experiencing a higher positive trade openness effect of the reform than non-LDCs.

Consequently, the effect of tax reform on the real exchange rate that works through the trade openness channel depends on the extent to which trade openness influences the real exchange rate. The literature clearly shows that the effect of trade openness on the real exchange rate is undetermined and empirical.

The effect of trade openness on the real exchange rate is ambiguous. on the one hand, restrictive trade policies (or a lower degree of trade openness) through higher tariff barriers, quotas, or non-tariff barriers reduce imports and induce a rise in the price of non-tradable relative to

4) Nonetheless, Munk (2008) has shown that this theory might not be valid under when taxation is associated with administrative costs. Similarly, Stiglitz (2003) has criticized the recommendation to developing countries by the IMF and the World Bank to replace border taxes with the value-added tax (VAT).

5) Other studies that have used the same indicator in their analysis include Gnangnon and Brun (2019a,b,c,d).

the price of tradable. Therefore, the real exchange rate appreciates. On the other hand, trade liberalization (or greater trade openness) fosters domestic competition and causes a depreciation of the real exchange rate (e.g., Dornbusch, 1974). According to Balassa (1975), lower import tariffs translate into higher imports, which deteriorate the current account and generate a depreciation of the real exchange rate. In contrast to Balassa, Edwards (1989a) argued that the effect of trade liberalization on the real exchange rate is not direct, as two opposite effects could be at play, namely an income effect (i.e., the welfare improvement effect of trade liberalization) and a substitution effect (i.e., because of the fall in the price of non-tradable relatively to the price of exports). Edwards (1989b) has confirmed these predictions using an intertemporal model of the real exchange rate and the assumption that tradable and non-tradable are substitutes, with the substitution effect being higher than the income effect (see also the model developed by Khan and Ostry (1992), which arrived at the same conclusion). According to Edwards (1989a), the model should account for the initial conditions of the tariff level. If the level of the tariffs is initially low, the substitution effect will dominate because as trade liberalization progresses, the price of non-tradable will relatively fall to that of exports. However, in the case of a large initial level of tariffs, liberalization would generate a welfare improvement (income effect) that may induce a rise in aggregate demand, including non-tradable, and appreciation of the real exchange rate. Incidentally, higher trade openness could enhance productivity gains (e.g., Camarero et al., 2015; Frankel and Romer, 1999; Kappeler, 2015; Hufbauer and Lu, 2016; Melitz 2003), contribute to the expansion of the tradable sector and lead to the depreciation of the real exchange rate. On the empirical aspect, among the existing studies on the effect of trade openness on the real exchange rate, Devereux and Connolly (1996) reported empirical evidence that higher import taxes have led to an appreciation of the real exchange rate in some Latin American countries (which indicates that liberalization would exert a real exchange rate depreciation effect). Li (2004) has also obtained that trade liberalization has produced a depreciation of the real exchange rate, an effect that would not be obtained if the trade liberalization were partial or incomplete. However, Gantman and Dabós (2018) recently discovered empirically that higher trade openness generates real exchange rate depreciation. Considering this finding, we hypothesize that if tax reform promotes trade openness, which has a depreciating effect on the real exchange rate, then we can expect it to result in the depreciation of the real exchange rate, with the magnitude of this effect rising as the level of trade openness rises. In contrast, if higher trade openness induces the appreciation of the real exchange rate, tax reform will result in the real exchange rate rising, and the magnitude of the real exchange rate appreciation will increase as the degree of trade openness rises. Therefore, the effect of tax reform on the real exchange rate through the trade openness channel is empirical.

III. Model Specification

To examine the effect of tax reform on the real exchange rate, including through trade openness, we draw from the studies on the determinants of the real exchange rate, especially in developing countries (e.g., Addison and Baliamoune-Lutz, 2017; Adu and Denkyirah, 2018; Aron et al. 1997; Dumrongrittikul and Anderson, 2016; Elbadawi, 1994; 1999; Elbadawi and Soto, 1995; Nyoni, 1998; Ouattara and Strobl, 2008; Sackey, 2001; Van Wijnbergen, 1985; White and Wignaraja, 1992). Specifically, we considered a baseline model specification that includes not only the indicator of tax reform but also standard determinants of the real exchange rate (excluding trade openness, which is the channel through which the effect of tax reform on the real exchange rate would materialize in the present study). Therefore, control variables include the general government final consumption expenditure, in the percentage of GDP (denoted "GCONS"); the Gross fixed capital formation in the percentage of GDP (denoted "GFCF"), which is a proxy for public investment; the total development aid (i.e., the so-called official development aid - ODA) (denoted "ODACST"), and the real per capita income (denoted "GDPC") that acts as a proxy for the development level. All variables have been described in Appendix Table 1. The channel variable (i.e., trade openness) through which the effect of tax reform on the real exchange rate operates, is also described in Appendix Table 1). We used two alternative measures of trade openness. The first is the standard measure of trade openness, i.e., the sum of exports and imports, in the percentage of GDP (denoted "OPEN"). The second measure is the trade openness indicator proposed by Squalli and Wilson (2011), and denoted "OPENSW." It is computed as the standard measure of trade openness (i.e., "OPEN") adjusted by the proportion of a country's trade level relative to the average world trade (see Squalli and Wilson, 2011: p1758).

Concerning the main regressor of interest in the analysis, namely the tax reform indicator, its computation has been drawn from Gnangnon (2019, 2020) and Brun (2019a, 2019b, 2019c), who as stated above, defined tax reform as the convergence of the tax structure of a given developing country toward developed countries' tax structure.

The indicator of tax reform is calculated using the semi-metric Bray-Curtis dissimilarity index (Bray & Curtis, 1957) as follows: $TAXREF_{it} = (1 - d_{it})$ (1) with

$$d_{it} = \frac{\left|DIRTAX_{it} - DIRTAXAve_t\right| + \left|INDIRTAX_{it} - INDIRTAXAve_t\right| + \left|TRTAX_{it} - TRTAXAve_t\right|}{\left[(DIRTAX_{it} + DIRTAXAve_t) + (INDIRTAX_{it} + INDIRTAXAve_t) + (TRTAX_{it} + TRTAXAve_t)\right]} \quad (2).$$

d_{it} represents the dissimilarity index between a given developing country's tax structure (for a given year) and the tax structure of developed countries. $TAXREF_{it}$ is the indicator of tax reform for a given developing country in a given year. The tax revenue variables used in formula

(2) exclude resource revenue (for further details, see Gnangnon, 2019; Gnangnon and Brun, 2019a, 2019b, 2019c). These tax revenue variables, i.e., DIRTAX, INDIRTAX, and TRTAX stand respectively for the direct tax revenue ratio, the indirect tax revenue ratio, and the trade tax revenue ratio for a given developing country in a year t. For developed countries, DIRTAXAve, INDIRTAXAve, and TRTAXAve are respectively the average (over all developed countries[6], in a given year) of the direct tax revenue ratio; the indirect tax revenue ratio; and the trade tax revenue ratio. Values of $TAXREF_{it}$ the range between 0 and 1, with a rise in these values reflecting higher convergence of tax structure, i.e., a greater extent of tax reform. Declining values of this index show a lower extent of tax reform, that is, a divergence between the tax structure of developing countries and the tax structure of developed countries.

