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## Article

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Article

# Asymmetric Exchange Rate Pass-Through in Turkish Imports of Cocoa Beans

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**Abstract:** The present paper uses asymmetric cointegration and error-correction modeling where a nonlinear adjustment of the exchange rate yields results that are different than those yielded by linear models. We study cocoa imports for Turkey with advanced ARDL and nonlinear ARDL frameworks. Our findings reveal that there is considerable asymmetry for the case of Turkish cocoa bean imports from Côte d'Ivoire. Compared with imports from Ghana, there are significant differences in Turkish importers' preferences when choosing between the two cocoa bean providers. Our results provide support for the nonlinear adjustment of the real Turkish lira–US dollar exchange rate and a hint of imperfect rivalry in Turkish cocoa bean imports.

**Keywords:** asymmetric cointegration; exchange rate pass-through; nonlinear ARDL; Turkish cocoa imports

**JEL Classification:** F14; F31



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## 1. Introduction

Economic theory states currency depreciation will have negative effect on imports and this behavior is expected to hold for consumers in international economics. Appreciation of a currency is expected to give consumers an opportunity to buy more with their local money. Cocoa is an important cash crop in the cocoa growing countries considering its vast market and worth globally. For instance, in 2016 the global cocoa market was worth USD 98 billion (World Atlas 2017). West Africa is the largest cocoa producing region in the world and contributes approximately 73% of the global cocoa supply (Addai et al. 2020). The two predominant cocoa growing countries in West Africa are Côte d'Ivoire and Ghana, which produce 40% and 20% of the world's cocoa, respectively. Thus, the two countries take home the largest share of the proceeds from global cocoa sales. However, the two countries retain only a small fraction of this amount since they normally export unprocessed cocoa beans (World Atlas 2017). In Côte d'Ivoire, cocoa sales make up 40% of the country's export revenue and contribute to 15% of the country's GDP. In addition, cocoa accounts for 30% of Ghana's export revenue and contributes to 11% of the country's GDP (Luckstead 2018; World Atlas 2017).

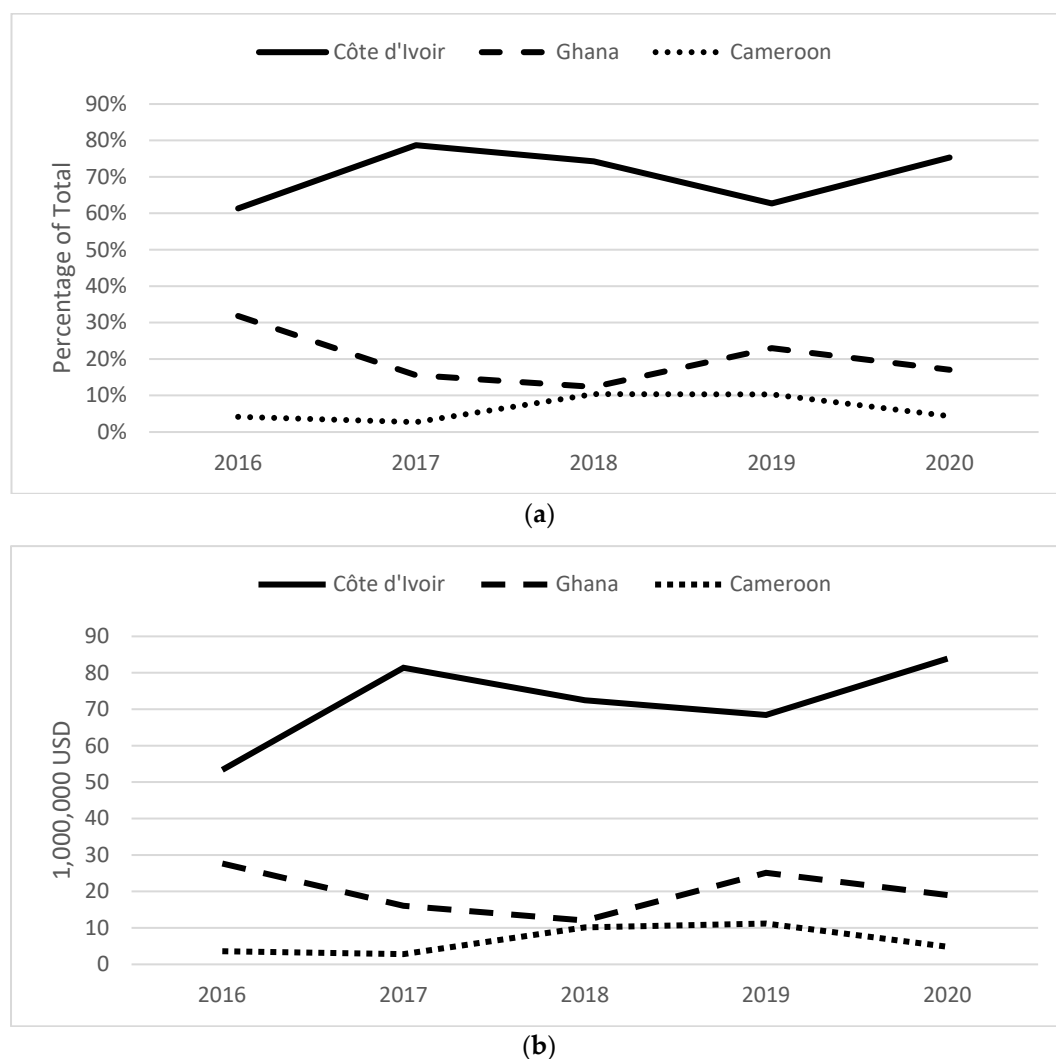
According to Pilling (2019), Ghana's cocoa bean exports earn the country USD 2 billion annually or less than one-fiftieth of the value of the chocolate that is manufactured, branded, and sold. Meanwhile, Côte d'Ivoire earns less than USD 4 billion annually from cocoa sales despite being a major producer. The majority of the cocoa producers in these two West African countries have remained poor despite being suppliers of the most important raw material in the world chocolate industry, a USD 100 billion industry. In Cote d'Ivoire, for instance, the average cocoa farmer earns 0.97 dollars a day, which is way below the World Bank's defined poverty line (World Atlas 2017).

