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Omer, Muhammad; Kamal, Junaid; de Haan, Jakob

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RESEARCH ARTICLE

Does an exchange rate depreciation improve the trade balance of Pakistan?

Muhammad Omer[1] · **Junaid Kamal**[2] · **Jakob de Haan**[3,4]

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Abstract

We investigate the impact of an exchange rate depreciation on Pakistan's trade balance, using data for 1968–2019 in a simultaneous four equations model estimated by GMM. Our results suggest that a real exchange rate depreciation decreases imports and increases exports. However, as exports are also affected by imports, a real exchange rate depreciation not only has a depressing effect on imports but also on exports. The income elasticity of imports is high. Our findings imply that the Marshal–Lerner Condition does not hold for Pakistan. Moreover, we find that trade liberalization and the country's nuclear ambitions impacted Pakistan's trade balance.

Keywords Pakistan · Marshal–Lerner condition · Trade balance · Real exchange rate

JEL Classification F12 · F24 · F31 · F33

Abbreviations

GBP	British Pound
USD	US Dollar
SBP	State Bank of Pakistan
MLC	Marshall–Lerner condition
GMM	Generalized method of moments
3SLS	Three stage least square
SUR	Seemingly unrelated regressions
PKR	Pakistan Rupee
GBP	Great Britain Pound

✉ Muhammad Omer
muhammad.omer@sbp.org.pk

[1] Economic Policy Review Department, State Bank of Pakistan, I.I. Chundrigar Road, Karachi, Pakistan

[2] Economic Policy Review Department, State Bank of Pakistan, Karachi, Pakistan

[3] University of Groningen, Groningen, The Netherlands

[4] CESifo, Munich, Germany

IMF	International Monetary Fund
PERA	Pakistan Economic Reform Act
Ads	Authorized dealers
FCAs	Foreign currency accounts
FX	Foreign exchange
2SLS	Two stage least square
IV	Instrumental variable
GLS	Generalized least squares
OLS	Ordinary least squares
GDP	Gross Domestic Products

Introduction

Pakistan has experienced a number of balance of payments crises since its inception. In response, the country has frequently devalued its currency when it was fixed against the British Pound (GBP) and the US Dollar (USD). Likewise, it allowed the Rupee to depreciate vis-à-vis the USD after it had adopted a managed floating exchange rate regime in the early eighties. In 2018, Pakistan once again experienced a balance of payments crisis; the third in the last ten years. The Central Bank of Pakistan (SBP) allowed the Rupee to depreciate by fifty-two percent between November 2017 and June 2018, in line with the advice of donor agencies.

In the economic literature, exchange rate misalignments are considered the most common cause of balance of payments crises [16, 35]. A depreciation will push the real exchange rate towards its equilibrium level [42], which will reduce imports and raise exports thereby improving the country's trade balance [33]. However, the trade balance will only improve if the Marshall–Lerner Condition (MLC) holds, i.e., the sum of the import and export elasticities needs to be greater than one.[1]

In the long run, a depreciation may improve factor productivity and thereby enhance economic growth [13, 29, 36, 43, 44, 49]. As factor productivity and economic growth are driven by a myriad of other factors, the present study assesses the effectiveness of the SBP exchange rate policies by analyzing the impact of the real exchange rate on imports and exports. By providing estimates of import and export elasticities, we can test whether the MLC condition holds for Pakistan.

Our work contributes to the literature in the following ways. First, the determinants of exports, imports, the real exchange rate and foreign exchange reserves are modeled simultaneously. Previous research on the MLC has used import and export equations. We add equations for the exchange rate and foreign exchange reserves, as these variables not only affect imports and exports, but are also affected by imports

[1] The Marshal Lerner Condition has some limitations. First, it is an equilibrium condition while a depreciation of the exchange rate generally occurs when the economy is in disequilibrium. Second, the MLC is defined as a *ceteris paribus* condition, i.e., a depreciation is considered while keeping the currencies of competing economies unchanged. This often doesn't hold: a depreciation in one economy frequently triggers a depreciation of the currencies of competing economies.

and exports. Therefore, ignoring these feedback mechanisms on the trade balance may lead to misleading results. The system of equations is then used to estimate the import and export elasticity of the real exchange rate. Second, we incorporate three dummy variables, reflecting the periods spent by Pakistan under IMF programs, the financial liberalization carried out since 1992, and the country's decision to detonate nuclear devices in 1998 which led to trade sanctions, respectively. These events may have had a profound impact on Pakistan's trade balance, but their contributions have never been quantified before.

We use the system generalized method of moments (GMM) estimator to deal with endogeneity and simultaneity. The exchange rate, imports, exports, and foreign exchange reserves are strongly related, causing serious endogeneity problems. GMM provides consistent and efficient estimates in the presence of one or more endogenous regressors. We use annual data from 1968 to 2019. Our findings suggest that a depreciation of the real exchange rate increases exports and decreases imports. In addition, we find that imports affect exports indicating that the decrease in imports in response to a real exchange rate depreciation is likely to have a depressing effect on exports. Moreover, our results suggest that the income elasticity of imports is very high. Overall, our findings show that a depreciation of the real exchange rate does not improve the trade balance, i.e., the Marshal–Lerner Condition does not hold for Pakistan. As a robustness check, we also estimate our model using three stage least square (3SLS) and seemingly unrelated regressions (SUR) estimators. The outcomes are similar to the GMM estimates, suggesting that our results are robust.

The rest of the paper is structured as follows. Section "Stylized facts about the exchange rate and trade dynamics in Pakistan" discusses the exchange rate dynamics in Pakistan, while Section "Literature review" presents a brief literature review. Section "Model" provides analytical details of the model, and Section "Methodology" discusses the methodology adopted. Section "Results" presents the estimation results, while Section "Conclusion" offers our conclusions.