The dependent variable, i.e., the real effective exchange rate index (denoted "REER") is extracted from the Bruegel datasets (see Darvas, 2012a, and 2012b). It has been computed for a given country, as the nominal exchange rate (which is a geometrically weighted average of the bilateral exchange rates between this country and its trading partners) multiplied by the consumer price index of the concerned country in period t, and divided by the geometrically weighted average of the consumer price indexes of its trading partners over the same period. The nominal effective exchange rate is based on 66 trading partners. An increase in REER indicates an appreciation of the real effective exchange rate, i.e., an appreciation of the home currency against the basket of currencies of trading partners, while a decrease in REER reflects a depreciation of the real effective rate.

Against this backdrop, we postulate the following model:

$$REER_{it} = \alpha_1 REER_{it-1} + \alpha_2 TAXREF_{it} + \alpha_3 GFCF_{it} + \alpha_4 GCONS_{it} + \alpha_5 ODACST_{it} + \alpha_6 GDPC_{it} + \alpha_7 BRMONEY_{it} + \alpha_8 TERMS_{it} + \mu_i + \omega_{it} \quad (3)$$

The analysis uses an unbalanced panel dataset that contains 107 countries over the period 1980-2019, based on the availability of data on the variables in the model (1). We follow the practice in the empirical macroeconomic literature and use non-overlapping sub-periods of 5-year average data (1980-1984; 1985-1989; 1990-1994; 1995-1999; 2000-2004; 2005-2009; 2010-2014; and 2015-2019) to dampen the effect of business cycles on variables. The subscript i in the model (1) represents the index for a given country, and the subscript t is associated with the time-period, i.e., each of the aforementioned eight time-periods. α_1 to α_8 are parameters to be estimated. μ_i are countries' fixed effects; ω_{it} is a well-behaving error term.

6) The list of developed countries (also referred as 'Old Industrialized countries') used to calculate the index of convergence in tax structure index for developing countries in the analysis includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden Switzerland, United Kingdom and the United States.

Let us briefly discuss the expected effects of the control variables on the real exchange rate. According to Balassa (1964) and Samuelson (1964), as countries develop, the improvement of their productivity in the tradable (goods) sector exceeds that of the non-tradable (goods) sector, and leads to a higher price of non-tradable relative to the price of tradable. Therefore, the Balassa-Samuelson hypothesis posits that the rise in the real per capita income reflected in the rise in the development level induces an appreciation of the real exchange rate.

The effect of government consumption (or expenditure) on the real exchange rate depends on whether it is spent on tradable or non-tradable. A higher government consumption of non-tradable would be associated with the real exchange rate appreciation, while a rise in the government consumption of tradable would result in a depreciation of the real exchange rate. Overall, the effect of government consumption on the real exchange rate is a priori ambiguous, and is an empirical matter. Nonetheless, according to some empirical studies (e.g., Corsetti and Müller, 2006; Galstyan and Lane, 2009), government consumption is likely channeled toward non-tradable goods, which suggests that it would be related to an appreciation of the real exchange rate. Meanwhile, Ravn et al. (2012) and Monacelli and Perotti (2010) obtained that an increase in government spending generates a real depreciation of the domestic currency. Along the same lines, we can expect that a rise in public investment in tradable (non-tradable) would be associated with depreciation (appreciation) of the real exchange rate (e.g., Ouattara and Strobl, 2008). Iwata (2013) has obtained empirical evidence that public investment shock induces an increase in private consumption, and an initial appreciation of the real exchange rate, which is followed by a depreciation of the real exchange rate. Similar findings have been reported by Ganelli and Tervala (2020).

Concerning the relationship between development aid and the real exchange rate, the literature has postulated that higher development aid inflows could lead to an appreciation of the real exchange, in particular, if these resource flows were spent by the recipient government in the non-tradable sector, thereby raising the price of non-tradable relative to the tradable (e.g., Addison and Baliamoune-Lutz, 2017; Adu and Denkyirah, 2018; Elbadawi, 1999; Nyoni, 1998; Ouattara and Strobl, 2008; Sackey, 2001; Younger, 1992). This argument is drawn from the standard Dutch Disease theory, which is a theory of the demand-side impact of a capital inflow (e.g., Bruno and Sachs, 1982; Corden, 1981, 1984; Corden and Neary, 1982). However, if development aid is spent on tradable, including for example, on the recipient country's productive capacity, it would lead to the expansion of the tradable sector relative to the non-tradable sector, and a depreciation of the exchange rate. Some studies have obtained that development aid inflows have generated an appreciation of the real exchange rate (e.g., Addison and Baliamoune-Lutz, 2017; Adu and Denkyirah, 2018; Elbadawi, 1999; Ouattara and Strobl, 2008; White and Wignaraja, 1992; Younger, 1992). However, other studies have uncovered a real exchange rate depreciation effect of development aid inflows (e.g., Nyoni, 1998; Sackey, 2001; Selaya and Thiele, 2010). Issa and Ouattara (2008) discovered no significant Dutch disease effect of development aid

either in the short-run or in the long-run in developing countries.

The literature has also shown that the effect of terms of trade on the real exchange rate operates through two opposite effects: an income and a substitution effect of terms of trade (e.g., Edwards, 1988; Edwards and Van Wijnbergen, 1987). The income effect occurs when the domestic income rises further to the rise in the price of exports or to a fall in the import price. To the extent that the price of a tradable is exogenous - as it is determined in the world market - the price of a non-tradable relative to a tradable would rise, which may generate an appreciation of the real exchange rate. Thus, according to the income effect, the terms of trade improvement are related to an appreciation of the real exchange rate. The substitution effect could arise from the situation where the foreign demand for exports decreases further with the rise in export prices, and leads to lower production of tradable demanded in the international market. This generates a movement of production factors away from the tradable sector toward the non-tradable sector. Consequently, the price of non-tradable rises relatively to the price of tradable, which makes the real exchange rate appreciate. Thus, concerning the substitution effect, a deterioration in terms of trade generates an appreciation of the real exchange rate, whereas an improvement in terms of trade is associated with a depreciation of the real exchange rate. Overall, the net effect of changes in the terms of trade on the real exchange rate is a priori undetermined and depends on whether the income effect dominates the substitution effect or vice versa. If the income effect dominates, then an improvement in terms of trade would lead to real exchange rate appreciation. However, if the substitution effect dominates, improvements in terms of trade would be associated with a depreciation of the real exchange rate. Edwards (1988) demonstrated that the income effect is likely to dominate the substitution effect, and significantly improve in terms of trade resulting in the appreciation of the real exchange rate. Several studies (e.g., Addison and Baliamoune-Lutz (2017; Clark and MacDonald, 1999; De Gregorio and Wolf, 1994; Gantman and Dabós 2018; Odedokun, 1997) have reported empirical evidence that terms of trade improvements have induced an appreciation of the real exchange rate.

However, a higher money supply would be associated with a rise in the level of the general domestic prices, and thus in the appreciation of the real exchange rate.