According to the Food and Agriculture Organization of the United Nations (FAO) 2019 data, 12,234,311 hectares of cocoa beans were harvested in the world, which produced

a total of 5,596,397 tons of cocoa beans. As well as Côte d'Ivoire and Ghana, other cocoa beans producers are Indonesia (14%), Nigeria (6%), Ecuador (5%), and Cameroon (5%) who accounted for 14%, 6%, 5%, and 5% of the global cocoa production in 2019, respectively.

### 1.1. Cocoa Market in Turkey

Turkey is one of the major importers of cocoa beans and exporters of cocoa related products globally. In 2020, the value of imports of the commodity group “Cocoa and cocoa preparations” to Turkey totaled USD 708 million, while exports of the same commodity group totaled USD 653 million (United Nations 2021). In 2020, Figure 1a, Turkey’s imports of cocoa from Côte d'Ivoire were worth USD 289 million, which represented 40% of Cocoa and cocoa preparations’ imports and 75% of cocoa beans imports. In the same period, Figure 1b, cocoa imports from Ghana and Cameroon were worth USD 64 million and USD 16.9 million with a share of 9.1% and 2.39%, respectively (United Nations 2021).



**Figure 1.** Turkish Imports of Cocoa Beans by Country of Origin. Panel (a) percentage of total; Panel (b) real value (USD 1,000,000).

In this paper we examine the total cocoa imports in Turkey mainly from two major producers from Africa: Côte d'Ivoire and Ghana. Turkish imports of cocoa beans from these two countries have made up, on average, more than 90% of all cocoa imports over the last five years. In the last 10 years or so, Turkey have started importing from Cameroon as well. Including Cameroon, as Table 1 shows, these three west African countries accounted for 97% of all Turkish cocoa imports in 2020.

**Table 1.** Turkish Imports of Cocoa Beans (%) by Country of Origin.

	2016	2017	2018	2019	2020
<b>Côte d’Ivoire</b>	61%	79%	74%	63%	75%
<b>Ghana</b>	32%	16%	12%	23%	17%
<b>Cameroon</b>	4%	3%	10%	10%	4%
<b>Total</b>	97%	97%	97%	96%	97%
<b>Ghana and Côte d’Ivoire</b>	93%	94%	87%	86%	92%

Cocoa and related products’ imports are an interesting study—for an economy such as Turkey—since the cocoa and cocoa preparations industry is a crucial sector of the country’s economy. In addition, the present study covers the years of the Turkish lira where a major reform was introduced by the authorities due to its devaluation because of inflation pressure and political instability. Since any type of move in the exchange rate can influence the activities in the foreign exchange markets such as arbitrage, the same must also be true against other major currencies as well.