Stylized facts about the exchange rate and trade dynamics in Pakistan

Pakistan pursued a fixed exchange rate regime from 1947 to 1981. During this period, the Pakistan rupee (PKR) was initially pegged to the GBP until 1971, after which Pakistan pegged its currency to the USD. Subsequently, the country adopted a managed floating regime in 1982 under which the central bank frequently intervened in the foreign exchange market to stabilize the rupee-dollar exchange rate.

Figure 1 shows the USD-PKR exchange rate and Pakistan's exports and imports. Except for a few years at the beginning of the sample, Pakistan's trade balance was negative during most of the period despite the frequent devaluations/depreciations against the US dollar. In fact, the trade deficit has widened in the last two decades. The persistent trade deficit forced the country to frequently ask for IMF support. Although Fig. 1 suggests that Pakistan's exports and imports are correlated with the exchange rate, drawing a causal inference on the economic relationship between these variables needs further investigation.

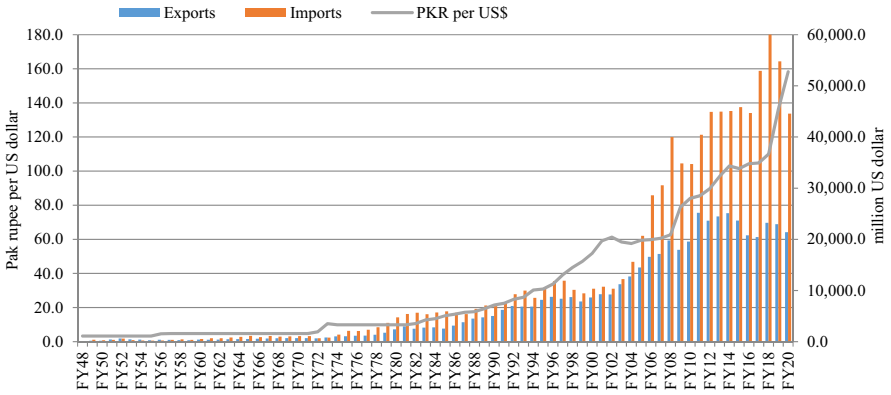

Fig. 1 The USD-PKR exchange rate and Pakistan's imports and exports, 1948–2020

The relationship between the exchange rate and the trade balance may have been affected by the following three events which we take into account in our model: (1) Pakistan's recourse to the IMF for balance of payment support; (2) The financial liberalization undertaken since 1992; and (3) Pakistan's decision to detonate nuclear devices in 1998, which resulted in (trade) sanctions. In the remainder of this section, we discuss these events in more detail.

Pakistan asked for IMF support for the first time in 1958, but the country did not utilize the total amount agreed upon under the package. Later on, in 1965 and in 1968, Pakistan entered into two other IMF programs. This time, Pakistan drew a significant part of the amount agreed upon for support. Since then, the country has on 22 occasions requested IMF support. Table 6 in the Appendix provides details of IMF programs Pakistan agreed upon. The latest IMF program started in May 2019. These IMF programs impose certain conditions to improve the recipient's macroeconomy, which often lead to drastic cuts in consumption. Consequently, the country's trade balance may have been affected by these IMF programs.

Although a financial liberalization process was initiated in 1989 and privatization of nationalized commercial banks started in 1991, the reform process in the foreign exchange market only started with the introduction of the Pakistan Economic Reform Act (PERA) of 1992. This reform aimed to promote industrialization by creating an environment conducive to domestic and foreign investment, trade and foreign exchange resource mobilization. For this purpose, various fiscal incentives such as tax holidays, tariff cuts and other profit augmenting opportunities to stimulate exports were introduced. Pakistan turned from an inward to an outward looking development strategy. A wide-ranging privatization program was initiated that opened up areas of the economy previously reserved for the public sector.

Pakistan gradually reduced its trade tariff rates from a maximum of 225% in 1986–87 to 70% in 1994–95. Later on, the maximum tariff was reduced further to 45% and 13 duty rates were merged into a five-band system. Moreover, barring a few items, the 10% regulatory duty was eliminated. As a result of these reforms, the average rate of import duties is estimated to have fallen from 19 to 17% between

1992 and 96 [54]. Moreover, Pakistan adopted an invoice-based system for determining the value of imports for custom purposes, replacing the previously used system of import trade prices. This removed a significant trade barrier, as the previous system led to higher tariffs due to overstating imports.

The condition for obtaining a license to import was abolished. Those registered with the trade promotion bureau were permitted for up to US$10,000 imports without letters of credit or registering the invoices or orders with authorized dealers (ADs). Exporters were allowed to retain part of the foreign currency proceeds for their personal use instead of selling all these proceeds to the ADs. Moreover, participants in international trade fairs/exhibitions were allowed to obtain foreign exchange without prior approval [46].

In addition, residents were allowed to open and operate foreign currency accounts (FCAs) with banks in Pakistan. The foreign exchange deposited in these accounts was not only freely transferable abroad, but was also exempted from income and wealth tax and disclosure requirements. In order to encourage foreign investment, restrictions on capital inflows and outflows were also liberalized [46].

Following nuclear tests on 28 and 30 May 1998, Pakistan faced economic sanctions by certain countries and multilateral institutions. This created a state of uncertainty, especially regarding Pakistan's ability to meet its external obligations. The resulting balance of payments crisis was addressed by extensive controls on foreign exchange transactions. Foreign currency accounts were frozen temporarily and capital outflows were discouraged by limiting the power of authorized dealers for sending outward remittances. To curb imports, several restrictive measures were introduced.