Before running the regressions, all variables in the model (3) were standardized. This helps to avoid measurement concerns when comparing estimates arising from regressions. Each variable is standardized by computing the ratio of the difference between the concerned variable and its mean (average) over the standard deviation of this variable. The standardized coefficients, which are the estimates of the standardized variables, allow for the identification of the variables that contribute the most to the dynamics of the real exchange rate. In particular, the standardization procedure helps in determining how the tax reform indicator is ranked among regressors in terms of its contribution to explaining the dynamics of the real exchange rate. The regressions based on the standardized variables exclude time dummies, as the standardized values of the

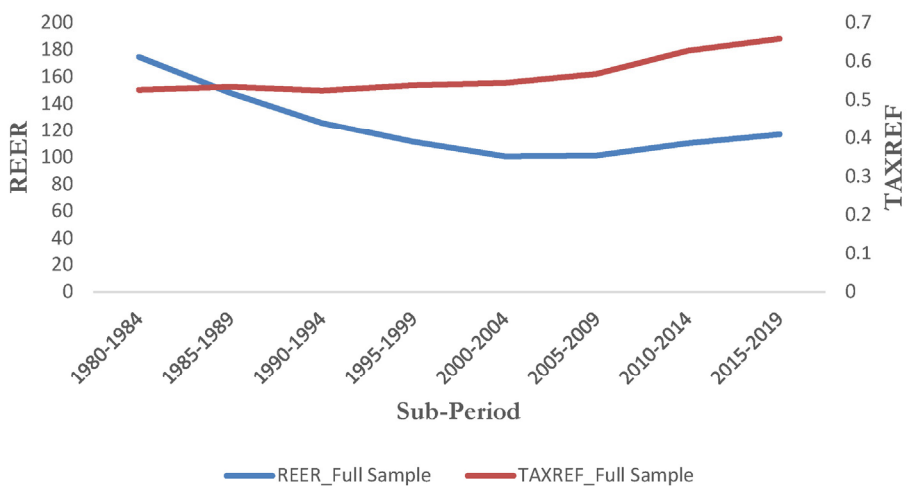
latter amount to zero. Appendix Table 2a shows standard descriptive statistics on unstandardized variables used in the model (1), and Appendix Table 2b reports the pairwise correlation between these variables. The list of countries used in the analysis is provided in Appendix Table 3. As observed in Appendix Table 2b, all correlation coefficients are lower than 0.8, as recommended by Studenmund (2011). Thus, our regressions are unlikely to suffer from severe multicollinearity problems.

Figure 1 presents the development of the indicators of tax reform and the real exchange rate. Figure 2 shows the correlation pattern between "TAXREF" and "REER" using unstandardized (i.e., normal) variables (see the left-hand side graph), and standardized variables (see the right-hand side graph). Data used for constructing the graphs in these Figures are based on non-overlapping sub-periods.

We observed in Figure 1 that countries exhibit a tendency for a strengthened tax transition reform over time. Simultaneously, the real effective exchange depreciated from a value of 174.8 from 1980-1984 to 100.6 in 2000-2004. After relative stability from 2000-2004 to 2005-2009, it then showed an upward trend from a value of 101.1 in 2005-2009 to a value of 117 in 2014-2019.

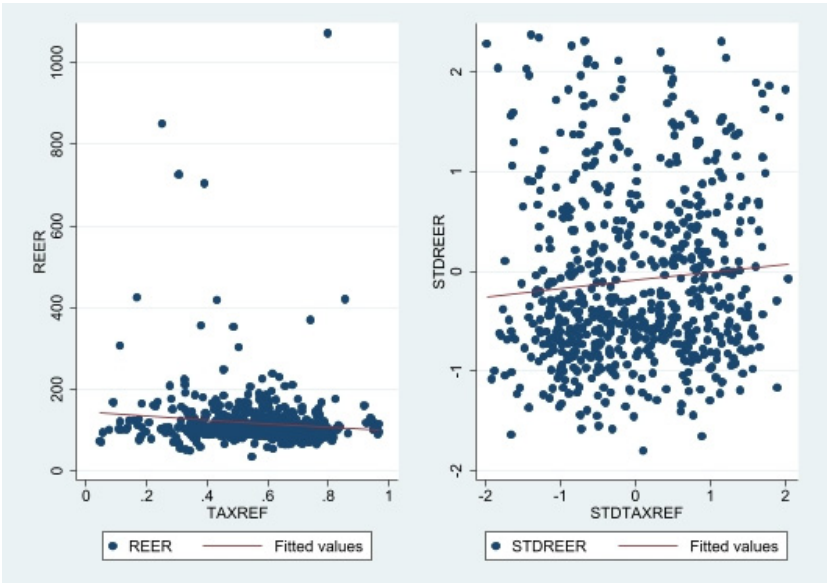
The correlation pattern in the left-hand side graph appeared negative, although the scatterplot is concentrated at the bottom of the graph (with outliers appearing in the graph). The right-hand side graph shows a better picture of the correlation pattern between tax reform and the real exchange rate (with the absence of outliers), with the correlation pattern being positive.

Figure 1. Development of the indicator of tax transition reform and the real effective exchange rate_over the full sample



Note. The variables "TAXREF" and "REER" represent respectively the unstandardized indicators of tax reform and real exchange rate.
(Source) Author.

Figure 2. Correlation patterns between the indicator of the tax transition reform and the real effective exchange rate over the full sample



Note. The variables "TAXREF" and "REER" represent respectively the unstandardized measures of tax reform and real exchange rate, while the variables "STDTAXREF" and "STDREER" are respectively the standardized indicators of tax reform and real exchange rate.
(Source) Author.

IV. Econometric Strategy

The estimation of the dynamic model (1) would not generate reliable estimates if it was estimated using standard econometric estimators, such as the within-fixed effect estimator, because the model is plagued with many endogeneity concerns, which the simple standard econometric estimators could not address. One significant endogeneity concern relates to the well-established bi-directional causality in the empirical literature between the real exchange rate variable and many of its determinants. In particular, all variables highlighted above, except for the terms of trade variable, have been considered endogenous. The tax reform variable is particularly endogenous because of the endogeneity of the trade openness variable, which is the main channel through which tax reform can affect the real exchange rate.As the real exchange rate has an effect on trade flows, and hence the level of trade openness, it will certainly influence the extent of tax reform in a given country, considering the relationship between trade openness and tax reform (Gnangnon, 2019). Another endogeneity bias, known as the Nickell bias (Nickell, 1981) - could result from the correlation between the one-period lag of the dependent variable and the specific effects of model (1), notably if the model was estimated using the within-fixed effects estimator.

Given the difficulty of finding appropriate instruments for all endogenous variables, considering the highly unbalanced nature of our dataset, we address these endogeneity concerns by following authors such as Ouattara and Strobl (2008) and estimate the dynamic model specification (3) using the two-step system-Generalized Method of Moments (GMM) estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). This estimator involves the estimation of a system of equations that combines an equation in levels and an equation in differences (first differences), where lagged values are used as instruments for the first-differenced regressors, and first differences of variables are used as instruments for the equation in levels. The two-step system GMM estimator is appropriate for dynamic panel models (including with the lag of the dependent variable as regressor) with a small time dimension and large cross-section, and where series exhibit strong persistence over time. It allows for tackling the potential endogeneity (i.e., reverse causality) issue of regressors, and hence helps uncover the causal effects of variables under analysis. Additionally, it allows for handling the endogeneity problem stemming from the correlation between the one-period lag of the dependent variable and countries' specific effects. As noted above, all regressors that would be used in the analysis have been considered endogenous, except for the terms of trade variable. The regressions used two lags of endogenous variables as instruments. Several diagnostic tests have been conducted to verify the two-step system GMM estimator. The consistency of this estimator is evaluated using the Arellano-Bond test of the presence of first-order serial correlation in the error term (denoted AR(1)), and of no second-order autocorrelation in the residuals (denoted AR(2)). We also presented the Sargan-Hansen test of over-identifying restrictions (OID), in which we expect the p-value of the related statistic to be greater than 0.10 to ensure that the instruments used in the regressions are valid. The validity of the two-step system GMM estimator rests on the non-rejection of the null hypotheses. We also ensure that the number of instruments used in the regressions does not exceed the number of countries, as otherwise, the aforementioned diagnostic tests may be less powerful (e.g., Bowsher, 2002; Ziliak, 1997; Roodman, 2009). The Windmeijer (2005) technique has been applied to correct the standard errors of estimates, given the small size nature of our sample.