### 1.2. Exchange Rates and Cocoa Exports

Currency exchange rates determine, to a significant extent, the benefits cocoa farmers reap from their toil. They also determine the level of short-run and long-run economic growth for exporting countries that is linked to cocoa exports. Being a globally traded commodity, the price of cocoa is dependent on exchange rates. Exchange rates also may, to some extent, affect the domestic price of cocoa as well as the quantity produced (Poku 2017). Basic economic theory denotes that the respective country’s currency exchange regime will determine its unit currency worth when compared with other currencies. A country may adopt either a pegged or a floating exchange rate system. While a pegged regime provides more monetary and financial stability, transparency, credibility, and low inflation, the impacts of external shocks are amplified in this system (Addai et al. 2020). Cote D’Ivoire runs on a pegged exchange rate system. The peg was switched from the French francs to the Euro in 1999. Ghana has run on a floating exchange system since her independence in 1957. These two economies experience varying effects of foreign currency fluctuations.

Studies indicate that pegged exchange rate systems, such as the system employed in Cote D’Ivoire, have negative impacts on net exports. Addai et al.’s (2020) study analyzed the effect of exchange rate regimes on the global cocoa trade using panel data from 10 leading cocoa producing countries from 1980 to 2016. The results from their study showed that countries that pegged their currencies to the euro suffered a statistically significant negative effect on net exports. However, countries that adopted floating exchange rate regimes did not suffer this effect. The study recommended that countries that export agricultural raw materials, such as cocoa beans, should adopt a more flexible exchange rate system so that their profits are not wiped out by the rigidity of the exchange rate regime.

Previous studies have documented an ambiguous relationship between exchange rate volatility (EV) and trade. For instance, Bahmani-Oskooee et al.’s (2013) study on trade flows between Brazil and US found that of the 21 food and agricultural industries included in the study, EV had no effect for 12 industries, reduced trade for 7, and increased trade for 2. Similar mixed results have been documented in other commodity specific studies with agricultural products more affected by EV than nonagricultural products (Bahmani-Oskooee and Durmaz 2016). Studies have also documented that developing countries appear to be more adversely affected by EV than developed countries (Bahmani-Oskooee 1991; Wang and Barrett 2007; Durmaz 2015).

Elsewhere, a study by Alori and Kutu (2019) examined the impact of exchange rates and price volatility on the exportation of cocoa in Nigeria. Their study revealed that while the price of cocoa in the international market and the value of exchange rates play a significant role in cocoa exports’ growth in Nigeria, the shocks to the exchange rate

account for the greatest volatility shocks to the value of the cocoa exported. Their study recommended the adoption of a free exchange rate market in order to enhance the export growth and cocoa output in Nigeria. These findings were reaffirmed by Uduh's (2017) study on the impact of the exchange rate on cocoa exports in Nigeria that recommended a free market exchange rate regime in Nigeria so as to increase cocoa output and hence exports.

Luckstead (2018) quantified the nonlinear and asymmetric pass-through of exchange rate volatility on U.S. imports of cocoa from Côte d'Ivoire, Ghana, and the Dominican Republic that accounted for more than 90% of U.S. cocoa imports. The results of the study provided evidence of nonlinear and asymmetric pass-through of exchange rates, regional quality difference, and imperfect competition in U.S. cocoa imports. The analysis provided an insight into potential imperfect competition in the international cocoa market, as, depending on elasticities, import volumes could be adjusted or maintained as exchange rates moved to maximize returns. The study also found that a rise or fall in U.S. income leads to an increase or decrease in U.S. cocoa imports.