Literature review

The literature assessing the impact of an exchange rate depreciation on trade has either tested the Marshall–Lerner condition (notable examples are Goldstein and Khan [18], Rose [45], Andersen [4], Reinhart [42], Mahmud et al. [30]; Prawoto [39]) or examined the so-called J-curve (cf. Noland [34], Bahmani-Oskooee and Kara [11], Akbostanci [2], Rehman and Afzal [41]). According to the latter line of literature, a country's trade deficit will initially worsen after a depreciation of its currency, mainly because higher prices on imports will be greater than the reduced volume of imports. We refer to Bahmani-Oskooee and Hegerty [9] for a review of the literature related to the J-curve.

Initially, studies on the MLC assessed its validity mostly in a multi-currency/country setup. However, Marquez [31] shows large differences in the estimates of bilateral elasticities and this information is lost when aggregated data are used. Likewise, focusing on multilateral elasticities implies losing valuable information for both policy applications (like estimating optimal bilateral tariffs) and empirical analyses of international trade (like predicting the change in the distribution of global imbalances in response to changes in income and prices).

Studies using bilateral exchange rates have progressed in two distinct directions [10, 32]. One strand of the literature has used bilateral trade data (examples include

Bahmani-Oskooee and Brooks [8], Wilson et al. [52], Mahmud et al. [30], Irandoust et al. [23], Jamilov [24]), while another strand has employed aggregate trade data between one country and the rest of the world (cf. Hasan and Khan [20], Gomes and Paz [19], Matesanz and Fugarolas [32], Turkay [51], Lucy et al. [28], Caporale et al. [14]).

Importantly, the first strand suffers from two problems. First, international trade is invoiced in the dominant currency, which is mostly the US dollar [15]. The literature on the 'dominant currency paradigm' suggests that currency fluctuations are highly influenced by the US dollar [12]. There is a disconnect between trade pricing in practice and many theoretical models in which international trade is assumed to be conducted in prices expressed either in the domestic or the trading partner's currency. Therefore, bilateral trade between countries is not only dependent on the exchange rate between these two countries but also on US dollar movements, which many of these studies have ignored.

Second, even if the influence of the US dollar is controlled for, most studies on bilateral trade have ignored third country effects, and therefore, the impact of global value chains on bilateral trade. Recent studies assessing the MLC at the commodity/item level between the trading partners suffer from a similar problem (for instance, Bahmani-Oskooee and Hosny [10]; Bahmani-Oskooee and Baek [7]). In our research, we therefore follow the second strand of literature, which assesses the MLC using trade of one country with the rest of the world. Next, we will briefly review some recent studies in this strand of literature.

The conclusions drawn in these studies testing whether the MLC holds are mixed. For example, Gomes and Paz [19] investigated whether a real exchange rate devaluation improves the trade balance in Brazil between 1990 and 1998. Their results suggest that the MLC holds in Brazil. Matesanz and Fugarolas [32] addressed the same research question for Argentina using data for 1962–2005. Their findings show that the MLC doesn't hold over this period in Argentina.

Caporale et al. [14] test the MLC hypothesis for Kenya using quarterly data from 1996Q1 to 2011Q4. The results suggest that the MLC holds in the long run. However, convergence to the long is relatively slow. Pandey [37] verify the MLC for India and find that it holds using data from 1993 to 2011.

Interestingly, in this strand of literature only two relevant studies that investigate the MLC for Pakistan could be identified, namely Hasan and Khan [20], and Yasmeen and Hafeez [53]. Hasan and Khan [20] examine if the exchange rate policy has improved the trade balance in Pakistan between 1972 and 1991. They report that the MLC holds. Yasmeen and Hafeez [53] explore the relationship between the trade balance and the terms of trade. Their estimates suggest that the MLC does not hold for Pakistan, neither in the short nor in the long run.[2]

[2] Other studies assessing whether the MLC holds for Pakistan mostly focus on bilateral trade (for example, Akhtar and Malik [3], Aftab et al. [1], Iqbal et al. [22], and Shahzad et al. [48]). These studies use different trading countries and time periods.

Model

Most studies examining the impact of an exchange rate depreciation on trade have used (i) the real exchange rate [14, 21] and (ii) reduced form equations for imports and/or exports [6]. The present study comes up with models for real imports and exports in line with existing practice. In addition, we estimate models for foreign exchange (FX) reserves and the real exchange rate to control for endogeneity and simultaneity. Limited availability of FX reserves may constrain imports, while imports and exports affect the amount of FX reserves. Therefore, ignoring FX reserves and the real exchange rate may create endogeneity issues. We include several control variables in each model based on economic theory and Pakistan's particular circumstances. Specifically, we incorporate three dummy variables: (1) *IMF*, which is one when Pakistan had an IMF program (for periods of these program, see Table 6 in the Appendix); (2) *Liberalization*, which is one from 1992 onwards; and (3) *Nuclear test*, which is one from 1998 onwards when Pakistan conducted nuclear tests. These variables are included in each equation. The details of all variables used are provided in Table 7 in the Appendix, while Table 8 and Table 9 provides summary statistics and correlation matrix, respectively.

Imports equation

Equation (1) shows the import demand model:

$$\begin{aligned}\text{Imports} = {} & \beta_0 + \beta_1 \text{Real exchange rate} + \beta_2 \text{Pak GDP} \\ & + \beta_3 \text{FX reserves} + \beta_4 \text{Concentration} \\ & + \beta_5 \text{Crude oil prices} + \beta_6 \text{IMF} \\ & + \beta_7 \text{Nuclear test} + \beta_8 \text{Liberalization} + \varepsilon_{1t}\end{aligned} \tag{1}$$

where the expected sign are as follows: $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 < 0$, $\beta_5 > 0$, $\beta_6 < 0$, $\beta_7 < 0$ $\beta_8 > 0$.Imports is the log of the index of imports (1990–91 = 100). Real exchange rate is the nominal exchange rate multiplied by the ratio of the CPI in the World and the CPI in Pakistan, and Pak GDP is Pakistan's real GDP in US dollars. We also include FX reserves, Concentration (i.e., the share of imports from China in Pakistan's total imports), Crude oil prices, and the three dummy variables as discussed above. FX Reserves, defined as Pakistan's liquid foreign exchange reserves (excluding gold) in US dollar, are taken up to capture restrictions on imports that developing economies face if their reserves are low. We use the lag of FX reserves for this purpose. Concentration captures the rise of China as a manufacturing powerhouse which coincided with a rapid rise in Pakistan's imports from China. It is defined as Pakistan's imports from China as percentage of total imports. Crude oil

prices are included to capture its impact on imports. For instance, a surge in crude oil prices leads to a strong increase in Pakistan's imports.[3]