At this stage in the analysis, we would like to point out that the above-mentioned requirements of the two-step system GMM estimator were not met when we used only the one-period lag-dependent variable as the regressor. Thus, to meet these requirements, we have used two lags of the dependent variable as regressors.

The empirical exercise using the two-step system GMM approach is conducted as follows: Column [1] of Table 1 contains the outcomes arising from the estimation of the dynamic model (3). In column [2] of Table 1, we display the estimates obtained by estimating a specification of model (3), which includes the interaction variable between the real per capita income and the tax reform indicators. This variant of model (3) allows for examining how the effect of tax reform on the real exchange rate varies for different development levels (i.e., different

levels of the real per capita income).

Table 1. *Effect of the Tax Transition Reform on the Real Effective Exchange Rate*

Estimator: Two-step System GMM

Variables	REER	REER	REER
	(1)	(2)	(3)
$REER_{t-1}$	0.569***	0.563***	0.568***
	(0.0275)	(0.0256)	(0.0216)
$REER_{t-2}$	-0.275***	-0.234***	-0.235***
	(0.0200)	(0.0172)	(0.0123)
TAXREF	-0.0652**	-0.0780***	-0.0941***
	(0.0283)	(0.0229)	(0.0301)
TAXREF*GDPC		-0.0757***	
		(0.0270)	
TAXREF*LDC			0.147***
			(0.0467)
LDC			-0.213***
			(0.0285)
GFCF	0.0558	0.0440	0.0909***
	(0.0378)	(0.0289)	(0.0265)
GCONS	-0.121***	-0.107***	-0.0750***
	(0.0295)	(0.0209)	(0.0239)
ODACST	0.0960***	0.0871***	0.0419**
	(0.0318)	(0.0226)	(0.0188)
GDPC	0.164***	0.233***	0.236***
	(0.0347)	(0.0260)	(0.0248)
BRMONEY	0.0771**	0.0680***	0.111***
	(0.0308)	(0.0249)	(0.0242)
TERMS	0.0432**	0.0486***	0.0504***
	(0.0203)	(0.0172)	(0.0171)
Observations - Countries	433 - 107	433 - 107	433 - 107
AR1 (P-Value)	0.0002	0.0004	0.0002
AR2 (P-Value)	0.5549	0.2701	0.4024
OID (P-Value)	0.3951	0.4402	0.2719

Note. *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust Standard Errors are in parenthesis. All variables have been standardized. The variables "TAXREF", "GDPC", "GFCF", "GCONS", "BRMONEY" and "ODACST" and the interaction variables have been considered as endogenous. The regressions have used 2 lags of endogenous variables as instruments.

In addition, we examined how the tax reform has an effect on the real exchange rate in two sub-samples, namely LDCs, and NonLDCs (i.e., countries in the full sample that are not classified as LDCs). LDCs are the group of the poorest and most vulnerable countries to environmental and external economic shocks in the world[7]. The tax revenue structure of these

7) Further information on the LDCs could be found online at: https://www.un.org/ohrlls/content/least-developed-countries

countries is more dependent on international trade tax revenue than the one of other developing countries (i.e., NonLDCs). Therefore, it is likely that the effect of tax reform on the real exchange rate in LDCs and NonLDCs would be different. In particular, countries (such as LDCs) whose tax structures are highly dependent on trade tax revenue might not successfully implement higher tax reform because the scope of raising substantial domestic revenue is limited (for example these countries have a large agricultural sector, which is difficult to tax) compared with countries whose tax structures are less dependent on trade tax revenue. As a result, tax reform is likely to have a lower real exchange rate depreciation effect in LDCs than NonLDCs, and in countries whose tax structure is highly dependent on trade tax revenue, tax reform may even result in the appreciation of the real exchange rate. We conducted an empirical test later in the analysis to determine the extent to which the effect of tax reform on the real exchange rate in countries of the full sample depends on countries' tax structure reliance on international trade tax revenue. To examine the effect of tax reform on the real exchange rate in LDCs versus NonLDCs, we estimated another variant of model (3), which includes the dummy "LDC" (which takes the value of 1 for LDCs, and 0, for NonLDCs) and the interaction between this dummy variable as well as the indicator of tax reform. The outcomes of the estimation of this model specification are presented in column [3] of Table 1.

Table 2 shows the results that enabled us to evaluate the extent to which the effect of tax reform on the real exchange rate depends on the degree of trade openness, i.e., whether this effect genuinely works through the trade openness channel. To obtain these results, we estimated two other variants of model (3), including each of the two above-mentioned trade openness indicators, which is included in the model along with its interaction with the tax reform variable.

Table 2. *Effect of the Tax Transition Reform on the Real Effective Exchange Rate through the Channel of Trade Openness*

Estimator: Two-step System GMM

Variables	REER	REER
	(1)	(2)
$REER_{t-1}$	0.431***	0.530***
	(0.0133)	(0.0112)
$REER_{t-2}$	-0.256***	-0.249***
	(0.0131)	(0.0125)
TAXREF	0.0365***	-0.0426*
	(0.0106)	(0.0222)
TAXREF*OPEN	-0.124***	
	(0.0207)	
TAXREF*OPENSW		-0.114***
		(0.0142)
OPEN	-0.213***	
	(0.0159)	

Table 2. *Continued*

Estimator: Two-step System GMM

Variables	REER	REER
	(1)	(2)
OPENSW		0.0385*
		(0.0208)
GFCF	0.145***	0.0661***
	(0.0190)	(0.0184)
GCONS	0.0143	-0.0339**
	(0.0213)	(0.0149)
ODACST	0.0246	0.0776***
	(0.0170)	(0.0152)
GDPC	0.189***	0.208***
	(0.0182)	(0.0179)
BRMONEY	0.0846***	0.101***
	(0.0191)	(0.0175)
TERMS	0.0745***	0.00648
	(0.0104)	(0.0115)
Observations - Countries	433 - 107	433 - 107
AR1 (P-Value)	0.0008	0.0003
AR2 (P-Value)	0.6459	0.3357
OID (P-Value)	0.5057	0.4949

Note. *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust Standard Errors are in parenthesis. All variables have been standardized. The variables "TAXREF", "OPEN", "OPENSW", "GDPC", "GFCF", "GCONS", "BRMONEY" and "ODACST" and the interaction variables have been considered as endogenous. The regressions have used 2 lags of endogenous variables as instruments.

Finally, as noted above, we examined whether the effect of tax reform on the real exchange rate in countries of the full sample depends on countries' level of tax structure reliance on international trade tax revenue. Thus, we used two indicators of countries' tax structure dependence on international trade tax revenue. The first indicator denoted "SHTRTAX1" is the share (in percentage) of trade tax revenue in non-resource tax revenue. Non-resource tax revenue is the difference between total tax revenue (percentage of GDP) (excluding social contributions) and tax revenue collected on natural resources (the latter includes a relevant component of economic rent, primarily from oil and mining activities). The second indicator denoted "SHTRTAX2" is the share (in percentage) of trade tax revenue in total public revenue. Total public revenue includes both tax and non-tax revenue, as well as grants and social contributions. Hence, to address this question, we estimated two specifications of model (3), each containing one of the two indicators of countries' tax structure dependence on international trade tax revenue along with the multiplicative variable between this indicator and that of tax reform. The results of this estimation are provided in Table 3.