Cocoa exports and exchange rates were reported to have a positive correlation with economic growth in Cote D'Ivoire (Ofori-Abebrese et al. 2017). Floating exchange regimes cushion economies against the amplified effects of external shocks. The flexibility of a floating exchange rate regime allows the cost of exports to vary with the volatility of the foreign currencies. The importer's currency fluctuations determine the number of imports and, consequently, the export revenue for the exporting country. In floating exchange systems, a change in the relative value of currency translates to a change in the quantity purchased for the same amount. However, as Ofori-Abebrese et al. (2017) observe, the effects of exchange rates have no significant effects on economic growth in Ghana, although cocoa exports have been directly linked to long-term economic growth.

The relationship between cocoa bean imports to Turkey and the exchange rate and income are examined. In the remainder of the paper, Section 2 discusses models and methodology. First, we use an ARDL model. Then we apply a nonlinear ARDL model, where exchange rate effects are analyzed by separating depreciations from appreciations with partial sum theory. Section 3 presents the dataset and the results. The last section is a conclusion with remarks and policy implications.

## 2. The Model and Method

We aim to distinguish the short-run effects of exchange rate uncertainty from its long-run effects on cocoa import flows. For this we follow the literature and employ an error-correction approach. At the reduced level, our import demand model takes the form of Bahmani-Oskooee et al. (2010) and long-run specification of demand for Turkish exports of commodity  $i$  as in Equation (1)

$$\ln M_t^i = a + b \ln Y_t + c \ln X_t^i + \epsilon_t^i \quad (1)$$

where  $\ln M_t^i$  is the log of Turkish import volume of cocoa beans from countries,  $i$  = Côte d'Ivoire and Ghana.  $\ln Y_t$  is the log of the per capita income representing Turkish domestic demand, the log of the real exchange rate ( $\ln X_t^i$ ) is (USD/TRY) for country  $i$ , and  $\epsilon_t^i$  is a random error term.

We expect an estimate of coefficient  $b$  to be positive, implying that as Turkish economy grows, Turkey imports more cocoa beans. An estimate of  $c$  is expected to be positive since a rise in  $\ln X$  means a real appreciation of the Turkish lira.

The above discussed estimates all belong to long-run model of Equation (1). To evaluate the short-run effects of exchange rate we then move on to identify (1) as an error-correction model. Here we follow the previous literature and employ Pesaran et al.'s (2001) bounds testing approach and convert (1) into (2)

$$\Delta \ln M_t^i = \phi_0 + \sum_{j=1}^k \phi_{1,j} \Delta \ln M_{t-j}^i + \sum_{j=1}^l \phi_{2,j} \Delta \ln Y_{t-j} + \sum_{j=1}^m \phi_{3,j} \Delta \ln X_{t-j}^i + \psi_0 \ln M_{t-1}^i + \psi_1 \ln Y_{t-1} + \psi_2 \ln X_{t-1}^i + \epsilon_t \quad (2)$$

The signs and magnitudes of coefficients of first-differenced variables judge short-run effects. In Equation (2),  $\psi_0$  is the normalized value of long-run effects that are measured by the estimates  $\psi_1$  and  $\psi_2$ .<sup>1</sup> Pesaran et al. (2001) recommend two tests for cointegration for the estimated long-run effects to be valid. First is the F test, which indicates the formed joint significance of lagged level variables. The second is the *t*-test to show the proven importance of  $\psi_0$  in Equation (2).<sup>2</sup> Nonstandard distributions of these two tests set out new critical values, which make up degree of integration of variables. It is known that one of the properties of most macro variables are a combination of I(0) and I(1) as in the present study<sup>3</sup>. Therefore, there is no need for pre-unit root testing, which is another advantage of employing this approach.

Equation (2) assumes that the changes in exchange rate on cocoa imports are symmetric. However, changes may very well be asymmetric if cocoa trades react differently when they expect appreciation versus depreciation in the local currency. Bahmani-Oskooee and Nouria (2020) point out that if traders assume more losses against any gains for holding foreign exchange to hedge uncertainties in future, then asymmetric effects may be possible. Belke and Göcke (2005) add that asymmetric effects could be attributed to nonlinearity. They find asymmetric response in their study of relationship between employment and the exchange rate, where authors address nonlinearities.