Exports equation

We follow previous studies, but add imports as a determinant of exports as a significant part of exports uses imported raw material as input.[4] Many countries have a high import intensity of exports, i.e., use imports to produce exports (Badar, 2006). The export demand function is given by:

$$\begin{aligned}\text{Exports} = {} & \beta_9 + \beta_{10}\text{Real exchange rate} + \beta_{11}\text{Imports} \\ & + \beta_{12}\text{World GDP} + \beta_{13}\text{IMF} \\ & + \beta_{14}\text{Nuclear test} + \beta_{15}\text{Liberalization} + \varepsilon_{2t}\end{aligned} \tag{2}$$

where Exports is the log of the index of exports (1990–91 = 100), while World GDP denotes World GDP in US dollar. It captures demand for Pakistan's exports.[5] The expected signs are as follows: $\beta_{10} > 0$, $\beta_{11} > 0$, $\beta_{12} > 0$, $\beta_{13} < 0$, $\beta_{14} < 0$, $\beta_{15} > 0$.

Exchange rate equation

The *Real exchange rate* is explained by imports and exports. We also include crude oil prices and remittances as these are expected to influence the real exchange rate significantly. Specifically, an increase in the *Crude oil price* causes domestic prices to rise which may lead to an appreciation of the real exchange rate. Pakistan is the seventh largest recipient of remittances in the world. The inflow of workers' remittances leads to an appreciation of the exchange rate. Therefore, both *Crude oil prices* and *Remittances* have been included in the real exchange rate equation besides the three dummy variables discussed above. The model is given by:

$$\begin{aligned}\text{Real exchange rate} = {} & \beta_{16} + \beta_{17}\text{Exports} + \beta_{18}\text{Imports} \\ & + \beta_{19}\text{Crude oil prices} + \beta_{20}\text{Remittances} \\ & + \beta_{21}\text{IMF} + \beta_{22}\text{Nuclear test} \\ & + \beta_{23}\text{Liberalization} + \varepsilon_{3t},\end{aligned} \tag{3}$$

where the expected signs are as follows: $\beta_{17} < 0$, $\beta_{18} > 0$, $\beta_{19} > 0$, $\beta_{20} < 0$, $\beta_{21} > 0$, $\beta_{22} > 0$, $\beta_{23} > 0$.

[3] Some studies, including Razafimahefa and Hamori [40], include tariffs in the import demand function. We refrain from doing so, for two reasons. First, tariffs generally have limited variability. Second, we use a dummy variable for liberalization that captures significant changes in tariffs.

[4] More than 80% of Pakistan's imports in FY21 consists of raw materials and capital goods which are used for producing exportable goods.

[5] Alternatively, GDP of Pakistan's trading partners could have been used. However, we prefer world GDP, as Pakistan's key trading partners (USA, European Union and China) cover a significant part of the world GDP.

Foreign exchange reserves equation

FX reserves, being the residual of the balance of payments, is essentially a function of Imports, Exports, and the Real exchange rate. We also include Concentration, Remittances and the three dummy variables discussed above. The increasing share of China in Pakistan's imports is likely to reduce pressure on Pakistan's FX reserves for two reasons. First, imports from China were relatively cheaper, and second, Pakistan has a currency swap agreement with China since 2011 under which Pakistani importers are allowed to pay for Chinese goods in local currency. For these reasons, the variable Concentration is included in the model for foreign reserves. We use lags of imports and exports. The model is given by:

$$\begin{aligned}\text{FX Reserves} = {} & \beta_{24} + \beta_{25}\text{Real exchange rate} + \beta_{26}\text{Exports}\,(-1) \\ & + \beta_{27}\text{Imports}\,(-1) + \beta_{28}\text{Concentration} \\ & + \beta_{29}\text{Remittances} + \beta_{30}\text{IMF} + \beta_{31}\text{Nuclear test} \\ & + \beta_{32}\text{Liberalization} + \varepsilon_{4t},\end{aligned} \tag{4}$$

where the expected signs are as follows: $\beta_{25}>0$, $\beta_{26}>0$, $\beta_{27}<0$, $\beta_{28}<0$, $\beta_{29}>0$, $\beta_{30}>0$, $\beta_{31}>0$, $\beta_{32}>0$.

Methodology

After the seminal contributions of Khan [27] and Goldstein and Khan [18], studies testing the MLC mostly employed structural equation modeling [two-stage least squares (2SLS) or three-stage least squares (3SLS)] to deal with the endogeneity of some variables. More recent studies have used cointegration analysis, following the Engle and Granger [17] or Johansen and Juselius [26] approach, or the ARDL approach of Pesaran et al. [38]. These techniques make assumptions about the distribution of the underlying data generating processes which requires a large sample size for asymptotic convergence of estimators. However, most studies using cointegration suffer from the small sample problem.[6] Moreover, if the normality assumptions do not hold, inferences may not capture the economic relationships investigated.

When the estimation involves the exchange rate, which has strong linkages to almost every sector of the economy, endogeneity may become a serious concern due to the feedback mechanisms between variables included in the model. To circumvent these problems, this study employs a system generalized method of moments

[6] For example, Toda and Yamamoto [50] notes that the finite sample properties of the Johansen [25] likelihood ratio tests for cointegrating ranks is sensitive to the value of the stationary root(s) of the process. Moreover, the performance of the test crucially depends on the correlation between the innovations that drive both the stationary and non-stationary components of the process. The author concludes that 100 observations are not sufficient to ensure a reasonably good performance of the test statistic.