Table 3. *Effect of the Tax Transition Reform on the Real Effective Exchange Rate for Varying Shares of International Trade Tax Revenue in Non-resource Tax Revenue (or Total Public Revenue)*

Estimator: Two-step System GMM

Variables	REER	REER
	(1)	(2)
$REER_{t-1}$	0.506***	0.543***
	(0.00865)	(0.0100)
$REER_{t-2}$	-0.276***	-0.241***
	(0.00946)	(0.01000)
TAXREF	0.0223	0.0147
	(0.0153)	(0.0112)
TAXREF*SHTRTAX1	0.0641***	
	(0.0168)	
TAXREF*SHTRTAX2		0.0386***
		(0.0108)
SHTRTAX1	0.0997***	
	(0.0120)	
SHTRTAX2		0.132***
		(0.0157)
GFCF	0.0236	0.00440
	(0.0204)	(0.0149)
GCONS	-0.0847***	-0.110***
	(0.0178)	(0.00732)
ODACST	0.0578***	0.0671***
	(0.0125)	(0.0136)
GDPC	0.260***	0.277***
	(0.0158)	(0.0142)
BRMONEY	0.137***	0.125***
	(0.0163)	(0.0155)
TERMS	0.0411***	0.0610***
	(0.0112)	(0.00889)
Observations - Countries	425 - 106	388 - 101
AR1 (P-Value)	0.0006	0.0014
AR2 (P-Value)	0.4939	0.4700
OID (P-Value)	0.3846	0.5077

Note. *p-value < 0.1; **p-value < 0.05; ***p-value < 0.01. Robust Standard Errors are in parenthesis. All variables have been standardized. The variables "TAXREF", " SHTRTAX1", " SHTRTAX2", "GDPC", "GFCF", "GCONS", "BRMONEY" and "ODACST" and the interaction variables have been considered as endogenous. The regressions have used 2 lags of endogenous variables as instruments.

V. Empirical Results

The reliability of the results in Tables 1-3 depends on the validity of the two-step system GMM estimator. The results of the diagnostic tests (regarding the consistency of the GMM

approach) described in the previous section are reported in Tables 1-3 at the bottom of this article and are fully satisfied. Additionally, the statistical significance at the 1% level of the coefficients of the lagged dependent variables - across all columns of the three Tables - shows the mean reversion of the real exchange rate variable, emphasizing the significance of a dynamic baseline specification in the analysis. All these results confirm the appropriateness of the use of the two-step system GMM approach in this empirical analysis.

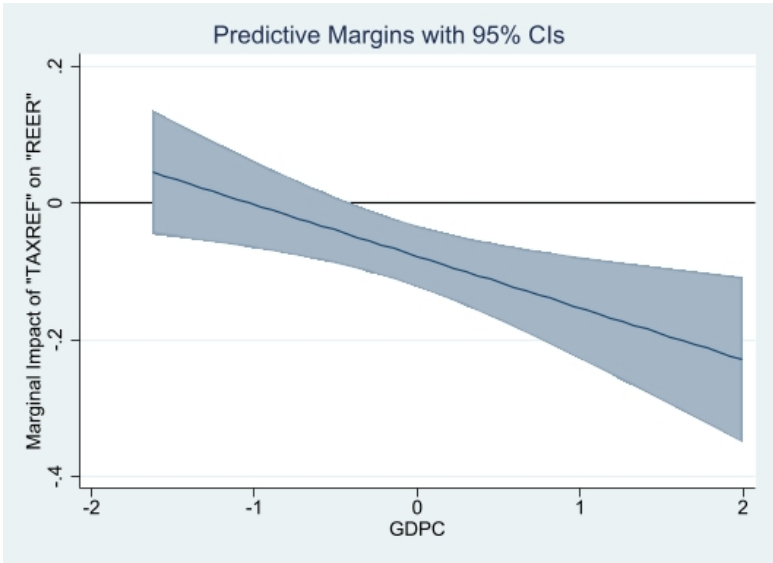
The result provided in column [1] of Table 1 shows a negative and statistically significant (at the 5%) coefficient of the variable "TAXREF," which indicates that a greater extent of tax reform induces a depreciation of the real exchange rate. Thus, appreciation in the index of tax reform by a 1 standard deviation led to a depreciation in the index of the real effective exchange rate by a -0.065 standard deviation. The coefficient of the indicator of public investment is not statistically significant among control variables (see results in column [1] of Table 1) at the conventional levels. However, an increase in real per capita income and development aid flows, a rise in the money supply, and an improvement in terms of trade are associated with an appreciation of the real exchange rate, at least at a 5% level. Government consumption is negatively and significantly associated with the real exchange rate, and the money supply positively influences the real exchange rate. Interestingly, at the 5% level, the regressor that contributes the most to the dynamics of the real exchange rate is the real per capita (i.e., the one that has the highest coefficient in absolute value), followed by the indicators of government consumption, development aid, money supply, tax reform, and terms of trade.

In addition, we observed in column [2] that both the coefficient of the tax reform variable and the interaction term of the variable ["TAXREF*GDPC"] are negative and statistically significant at the 1% level. Taken together, these two results imply that tax reform causes real exchange rate depreciation and the magnitude of this real exchange rate depreciation increases as countries' real per capita income rises. In other words, developed countries (among those in the full sample) experience a higher magnitude of the real exchange rate depreciation effect than relatively developing countries. To get a clearer picture of this impact, we presented in Figure 3, and at the 95% confidence intervals, the marginal impact of tax reform on the real exchange rate conditioned on the real per capita income. It appeared from Figure 3 that the marginal effect of tax reform on the real exchange rate depreciated as the real per income rises. Tax reform does not have a significant effect on the real exchange rate in countries whose real per capita income is lower than the value[8] of US$ 2233 (these countries include the LDCs). However, for the other countries (i.e., those whose real per capita income is higher than US$ 2233), tax reform is associated

8) This value of the real per capita income is obtained as follows US$ 2233 [= 5645.894*(-0.3665) + 4302.228]). The number "5645.894" is the standard deviation of the real per capita income indicator over the full sample. The number "4302.228" is the mean (i.e., average) value of the real per capita income over the full sample. Finally, the value "-0.3665" is the standardized value of the real per capita income, and is extracted from the Stata software when constructing Figure 3.

with a depreciation of the real exchange rate, and the higher the real per capita income, the larger the real exchange rate depreciation effect of tax reform. In other words, tax reform induces a depreciation of the real exchange rate essentially in relatively developed countries (particularly those with a real per capita income higher than US$ 2233), with the magnitude of this effect appreciating as the real per capita income rises.