Asymmetric response of trade flows has been covered in the literature broadly, and this study also expects similar results for cocoa imports (see studies Bahmani-Oskooee and Fariditavana (2016), Arize et al. (2017), Bahmani-Oskooee and Durmaz (2020), and Bahmani-Oskooee and Durmaz (2021)). For this we use Shin et al. (2014) to assess asymmetry effects of exchange rate changes. The model then replaces  $\ln X_t^i$  with its two decomposed variables, one being for appreciation and the other is for depreciation. We generate  $\Delta \ln X_j$  which is rate of change of  $\ln X_t^i$ .  $\Delta \ln X_t^i$  has positive values (lira appreciation against foreign currency) and negative values (depreciation).  $\Delta \ln X_j^+$  indicates the positive values and  $\Delta \ln X_j^-$  indicates negative. Then

$$\begin{aligned} POS_t &= \sum_{j=1}^t \Delta \ln X_j^+ = \sum_{j=1}^t \max(\Delta \ln X_j, 0), \\ NEG_t &= \sum_{j=1}^t \Delta \ln X_j^- = \sum_{j=1}^t \min(\Delta \ln X_j, 0) \end{aligned} \quad (3)$$

where  $POS_t$  is the partial summation of positive changes in exchange rates, and  $NEG_t$  is the partial summation if negative exchange rate changes.

Following recommendation of Shin et al. (2014), we then go back to Equation (2) and replace  $\ln X_t^i$  with  $POS_t$  and  $NEG_t$ . The new error-correction model we gain is

$$\begin{aligned} \Delta \ln M_t^i &= \phi_0 + \sum_{j=1}^k \phi_{1,j} \Delta \ln M_{t-j}^i + \sum_{j=1}^l \phi_{2,j} \Delta \ln Y_{t-j} + \sum_{j=1}^m \phi_{3,j} \Delta POS_{t-j} + \\ &\sum_{j=1}^n \phi_{4,j} \Delta NEG_{t-j} + \psi_0 \ln M_{t-1}^i + \psi_1 \ln Y_{t-1} + \psi_2 POS_{t-1} + \psi_3 NEG_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

Adding POS and NEG variables into Equation (4) introduces nonlinearity; Shin et al. (2014) name it as a nonlinear ARDL model.

### 3. Data and the Results

Appendix A displays all data sources and information in detail. Data for real exchange rates are from the U.S. Department of Agriculture, Economic Research Service (2021). We use the industrial production index as a proxy for Turkish real per capita income from the International Financial Statistics of the IMF (2021). We obtained cocoa import values data from the Turkish Statistical Institute (TurkStat). All are reported in US dollar values and converted in real values using the U.S. import deflator collected from the U.S. Department of Labor, Bureau of Labor Statistics. All are based on the year 2015. Our dataset for Turkish



cocoa imports is monthly and runs between 1970 January and 2020 December for Ghana, and 1982 March and 2020 December for Côte d'Ivoire. Thus, we impose a maximum of 10 lags and choose to employ Akaike's Information Criterion (AIC) to select an optimum model on each case. Table 2 shows summary statistics. Figure 2 shows the real exchange rates for US Dollars over the Turkish lira.

**Table 2.** Descriptive Statistics.

	Mean	Median	Minimum	Maximum	Standard Deviation	Observations
<b>Ghana</b>						
Imports	2,865,931.87	405,301.11	0.00	24,774,449.19	184,066.87	612
Exchange Rate	2.93	2.91	1.42	4.73	0.03	612
Income	46.52	36.44	11.09	130.40	1.25	612
<b>Côte d'Ivoire</b>						
Imports	5,398,122.77	2,006,233.42	0.00	42,964,255.07	309,380.43	466
Exchange Rate	3.11	3.16	1.83	4.73	0.03	466
Income	55.84	42.57	20.45	130.40	1.38	466



**Figure 2.** Real exchange rate USD/TRY.

Table 3 reports associated coefficient estimates and Table 4 diagnostic tests. In this section our analyses continue with the pass-through effects and cointegration of exchange rates and per capita income. We provide two different models for examination. First is the original ARDL model, without asymmetric effects. Next is the second model called the NARDL model, where asymmetries are included with decomposed exchange rates as partial summation.