(GMM) estimator which provides consistent and efficient estimates in case of one or more endogenous regressors. More importantly, GMM does not require full information of the distribution of the data unlike simultaneous equation models (2SLS or 3SLS) or cointegration models. Instead, it exploits the moment conditions by making assumptions about specific moments of the random variables. This makes that GMM estimates more efficient.

Assume that Eq. (5), shown in matrix notation, is to be estimated,

$$y = X\beta + u, \tag{5}$$

where,$E(uu) = \Omega$, and the regressor matrix X is of order nxK where n is the number of observations. Moreover, let us assume that K_1 is a group of endogenous regressors included in X_1 and (K-K_1) are the remaining exogenous regressors included in X_2. The full set of instrumental variables Z is assumed to be exogenous, i.e., $E(Z_i u_i) = 0$ with order nxL. The matrix Z is partitioned into (Z_1, Z_2), where the Z_1 matrix includes a set of L_1 instruments for the endogenous variables and the remaining ($L - L_1$) instruments in Z_2 matrix are set of exogenous instruments.

A GMM estimator can be obtained as follows:

$$\beta_{\mathrm{GMM}} = \left(X' ZWZ' X\right)^{-1} X' ZWZ' y, \tag{6}$$

with the distribution of the variance covariance matrix given by,

$$V\left(\widehat{\beta}_{\mathrm{GMM}} = \frac{1}{n}\left(Q'_{XZ} W Q_{XZ}\right)^{-1}\left(Q'_{XZ} WSW Q_{XZ}\right)\left(Q'_{XZ} W Q_{XZ}\right)^{-1}, \right. \tag{7}$$

where W is the optimal weighing matrix and S is the covariance matrix of the moment condition, that is $S = \frac{1}{n} E(Z' uu' Z)$. In our research, imports, exports, the real exchange rate and FX reserves are endogenous variables, which are instrumented using their lags mostly. In addition, the set of exogenous variables include the dummy variables.

It is important to note that we use System GMM, in which two or more variables are explained jointly through a system of simultaneous equations; similar to 2SLS and instrumental variable (IV) approaches. When a complete system of structural equations is specified, assuming the equations are specified correctly, joint estimation of all the equations provide estimates more efficient than equation by equation 2SLS/3 SLS or SUR estimators.

For robustness purposes, this study also reports estimates using 3SLS and seemingly unrelated regressions (SUR). Both 3SLS and SUR are K-class estimators used to obtain parameter estimates of the structural equations. However, these estimators require the distribution of the error terms to be normal. The 3SLS procedure also uses an instrumental-variables approach to produce consistent estimates and employs generalized least squares (GLS) to account for the correlation structure

in the disturbances across the equations. The 3SLS estimates of a set of nonlinear equations are consistent, asymptotically normal, and, under some conditions, asymptotically more efficient than single equation estimates. Similarly, the SUR model exploits the fact that the individual equations are related to one another. This is a generalization of a linear regression model that consists of several regression equations, each having its own dependent variable and potentially different sets of exogenous explanatory variables. The SUR model is a particular case of simultaneous equations using feasible generalized least squares with a specific form of the variance–covariance matrix. The estimates obtained are consistent and efficient compared to ordinary least squares (OLS) estimates.

Results

This study uses data from FY1968[7] to FY2019.[8] For estimation, all non-dummy variables have been used in its logarithm form. Table 10 in the Appendix provides unit root test results. All variables are found to be stationary in levels, except Crude oil prices and Pakistan GDP. The unit root test statistics for crude oil price is significant at 12% level and hence could be considered as stationary. Similarly, statistics for Pak GDP (innovative outlier test) is very close to the 10% critical value and could be safely considered level stationary. For the unit root tests, we have used both conventional unit root tests (Dickey–Fuller and Philips–Perron tests) and unit root tests incorporating structural breaks. Test statistics suggest that some of the variables experienced significant structural shifts. After controlling for structural breaks, these variables are found to be stationary in levels. Importantly, the period of the shifts identified are in the vicinity of the events when financial liberalization was undertaken, Pakistan detonated a nuclear device, or entered in some IMF program. Therefore, the dummies incorporated in the model adequately control for these shifts.

Tables 1, 2, 3 and 4 show the model estimates of the four variables of interest, i.e., imports, exports, the real exchange rate, and FX reserves using GMM. The signs of most of the estimated coefficients are in line with our expectations. We use the Sargan–Hansen test for over-identifying restrictions; the outcomes are reported in the lower panel of the tables. The joint null hypothesis that the instruments are valid cannot be rejected at the 5% significance level. The 3SLS and SUR estimates are provided as a robustness check. For 3SLS and SUR, we test the stationarity of the residuals of each equation. These residuals are mostly stationary or are close to stationary (results available on request). For the SUR estimates, we use the Breusch-Pagan test for independence of the equations. The null hypothesis that the equations are independent is rejected at the 5% significance level.

[7] The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

[8] We used annual data as quarterly data for most of the trade variables are available only since last two decades. Moreover, Pakistan's GDP is available only at annual frequency.