Figure 3. Marginal Impact of "TAXREF" on "REER" for varying levels of the real per capita income



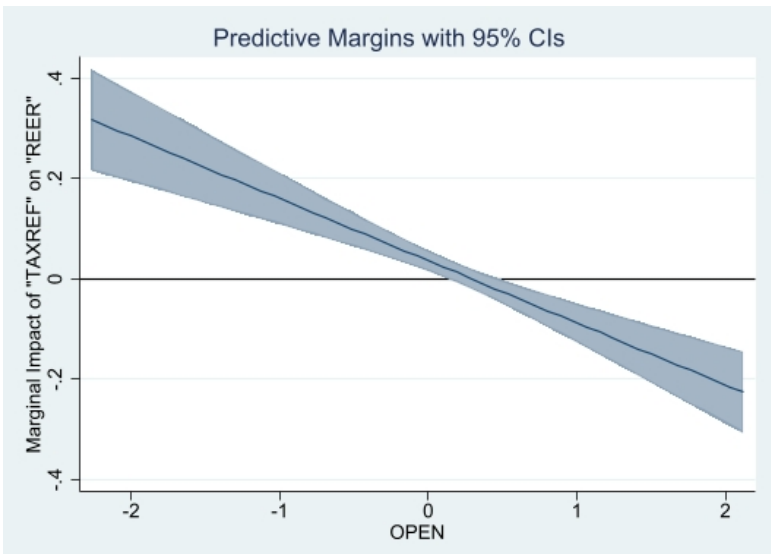
(Source) Author.

Turning to the estimates presented in column [3] of the Table, we observed that the coefficient of the interaction variable ["TAXREF*LDC"] is positive, while that of the variable "TAXREF" is negative, both being significant at the 1% level. It follows that, while tax reform has a higher positive effect on the real exchange rate in LDCs than in NonLDCs, the net effects of tax reform on the real exchange rate in both LDCs and NonLDCs are 0.053 [= 0.147 - 0.0941] and - 0.094, respectively. These findings show that on average over LDCs, tax reform is associated with an appreciation of the real exchange rate, while it is associated with a depreciation of the real exchange rate over NonLDCs.

The results in the two columns of Table 2 indicate that the interaction term related to the interaction variables (between a relevant indicator of trade openness and the indicator of tax reform) are negative and statistically significant at the 1% level. Simultaneously, the coefficient of "TAXREF" is positive and significant at the 1% level (see column [1] of Table 2), while the coefficient of "TAXREF" is yet negative, but significant only at the 10% level (see column [2] of Table 2). Thus, we can conclude from the results in column [1] of Table 2 that, on average

over the full sample, the effect of tax reform on the real exchange rate changes significantly when the levels of trade openness ("OPEN") is higher than the value[9] of 90.5% (note that over the full sample, values of the indicator "OPEN" range between 14.4% and 368.4% - see Appendix Table 2a). Therefore, tax reform is associated with a depreciation of the real exchange rate in countries whose level of trade openness is higher than 90.5%, and for these countries, the real exchange rate depreciation effect of tax reform is higher, so also the level of trade openness. Conversely, countries whose level of trade openness is lower than 90.5% experience an appreciation of the real exchange rate, and the lower the level of trade openness, the higher the magnitude of the real exchange rate appreciation effect of tax reform. Figure 4 shows, at the 95% confidence intervals, the marginal impact of tax reform on the real exchange rate conditioned on the level of trade openness ("OPEN"). It appears that tax reform does not have a significant effect on the real exchange rate for the level of trade openness higher than the value[10] of 85.8% and lower than the value[11] of 98.3%. The marginal impact of tax reform

Figure 4. Marginal Impact of "TAXREF" on "REER" for varying levels of trade openness ("OPEN")



(Source) Author.

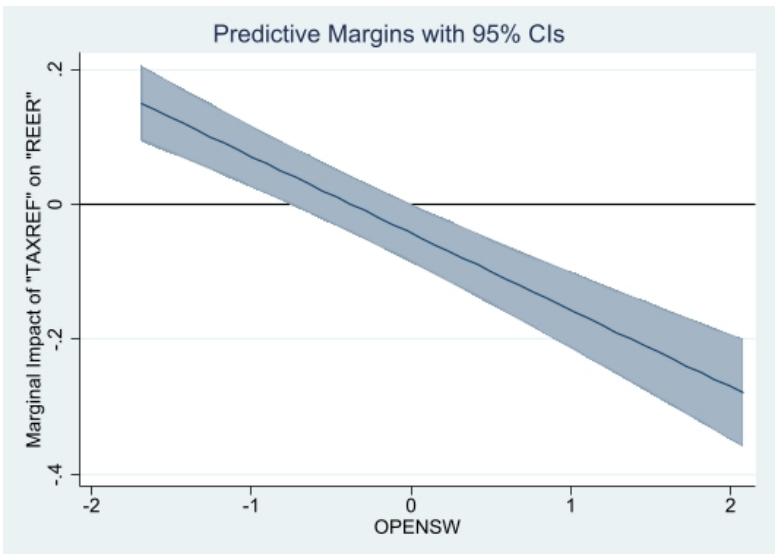
9) This value of the real per capita income is obtained as follows 90.5% [= 43.881*(0.0365/0.124) + 77.544]). The number "43.881" is the standard deviation of the indicator "OPEN" over the full sample. The number "77.544" is the mean (i.e., average) value of the indicator "OPEN" over the full sample. Finally, the value "0.0365/0.124" is the ratio of the estimate associated with the variable "TAXREF" to the estimate of the interaction variable ["TAXREF*OPEN"].

10) This value of trade openness (i.e., "OPEN") is obtained as follows 85.8% [= 43.881*(0.18906) + 77.544]). The number "43.881" is the standard deviation of the indicator "OPEN" over the full sample. The number "77.544" is the mean (i.e., average) value of the indicator "OPEN" over the full sample. Finally, the value "0.18906" is the standardized value of the indicator "OPEN", which was extracted from the Stata software when constructing Figure 4.

on the real exchange rate is positive and significant (i.e., tax reform is associated with an appreciation of the real exchange rate) when the level of trade openness is lower than the value of 85.8%. In contrast, countries whose values of trade openness are higher than 85.8% experienced a real exchange rate depreciation effect of tax reform, with the magnitude of this effect increasing as countries further opened up their economies to international trade.

However, we can infer from the results in column [2] of Table 2 that, at the 5% level, tax reform is consistently associated with a depreciation of the real exchange rate, with this effect becoming higher as the level of trade openness ("OPENSW") further increases, i.e., as countries further integrate into the world trade market. Figure 5 presents, at the 95% confidence interval, the marginal impact of tax reform on the real exchange rate for varying levels of trade openness ("OPENSW"). The pattern in Figure 5 is quite similar to the one in Figure 4. These findings suggest that the effect of tax reform on the real exchange rate depends on the level of trade openness: the greater the degree of trade openness, the higher the magnitude of the real exchange rate depreciation effect of tax reform.

Figure 5. Marginal Impact of "TAXREF" on "REER" for varying levels of trade openness ("OPENSW")



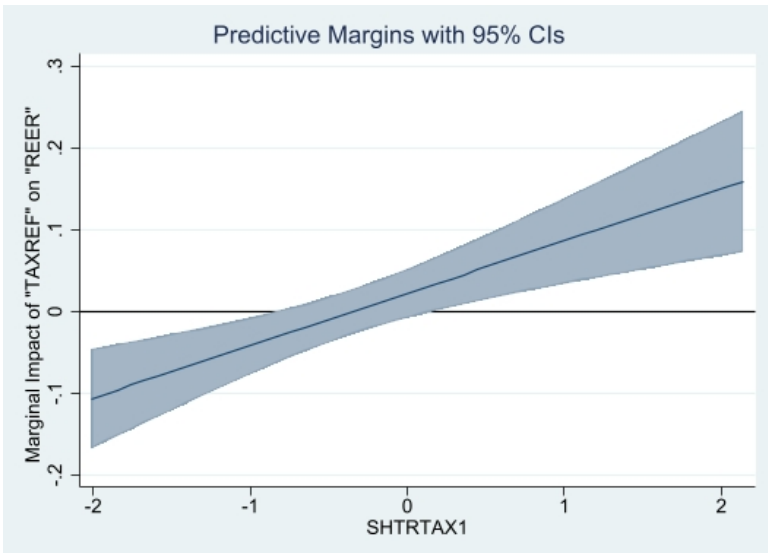
(Source) Author.