Next, we discuss the bounds testing approach for cointegration by [Pesaran et al. \(2001\)](#) where we apply and reject a spurious relationship between the real value of Turkish cocoa imports and real exchange rates and real per capita income. For both models in the two countries, we find evidence of cointegration with high F-values. In other words, we can conclude that there exists a meaningful inference in the Turkish imports of cocoa from both countries on the pass-through relationship in exchange rates and income. Another source of cointegration relationship evidence is also backed up in our results in short-run models, which include lagged ECM term. To confirm a cointegrating relationship, as suggested by [Pesaran et al. \(2001\)](#), we employ long-run estimates and Equation (1) to generate an error term, which we denote by ECM. Subsequently,  $ECM_{t-1}$  replaces the linear combination of the lagged level variables, after which we estimate  $ECM_{t-1}$  once more. To confirm

cointegration, the  $ECM_{t-1}$  coefficient needs to be negative and significant. It is found to be statistically significant in both countries in both models.

**Table 3.** Long-Run Turkish Cocoa Import Elasticities.

	Ghana		Côte d'Ivoire	
	Elasticity	p-Value	Elasticity	p-Value
<b>Model 1: ARDL</b>				
<b>LX</b>	1.474	0.404	1.067	0.724
<b>LY</b>	3.201	0.000	2.513	0.063
<b>Model 2: NARDL</b>				
<b>POS</b>	9.922	0.037	−2.234	0.697
<b>NEG</b>	2.613	0.490	13.783	0.038
<b>LY</b>	−8.076	0.092	25.584	0.000

**Table 4.** Diagnostic Tests Associated with Nonlinear ARDL Model.

	F	$ECM_{t-1}$	LM	RESET	CSM(SQ)	Adj. R <sup>2</sup>
<b>Ghana</b>	7.766 **	−0.437 **	18.668 *	0.015	(S)(US)	0.385
<b>Côte d'Ivoire</b>	5.593 **	−0.467 **	12.991	26.784 **	(S)(US)	0.413

a. The upper bound critical value of the F test is 4.35 at 5% and 3.77 at 10% level of significance when there are three exogenous variables ( $k = 3$ ), Pesaran et al. (2001, Table CI-Case III, p. 300). b.  $ECM_{t-1}$ 's upper bound critical value is −3.78 at 5% and −3.46 at 10% level of significances when  $k = 3$ , Pesaran et al. (2001, Table CII-Case III, p. 303). c. Lagrange Multiplier (LM) test is for residual serial correlation. It is distributed as  $\chi^2$  with one degree of freedom (12th order). LM's critical value is 21.02 at 5% and 18.54 at 10% level of significances. d. Ramsey's test (RESET) is for misspecification. RESET is distributed as  $\chi^2$  with one degree of freedom, critical values are 3.84 at 5% and 2.71 at 10% level of significances. For both Wald tests, same values also apply. e. \*\* and \* are 5% and 10% level of significances shown, respectively.

Table 3 displays the long-run elasticities and  $p$ -values for Ghana in the first column and Côte d'Ivoire in the second column for exchange rates. Our results confirm the general theoretical expectation that an appreciation in the Turkish lira against the US dollar (increase in USD/TRY) leads to an increase in Turkish imports of cocoa beans. Where one Turkish lira buys more dollars, hence, more cocoa beans in return. The opposite is also true: depreciation (decrease in USD/TRY) will lead to a decrease in Turkish imports since one Turkish lira buys fewer cocoa beans. In the ARDL models, while none are statistically significant, the exchange rate elasticities are elastic for Ghana and almost unitary elastic for Côte d'Ivoire. We see that, ceteris paribus, a one percent increase in the exchange rate (LX) results in a 1.47% and 1.07% increase in Turkish cocoa bean imports from Ghana and Côte d'Ivoire, respectively. For both countries, income elasticities are elastic and statistically significant. Again, ceteris paribus, a one percent increase in income (LY) is expected to lead to a 3.2% and 2.5% increase in Ghana and Côte d'Ivoire, respectively. These values may point to quality differences in Ghana and Côte d'Ivoire grown cocoa beans since Ghana's income elasticity is more responsive to demand conditions than Côte d'Ivoire's.