Table 1 Estimates of the model for imports

	GMM	3SLS	SUR
Real exchange rate	– 0.2992* (0.000)	– 0.2739* (0.000)	– 0.2989* (0.000)
Pak GDP	1.7250* (0.000)	1.6899* (0.000)	1.7349* (0.000)
FX Reserves (− 1)	0.0348* (0.047)	0.0383* (0.019)	0.0359* (0.039)
Concentration	– 0.0169 (0.703)	– 0.0510 (0.283)	– 0.0562 (0.195)
Crude oil prices	0.3138* (0.000)	0.3624* (0.000)	0.3566* (0.000)
IMF	– 0.0229 (0.214)	– 0.0409** (0.072)	– 0.0396** (0.078)
Nuclear test	– 0.1526* (0.001)	– 0.2072* (0.000)	– 0.2006* (0.000)
Liberalization	0.2046* (0.000)	0.2335* (0.001)	0.2473* (0.000)
Intercept	– 5.4577* (0.000)	– 5.4762* (0.000)	– 5.5761* (0.000)
Diagnostics			
R-square		0.9961	0.9962
Chi-square statistics		12,495.4*	12,698.5*
p-value		(0.000)	(0.000)
Tests			
Test of over-identifying restrictions: Chi-square	17.7426 (0.124)		
Breusch–Pagan test of independence: Chi-square			31.105* (0.000)

This table shows estimates for Eq. (1) using system GMM, 3SLS and SUR estimators. Model diagnostics show the fit of the model and the stationarity of the errors when estimates are obtained using 3SLS and SUR. For GMM, the Chi-square test statistic shows the outcome of Hansen's *J*-test for over-identifying restrictions. The null hypothesis is that all included instruments are relevant. The null hypothesis for the Breusch–Pagan test is that the equations included in the system are independent

p-values are shown in brackets. * and ** indicate 5% and 10% level of significance, respectively

Imports equation

Table 1 shows the estimates of the model for imports, which are mostly in line with theory. For example, a depreciation of the real exchange rate by 1% leads to a decrease of almost 0.30% of imports. Moreover, the income elasticity of imports is positive and large and similar across all three estimates. To be more specific, an increase in real income (Pak GDP) of 1% leads to around an increase in imports of 1.7 percent. This result may reflect that under Pakistan's tax system high-income people do not see their taxes increase in line with the increase of their income. As a consequence, high-income earners demand more imported goods, specifically consumer goods, so that imports strongly increase with income.

The coefficient of FX reserves appears significant (at the 5% significance level) suggesting that the level of last year's FX reserves has an impact on the country's imports, though it is low. This supports our hypothesis that the developing economies imports are constrained by the level of their FX reserves. The coefficient of Concentration, on the other hand, is negative (as expected) but insignificant.

Table 2 Estimates of the model for exports

	GMM	3SLS	SUR
Real exchange rate	0.4898* (0.000)	0.4967* (0.000)	0.5529* (0.000)
Imports	0.8527* (0.000)	0.7009* (0.000)	0.7190* (0.000)
World GDP	– 0.8606** (0.051)	– 0.4754* (0.031)	– 0.6200* (0.011)
IMF	0.0218 (0.491)	0.0286 (0.406)	0.0276* (0.420)
Nuclear test	– 0.0345 (0.565)	– 0.0490 (0.433)	– 0.0419* (0.511)
Liberalization	– 0.0525 (0.485)	– 0.1051 (0.188)	– 0.1644 (0.040)
Intercept	7.3851* (0.084)	3.6439** (0.090)	4.9843* (0.035)
Diagnostics			
R-square		0.9900	0.9893
Chi-square statistics		4915.6*	4947.9*
p-value		(0.000)	(0.000)
Overall test			
Test of over-identifying restrictions: Chi-square	17.7426 (0.124)		
Breusch–Pagan test of independence: Chi-square			31.105* (0.000)

This table shows estimates for Eq. (2) using system GMM, 3SLS and SUR estimators. See the notes to Table 1 for further explanation

Table 3 Estimates of the model for the real exchange rate

	GMM	3SLS	SUR
Crude oil prices	– 0.3770* (0.000)	– 0.2138* (0.001)	– 0.2516* (0.000)
Imports	– 0.6406 (0.159)	– 0.7408* (0.000)	– 0.5076* (0.001)
Exports	1.9362* (0.000)	1.8709* (0.000)	1.6173* (0.000)
Remittances	– 0.1316 (0.365)	– 0.0707 (0.120)	– 0.0789 (0.154)
IMF	– 0.0179 (0.785)	– 0.0178 (0.767)	– 0.0054 (0.924)
Nuclear test	0.3897* (0.000)	0.2832* (0.002)	0.2989* (0.001)
Liberalization	– 0.1306 (0.469)	0.1130 (0.437)	0.2047 (0.136)
Intercept	2.6052* (0.000)	2.2767* (0.000)	2.2610* (0.000)
Diagnostics			
R-square		0.9713	0.9755
Chi-square statistics		1980.9*	2176.9*
p-value		(0.000)	(0.000)
Overall test			
Test of over-identifying restrictions: Chi-square	17.7426 (0.124)		
Breusch–Pagan test of independence: Chi-square			31.105* (0.000)

This table shows estimates for Eq. (3) using system GMM, 3SLS and SUR estimators

See the notes to Table 1 for further explanation

Table 4 Estimates of the model for FX reserves

	GMM	3SLS	SUR
Real exchange rate	0.3915 (0.254)	– 0.2261 (0.489)	– 0.1022 (0.732)
Remittances	0.4049 (0.159)	0.8339* (0.000)	0.8733* (0.000)
Exports (-1)	– 0.8999 (0.144)	0.4227 (0.466)	0.1892 (0.733)
Imports (-1)	0.2591 (0.641)	– 1.0180* (0.026)	– 0.9583* (0.036)
Concentration	0.6002* (0.034)	0.5138* (0.014)	0.5510* (0.008)
IMF	0.1127 (0.441)	0.1360* (0.351)	0.1345* (0.356)
Nuclear test	1.1221* (0.001)	1.2035 (0.000)	1.1589* (0.000)
Liberalization	0.6805 (0.193)	1.0898* (0.009)	1.0984* (0.007)
Intercept	– 2.0314* (0.032)	0.0666 (0.929)	– 0.1647 (0.815)
Diagnostics			
R-square		0.9000	0.9017
Chi-square statistics		455.7*	457.6*
p-value		(0.000)	(0.000)
Overall test			
Test of over-identifying restrictions: Chi-square	17.7426 (0.124)		
Breusch–Pagan test of independence: Chi-square			31.105* (0.000)

This table shows estimates for Eq. (4) using system GMM, 3SLS and SUR estimators

See the notes to Table 1 for further explanation

The coefficient of Crude oil prices appears positive, significant and consistent in all three estimates. A 1% increase in Crude oil prices leads to an increase in Pakistan's imports of 0.31%. Among the dummy variables, the impact of Liberalization is positive while that of Nuclear test is negative. The coefficients of both variables are significant at the 5% level. These results suggest that while financial liberalization has led to an increase in imports, the nuclear tests had the opposite impact on Pakistan's imports.