Considering the results in Table 3, we observe in the two columns that the interaction terms

11) This value of trade openness (i.e., "OPEN") is obtained as follows 98.3% [= 43.881*(0.47217) + 77.544]). The number "43.881" is the standard deviation of the indicator "OPEN" over the full sample. The number "77.544" is the mean (i.e., average) value of the indicator "OPEN" over the full sample. Finally, the value "0.47217" is the standardized value of the indicator "OPEN", which was extracted from the Stata software when constructing Figure 4.

related to the variables ["TAXREF*SHTRTAX1"] and ["TAXREF*SHTRTAX2"] are positive and significant at the 1% level, while the coefficients of the variable "TAXREF" are not significant at the 10% level. We deduce that on average over the full sample, tax reform is always associated with an appreciation of the real exchange rate, regardless of the share of trade tax revenue in non-resource tax revenue, or total public revenue. Additionally, the higher the share of trade tax revenue in non-resource tax revenue (or in total public revenue), the larger the magnitude of the positive effect of tax reform on the real exchange rate (i.e., the higher the real exchange rate appreciation effect of tax reform). Figures 6 and 7 show at the 95% confidence intervals, the marginal impact of tax reform on the real exchange rate respectively for varying shares of trade tax revenue in non-resource tax revenue, and varying shares of trade tax revenue in total public revenue. It appears that both Figures display similar patterns. In particular, Figure 6 shows that the marginal impact of tax reform on the real exchange rate appreciates as the share of trade tax revenue in non-resource tax revenue rises. This marginal impact has positive and negative values but is not always statistically significant. Tax reform is associated with a depreciation of the real exchange rate in countries whose share of trade tax revenue in non-resource tax revenue is lower than the value[12] of 7.36%. In contrast, it induces an appreciation of the real exchange

Figure 6. Marginal Impact of "TAXREF" on "REER" for varying shares of international trade tax revenue in non-resource tax revenue ("SHTRTAX1")

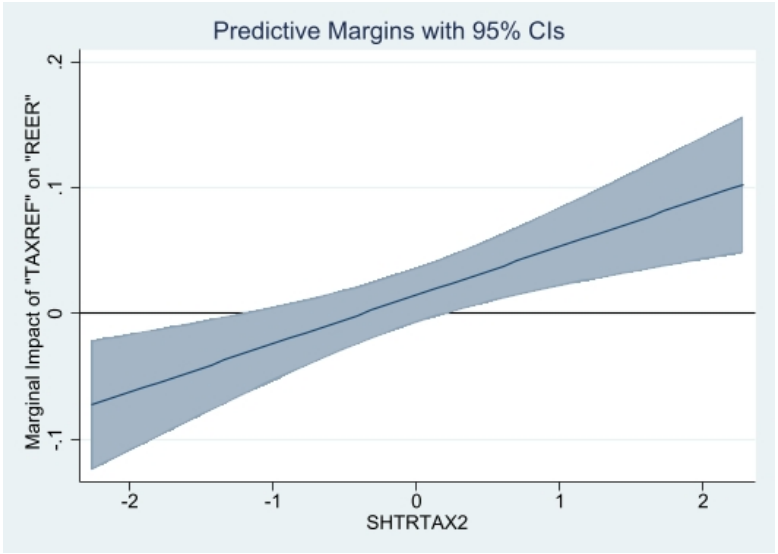


(Source) Author.

12) This value of the variable "SHTRTAX1" is obtained as follows 7.36% [= 16.517*(-0.8255) + 20.991]). The number "16.517" is the standard deviation of the indicator "SHTRTAX1" over the full sample. The number "20.991" is the mean (i.e., average) value of the indicator "SHTRTAX1" over the full sample. Finally, the value "-0.8255" is the standardized value of "SHRTAX1", which was extracted from the Stata software when constructing Figure 6.

rate in countries whose share of trade tax revenue in non-resource tax revenue is higher than the value[13] of 24.14%: for these countries, the higher the share of trade tax revenue in non-resource tax revenue, the larger is the magnitude of the real exchange rate appreciation effect of tax reform. Finally, countries whose share of trade tax revenue in non-resource tax revenue ranges between 7.36% and 24.14%, experience no significant effect of tax reform on the real exchange rate.

Figure 7. Marginal Impact of "TAXREF" on "REER" for varying shares of international trade tax revenue in total public revenue ("SHTRTAX2")



(Source) Author.

Figure 7 shows a pattern similar to that of Figure 6, with the difference, which lies in the values of the share of trade tax revenue in total public revenue, above which the effect of tax reform on the real exchange rate change sign. Here, tax reform is associated with an appreciation of the real exchange rate in countries whose share of trade tax revenue in total public revenue is higher than the value[14] of 14.8%. Otherwise (i.e., for values of this share lower than 14.8%), tax reform does not either have a significant effect on the real exchange rate or induces a depreciation of the real exchange rate (particularly for very low shares of trade tax revenue

13) This value of the variable "SHTRTAX1" is obtained as follows 24.14% [= 16.517*(0.1905) + 20.991]). The number "16.517" is the standard deviation of the indicator "SHTRTAX1" over the full sample. The number "20.991" is the mean (i.e., average) value of the indicator "SHTRTAX1" over the full sample. Finally, the value "0.1905" is the standardized value of "SHRTAX1", which was extracted from the Stata software when constructing Figure 6.

14) This value of the variable "SHTRTAX2" is obtained as follows 14.8% [= 11.500*(0.1438) + 13.148]). The number "11.500" is the standard deviation of the indicator "SHTRTAX2" over the full sample. The number "13.148" is the mean (i.e., average) value of the indicator "SHTRTAX2" over the full sample. Finally, the value "0.1438" is the standardized value of "SHRTAX2", which was extracted from the Stata software when constructing Figure 7.

in total public revenue).

Overall, following Table 3, tax reform tends to induce an appreciation of the real exchange rate in countries whose tax structures are highly dependent on international trade tax revenue. In contrast, in countries whose public revenue is less dependent on international trade tax revenue, tax reform is associated with a depreciation of the real exchange rate.

Finally, it is worth highlighting that with some exceptions, estimates of control variables across Tables 2 and 3 are consistent with those in Table 1.

VI. Conclusion

This article has shown that tax reform in developing countries, which involves reducing the tax structure's dependence on international trade tax revenue (which reflects a convergence of these countries' tax structure toward the tax structure of developed countries), - is associated with the depreciation of the real exchange rate. The magnitude of this depreciating effect is larger for advanced developing countries compared with relatively developing countries. However, the real exchange rate depreciation effect of tax reform depends on the level of trade openness. In particular, the magnitude of the real exchange rate depreciation effect of tax reform rises as countries enjoy a larger degree of trade openness. Interestingly, countries whose tax structure is highly dependent on trade tax revenue tend to experience a real exchange rate appreciation effect of tax reform, while countries with weak public revenue dependence on international trade tax revenue experience a real exchange rate depreciation effect of tax reform.