The NARDL model results show the asymmetric pass-through analyses. We begin with Ghana, and, as expected, Turkish cocoa bean imports from Ghana are very elastic with respect to appreciation in TRY. Ceteris paribus, a one percent appreciation in the Turkish lira (POS) leads to a 9.92% rise in Turkish cocoa imports. Although TRY depreciation (NEG) is not significant, our study finds that if TRY depreciates, Turkish imports from Ghana fall, ceteris paribus. Another indication from the results is the exclusive Ghanaian cocoa bean exporter (the Ghanaian Cocoa Marketing Board) is indeed responsive to TRY depreciation. Not having an asymmetric result in the Ghana model could be one of the reasons why income elasticity is negative and statistically significant at 10%. Turkey has been shifting



its import mix of cocoa beans to Côte d'Ivoire away from Ghana in the last five years. As a result, imports from Ghana are more responsive to changes in the exchange rates than changes in income.

Continuing with the Table 2 model 2 for Côte d'Ivoire, the long-run import elasticity is elastic with respect to TRY depreciation (NEG) at 13.78%, meaning, *ceteris paribus*, a one percent depreciation in Turkish lira is expected to result in a 13.78% decrease in imports. We clearly see that Turkish cocoa bean importers may move away from Côte d'Ivoire's cocoa beans when TRY depreciates. The same cannot be said for TRY appreciation (POS) as it is not statistically significant, which implies that Turkish importers do not purchase more cocoa produced in Côte d'Ivoire in the presence of lira appreciation. Thus, this points out to asymmetric responses from Turkish importers to the appreciation and depreciation of TRY where Côte d'Ivoire-produced cocoa beans are concerned. We may draw another conclusion in that Côte d'Ivoire cocoa beans are of low quality and Ivorian cocoa farmers do not have support in farming or international promotion, which indicates that Turkish importers' behavior is consistent. In model 2, income is statistically significant and goes up to 25.58% from 2.5%. When exchange rate asymmetries are added in the model, imports are now more responsive to demand shocks.

Table 4 presents diagnostic tests associated with the two NARDL models. The reported F test is significant for both Ghana and Côte d'Ivoire cases, which confirms cointegration and prove long-run effects to be applicable and not spurious. As Table 4 shows, in both cases,  $ECM_{t-1}$  has significantly negative coefficients, confirming cointegration. The Lagrange Multiplier (LM) statistic test is used to check for serial correlation. While LM is insignificant in Côte d'Ivoire's case, implying a lack of serial correlation, for Ghana, LM signals a serial correlation problem at the 10% level of significance. Ramsey's RESET test is applied to determine misspecification. Although Ghana's case is insignificant providing for a correctly specified optimum model, Côte d'Ivoire fails this test. For the next diagnostic, we apply the familiar CUSUM (CSM) and CUSUMSQ (SQ) tests to the residuals of each model to verify the stability of the short- and long-run coefficient estimates. We denote stable estimates by (S) and unstable (US). While the CUSUM test confirms both cases as stable, CUSUMSQ reports them as unstable. Lastly, both models have similar adjusted r-squared (Adj.  $R^2$ ), 0.39 for Ghana and 0.41 for Côte d'Ivoire. This may be an indication of similar qualities in cocoa beans of both countries.

#### *Testing for Asymmetry in Pass-Through Effects*

Once cointegration is determined, the asymmetric long-run coefficient exchange rate and income estimates are applicable. Our results evidently indicate, either by the reported F test or  $ECM_{t-1}$  test in Table 4, that cointegrations for both cases are confirmed. Next, we test the pass-through effects for Turkish cocoa imports from Côte d'Ivoire and Ghana for the NARDL model. Regarding the asymmetric effects of exchange rate changes, we assess and test two hypotheses. We employ the Wald test to establish if we can reject the null hypothesis of  $\sum \hat{\phi}_{3,j} = \sum \hat{\phi}_{4,j}$  from Equation (4). If the Wald statistic is significant, then one can reject the null and conclude that there is evidence for an asymmetric short-run effect. For long-run asymmetric effects of exchange rate changes, once again we use the Wald test. However, this time, rejecting the null of *normalized*  $\hat{\psi}_2 = \text{normalized } \hat{\psi}_3$  will establish a long-run asymmetry.

Table 5 show the results of the Wald test designated by Wald-S and Wald-L. The reported statistics are significant in both models, which establish the significant asymmetry effects of exchange rate changes in the short run and the long run.