Exports equation

Table 2 shows the estimates of the model for exports. As expected, the coefficient of the *Real exchange rate* is positive and significant, suggesting that a 1% depreciation of the real exchange rate leads to almost 0.49% increase in Pakistan's exports. Besides, the results in Table 2 suggest that the import propensity of exports is positive and significant. A 1% increase in imports raises exports by almost 0.85%. This result is in line with the findings of Bader [5] for the 1973–2005 period. It thus suggests that although a depreciation of the real exchange rate depresses Pakistan's imports, it also has a negative impact on the country's exports.

Table 5 Marshal Lerner condition

	Real exchange rate
GMM	– 0.2111* (0.017)
3SLS	– 0.2294* (0.011)
SUR	– 0.1482** (0.070)

This table shows whether the MLC holds using the coefficients in Tables 1 and 2 for the elasticity of imports (β_1) and exports (β_{10}), respectively, for the respective estimators (i.e., GMM, 3SLS and SUR)

The coefficient of World GDP is insignificant at 5% level. The coefficients of all dummy variables are also insignificant indicating that these factors had no effect on Pakistan's exports in our sample period.

Real exchange rate equation

Table 3 shows the estimates of the model for the real exchange rate. Not surprisingly, the coefficient of Crude oil *prices* is negative and significant indicating that a 1% increase in the price of crude oil leads to an appreciation of the real exchange rate of almost 0.38 percent. Since domestic energy prices follow crude oil prices, any increase in the price of crude oil generally increases the domestic price level; this inflation leads to an appreciation of the real exchange rate.

Moreover, the coefficient of Exports appears to be significant and positive. A 1% increase in exports leads to a depreciation of the real exchange rate by almost 1.9 percent. The results in Table 2 suggest that Pakistan's exports strongly depend on imports. Any increase in export creates an increased demand for imports, causing an increased demand for foreign exchange. This, in turn, leads to a depreciation of the real exchange rate. Imports, on the other hand, have an insignificant effect on real exchange rate; although, estimates of 3SLS and SUR shows its significant impact. Probably, higher imports sets in expectation of higher exports and may lead to the appreciation of exchange rate.

The coefficient of remittances appears insignificant. Among the dummy variables, only nuclear test has a significant effect on Pakistan's real exchange rate. Contrary to the general perception, IMF programs have no significant impact on Pakistan's real exchange rate.

Foreign exchange reserves equation

Table 4 shows the estimates of the model for foreign exchange reserves. The coefficients of real exchange rate, Imports, and Exports are insignificant at the 5 the percent in the GMM estimates, while the coefficient of Imports is significant in in the 3SLS and SUR estimates. The coefficients of Concentration and Remittances are significant (albeit for the latter only in in the 3SLS and SUR estimates.

The coefficient of Nuclear test is significant at the 5% level indicating that reserves have increased by 1.1% since Pakistan conducted nuclear tests in 1998.

Immediately after the nuclear test, Pakistan faced sanctions which depleted its foreign exchange reserves. However, as the situation improved later on and sanctions were lifted, the country saw a record accumulation of reserves. The coefficients of Liberalization, and IMF are insignificant in the GMM estimates, but are significant in the in the 3SLS and SUR estimates.

Marshal Lerner condition

Our estimations allow to assess whether the MLC holds for Pakistan, i.e.:

$$\beta_1(\text{Imports}) + \beta_{10}(\text{Exports}) - 1 > 0$$

Table 5 shows the estimates of the Marshal-Lerner condition (MLC). The null hypothesis that the sum of the import and export elasticities of the real exchange rate is greater than one is rejected for all models, independent of the estimator used. In other words, our findings suggest that a real exchange rate depreciation does not improve Pakistan's balance of payments position.

Conclusion

We have investigated the impact of an exchange rate depreciation on Pakistan's exports and imports. To control for endogeneity and simultaneity, we have used system GMM to estimate equations for exports, imports, the real exchange rate, and foreign reserves over the 1968–2019 period.

Our findings suggest that a depreciation of the real exchange rate increases exports and decreases imports. However, we fail to find support for the Marshall-Lerner Condition, suggesting that a real exchange rate depreciation does not improve Pakistan's balance of trade. It is important to mention two caveats. First, the MLC assumes an equilibrium condition with no balance of payment crisis. However, our assessment is based on a period when Pakistan frequently faced balance of payment crises. Second, the MLC assumes that the currencies of competing economies remain unchanged. This generally doesn't hold in the real world: a depreciation of one currency often triggers depreciations of currencies of competing economies.

Finally, in the wake of balance of payment crises, economies adopt various policy measures besides depreciating their exchange rate. These include, but are not limited to, monetary tightening, the imposition of additional tariffs, and raising non-tariff barriers. Future research could consider including such policy measures.

Appendix

See Tables 6, 7, 8, 9 and 10.