Considering the unavoidable liberalization of trade policies promoted at the multilateral level (including by the World Trade Organization) and its possible adverse effects on international trade tax revenue, governments in developing countries should reduce the dependence of their public revenue structure on international trade tax revenue, by strengthening the domestic revenue components of tax revenue. Pursuing the tax reform process in developing countries, notably in the context of higher trade openness, would lead to a depreciation of the real exchange rate. The latter would enhance the international competitiveness of countries' trading firms and encourage their export performance, especially through export diversification, which is key for economic growth and development in commodity-dependent countries. However, the real exchange rate depreciation may have adverse economic effects, such as a rise in public debt denominated in foreign currencies, but its positive effects on export performance (and hence on foreign exchange revenue) and economic growth may dominate its public debt rising effects.

We hope that this analysis opens up avenues for exploring other potential channels (than trade openness) through which tax reform can affect the movements of the real exchange rate in developing countries.

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Appendix

Table A1. *Definition and Source of Variables*

Variable	Definition	Source
REER	This is the measure of the real effective exchange rate (REER). It is computed using a nominal effective exchange rate based on 66 trading partners. An increase in the index indicates an appreciation of the REER, i.e., an appreciation of the home currency against the basket of currencies of trading partners.	Bruegel Datasets (see Darvas (2012a, 2012b)). The datatset could be found online at: http://bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/
TAXREF	This the index of convergence of the tax structure of a given developing country toward the developed countries' tax structure. Its values range between 0 and 1, with a rise in these values reflecting greater tax structure convergence, i.e., greater tax reforms.	Author's computation (see Section 3) based on data extracted from the 'UNU-WIDER Government Revenue Dataset'. Version 2021. https://doi.org/10.35188/UNU-WIDER/GRD-2021
OPEN	This is the measure of trade openness. It is calculated as the sum of exports and imports, in percentage of GDP.	World Development Indicators (WDI) of the World Bank.
OPENSW	This is the measure of trade openness suggested by Squalli and Wilson (2011). It is calculated as the measure of trade openness (the variable "OPEN" previously described) adjusted by the proportion of a country's trade level relative to the average world trade (see Squalli and Wilson, 2011: p1758).	Authors' calculation based on data from the WDI.
SHTRTAX1	This is the share (in percentage) of trade tax revenue in non-resource tax revenue. Non-resource tax revenue is the difference between total tax revenue (% GDP) (excluding social contributions) and tax revenue collected on natural resources (the latter includes a significant component of economic rent, primarily from oil and mining activities).	Author's calculation based on data extracted from the UNU-WIDER Government Revenue Dataset'. Version 2021. https://doi.org/10.35188/UNU-WIDER/GRD-2021
SHTRTAX2	This is the share (in percentage) of trade tax revenue in total public revenue. Total public revenue includes both tax and non-tax revenue, as well as grants and social contributions.	Author's calculation based on data extracted from the UNU-WIDER Government Revenue Dataset'. Version 2021. https://doi.org/10.35188/UNU-WIDER/GRD-2021
ODACST	This is the net real development aid, in constant 2019 US$ prices.	Database of the Organization for Economic Cooperation and Development (OECD)
GCONS	This is the general government final consumption expenditure (% of GDP).	Data on General government final consumption expenditure (% GDP) extracted from the WDI.
GFCF	Gross fixed capital formation (% of GDP)	WDI
BRMONEY	This is the broad money (% of GDP).	WDI
TERMS	This is the terms of trade, computed as the ratio of the export price index to import price index.	Author's calculation based on terms of trade data extracted from the WDI.
GDPC	GDP per capita (constant 2015 US$)	WDI

Table A2. *Pairwise Correlation among (Unstandardized) Variables used in the Model*

(a)

	REER	TAXREF	OPEN	OPENSW	SHTRTAX1	SHTRTAX2	GFCF
REER	1.0000						
TAXREF	-0.1528*	1.0000					
OPEN	-0.1027*	0.1935*	1.0000				
OPENSW	0.0077	0.1644*	0.4879*	1.0000			
SHTRTAX1	0.0890*	-0.6157*	-0.0483	-0.2068*	1.0000		
SHTRTAX2	0.0253	-0.3790*	-0.0295	-0.2102*	0.8725*	1.0000	
GFCF	-0.0654	0.1689*	0.2857*	0.2252*	-0.1791*	-0.2669*	1.0000
GCONS	-0.0745	0.3097*	0.2783*	-0.0729	0.0734	0.0079	0.1046*
TERMS	0.0299	-0.0722	-0.0622	-0.0587	-0.0963*	-0.1190*	0.0741
ODACST	0.0510	-0.0136	-0.3124*	-0.0848*	-0.1737*	-0.0940*	-0.0150
GDPC	0.0372	0.0984*	0.3601*	0.4780*	-0.0277	-0.2199*	0.1020*

Note. *p-value < 0.1.

(b)

	GCONS	TERMS	ODACST	GDPC
GCONS	1.0000			
TERMS	-0.0618	1.0000		
ODACST	-0.1763*	0.0258	1.0000	
GDPC	0.0828*	0.0289	-0.2933*	1.0000

Note. *p-value < 0.1.

Table A3. *List of Countries of the Full Sample*

Full Sample				LDCs
Albania	Equatorial Guinea	Mauritania	Tunisia	Angola
Algeria	Eritrea	Mauritius	Turkey	Bangladesh
Angola	Eswatini	Mexico	Uganda	Benin
Argentina	Fiji	Moldova	Ukraine	Bhutan
Armenia	Gabon	Mongolia	United Arab Emirates	Burkina Faso
Azerbaijan	Gambia, The	Morocco	Uruguay	Burundi
Bahamas, The	Georgia	Mozambique	Uzbekistan	Cambodia
Bangladesh	Guatemala	Namibia	Zambia	Central African Republic
Barbados	Guinea	Nepal		Chad
Belarus	Guinea-Bissau	Niger		Comoros
Belize	Guyana	Nigeria		Congo, Dem. Rep.
Benin	Haiti	North Macedonia		Eritrea
Bhutan	Honduras	Pakistan		Gambia, The
Bosnia and Herzegovina	Hong Kong SAR, China	Panama		Guinea
Botswana	India	Papua New Guinea		Guinea-Bissau
Brazil	Indonesia	Paraguay		Haiti
Brunei Darussalam	Iran, Islamic Rep.	Philippines		Lao PDR
Burkina Faso	Israel	Rwanda		Lesotho
Burundi	Jamaica	Saudi Arabia		Liberia
Cabo Verde	Jordan	Senegal		Madagascar
Cambodia	Kazakhstan	Serbia		Mali
Central African Republic	Kenya	Seychelles		Mauritania
Chad	Korea, Rep.	Sierra Leone		Mozambique
Chile	Kyrgyz Republic	Singapore		Nepal
China	Lao PDR	Solomon Islands		Niger
Comoros	Lebanon	South Africa		Rwanda
Congo, Dem. Rep.	Lesotho	Sri Lanka		Senegal
Congo, Rep.	Liberia	Sudan		Sierra Leone
Costa Rica	Libya	Syrian Arab Republic		Solomon Islands
Cote d'Ivoire	Madagascar	Tajikistan		Sudan
Dominican Republic	Malaysia	Tanzania		Tanzania
Ecuador	Maldives	Thailand		Uganda
El Salvador	Mali	Tonga		Zambia