Table 6 IMF programs Pakistan

	Facility	Date of arrangement	Expiration date
1	Extended Fund facility	September 4, 2013	September 30, 2016
2	Standby Agreement	November 24, 2008	September 30, 2011
3	Extended Fund facility	December 6, 2001	December 5, 2004
4	Standby Agreement	November 29, 2000	September 30, 2001
5	Extended Fund facility	October 20, 1997	October 19, 2000
6	Extended Fund facility	October 20, 1997	October 19, 2000
7	Standby Agreement	December 13, 1995	September 30, 1997
8	Extended Fund facility	February 22, 1994	December 13, 1995
9	Extended Fund facility	February 22, 1994	December 4, 1995
10	Standby Agreement	September 16, 1993	February 22, 1994
11	Structural Adjustment Facility Commitment	December 28, 1988	December 27, 1991
12	Standby Agreement	December 28, 1988	November 30, 1990
13	Extended Fund facility	December 2, 1981	November 23, 1983
14	Extended Fund facility	November 24, 1980	December 1, 1981
15	Standby Agreement	March 9, 1977	March 8, 1978
16	Standby Agreement	November 11, 1974	November 10, 1975
17	Standby Agreement	August 11, 1973	August 10, 1974
18	Standby Agreement	May 18, 1972	May 17, 1973
19	Standby Agreement	October 17, 1968	October 16, 1969
20	Standby Agreement	March 16, 1965	March 15, 1966
21	Standby Agreement	December 8, 1958	September 22, 1959

Table 7 Variable description and sources

Variable	Description	Unit	Source
Pak GDP	Log of Pakistan's real GDP	Billion 2010 US$	Haver
World GDP	Log of World real GDP	Billion 2010 US$	Haver
Real exchange rate	Log of (ER*World Prices/ Domestic Prices)	PKR/US$	Authors Calculation
Imports	Log of Index of imports volume	1990–91 = 100	SBP
Exports	Log of Index of exports volume	1990–91 = 100	SBP
Remittances	Log of workers' remittances Pakistan receives	Billion US$	SBP
FX Reserves	Log of Pakistan's foreign exchange reserves excluding Gold	Billion US$	SBP
Concentration	Log of concentration: percentage of China in Pakistan's total Imports	Percent	Haver
Crude oil prices	Log crude oil (Dubai Fateh index) prices	US$ per barrel	Haver
IMF	= 1, when Pakistan was in IMF program = 1, otherwise 0		
Nuclear test	= 1, since 1998, otherwise 0		
Liberalization	= 1, since 1992, otherwise 0		

SBP Handbook of Statistics on Pakistan's Economy [47], *Haver* Haver Analytics World Bank

Table 8 Descriptive statistics

	Mean	Variance	Std. dev	Minimum	Maximum
Imports	2.19	1.72	1.31	– 0.40	4.09
Exports	1.69	1.63	1.28	– 1.07	3.23
Real Exchange Rate	3.27	1.65	1.28	1.11	4.73
Pak GDP	4.43	0.52	0.72	3.15	5.55
FX Reserves	0.55	2.50	1.58	– 2.05	2.98
Concentration	1.72	0.54	0.74	0.62	3.25
World GDP	10.61	0.21	0.45	9.77	11.35
Remittances	1.00	1.86	1.36	– 2.69	3.26

Table 9 Correlation matrix

	Pak GDP	World GDP	Real exchange rate	Imports	Exports	Remittances	FX Reserves	Concentration	Crude oil prices
Pak GDP	1.00								
World GDP	0.99	1.00							
Real exchange rate	0.95	0.93	1.00						
Imports	0.97	0.97	0.86	1.00					
Exports	0.99	0.98	0.95	0.97	1.00				
Remittances	0.86	0.86	0.68	0.93	0.85	1			
FX Reserves	0.89	0.90	0.82	0.88	0.87	0.8172	1		
Concentration	0.89	0.92	0.78	0.88	0.86	0.7925	0.8728	1	
Crude oil prices	0.76	0.78	0.60	0.88	0.79	0.90	0.77	0.72	1.00

Table 10 Unit root test results

	Conventional tests				Tests incorporating structural break			
	Dickey–Fuller		Philips–Perron		Additive outlier test		Innovative outlier test	
	Drift only	Drift & trend	Drift only	Drift & trend	Test stats	break date	Test stats	break date
Pak GDP	– 2.032	– 1.361	– 1.818	– 1.060	– 1.916	1993	– 3.496	1976
World GDP	– 2.217	– 4.066*	– 2.141	– 3.887*	– 2.270	2000	– 2.676	1993
Real exchange rate	– 1.614	– 1.016	– 1.457	– 0.671	– 2.917	1990	– 4.421*	1980
Imports	– 1.908	– 2.955	– 1.809	– 1.798	– 1.814	2007	– 5.326*	2002
Exports	– 2.734**	– 1.915	– 2.868**	– 1.119	– 3.266**	1991		
Remittances	– 2.726	– 2.443	– 2.356	– 2.703	– 2.428	2002	– 4.034**	2000
FX Reserves	– 1.144	– 2.646	– 1.030	– 3.126**	– 3.646**	1998	– 3.647	1999
Concentration	– 0.396	– 1.819	0.126	– 2.728	– 3.370**	2004	– 2.317	2001
Crude oil prices	– 2.495	– 2.811	– 2.491	– 2.03	– 2.804	2006	– 3.723	2002
95% Critical Values	*– 2.928*	*– 3.504*	*– 2.928*	*– 3.498*	*– 3.56*		*– 4.27*	
90% Critical Values	*– 2.599*	*– 3.182*	*– 2.599*	*– 3.179*	*– 3.22*		*– 3.86*	

Italics indicates the Critical values and should be seperated from the variables

* indicates 5% level of significance

** indicates 10% level of Significance

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Author contributions JK gathered data and contributed with Sections "Stylized facts about the exchange rate and trade dynamics in Pakistan" and "Literature review", MO contributed with Sections "Model", "Methodology" and "Results" while JD contributed with Introduction, Section "Conclusion" (conclusion) and overall review and improvement of the paper.

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