**Table 5.** Wald Tests Associated with Nonlinear ARDL Model.

	Wald-S	Wald-L
<b>Ghana</b>	12.550 **	7.741 **
<b>Côte d’Ivoire</b>	6.428 **	10.212 **

a. 5% level of significances shown \*\*.

In Ghana’s case, although we have a significant Wald test result, we do not confirm it with the results shown in Table 3, where we have the same signs for POS and NEG coefficients.

For Côte d’Ivoire, we reject the null hypothesis in favor of the alternate with a *p*-value of 0.00, and conclude that we have strong evidence of an asymmetric relationship in short- and long-run exchange rate pass-through.

#### 4. Conclusions

There are still not many studies with analyses of the nonlinear and asymmetric pass-through of exchange rates in agricultural markets. For policy makers and business owners, following changes in exchange rates and income levels and their effects on agricultural commodities is crucial. The present study attempts to add to the literature of agricultural trade by analyzing the nonlinear exchange rate pass-through in Turkish cocoa bean imports from two important sources in Africa: Ghana and Côte d’Ivoire. Accordingly, our findings are relevant to these two sources and chocolate confectioneries in Turkey.

In terms of policy, the study recommends for Côte d’Ivoire to have a body that is charged with the monitoring of cocoa bean quality as one of the drivers of cocoa bean demand is quality. The study also recommends for Turkish cocoa bean imports to diversify their import markets so as to improve the bilateral cocoa trade. The study also suggests that policymakers should enact policies to stabilize the exchange rate to foster trade.

One of the limitations of the study is that the currencies of the considered countries do not trade directly. They are, therefore, traded with the US dollar and neither of the countries has direct determination of or influence on USD daily rate determination.

In the present study we use ARDL and NARDL methodologies to assess cocoa bean imports from Ghana and Côte d’Ivoire to Turkey. Our study reveals the preferences of Turkish imports for cocoa beans are driven by quality concerns, with fluctuations in these preferences affected by changes in exchange rates. It should be noted that Côte d’Ivoire, which may not meet the quality expectations of certain importers, lacks an agency to monitor cocoa exports, while Ghana sports a Cocoa Marketing Board. This paper considers the cocoa bean imports and exchange rate relationship with the Turkish data and contributes to the literature in two ways. First, we employ longer monthly data. Second, we examine whether changes in the exchange rate have asymmetric effects on cocoa imports. Employing a linear model, similar to the previous literature, we are able to confirm the general expected economic theory for exchange rate change with insignificant coefficients. However, our findings indicate strong results when depreciations are separated from appreciations with partial sum theory and applying a nonlinear model.

We conclude that there is considerable asymmetry for the case of the Côte d’Ivoire cocoa bean where depreciation in TRY leads to a drop in Turkish imports, but appreciation does not yield an increase in imports. On the other hand, for Ghana, since both POS and NEG coefficients have the same signs, we do not find support for asymmetry. While appreciation in TRY leads to a rise in Turkish imports of Ghana’s cocoa beans, depreciation in TRY does not indicate a decrease in imports. We may conclude that when TRY depreciates against the dollar, Turkish importers do not have many better-quality cocoa beans. Finally, these findings all support nonlinear adjustment of the real Turkish lira–US dollar exchange rate and a hint of imperfect rivalry in Turkish cocoa bean imports. Searching for other cocoa bean sources may help to improve the Turkish bilateral cocoa trade.

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## Appendix A

Monthly data over the period 1970:1–2020:12 (Ghana) and 1982:3–2020:12 (Côte d’Ivoire) is used to carry out the present empirical analysis. The data come from the following sources:

- (a) Turkish Statistical Institute (TurkStat).
- (b) U.S. Department of Agriculture, Economic Research Service (2021).
- (c) International Financial Statistics of the IMF (2021).

Variables:

Mi = the real value of cocoa imports from Ghana and Côte d’Ivoire (Source a).

XR = the real exchange rate between the lira and the dollar. A decline reflects a real depreciation of the lira (Source b).

YTR = Measure of Turkey’s economic activity. Following [Bahmani-Oskooee and Aftab \(2017\)](#), we also use the industrial production index since it is available monthly (Source c).

## Notes

- <sup>1</sup> Normalization implies dividing  $\psi_1$  and  $\psi_2$  by  $\psi_0$ . [Bahmani-Oskooee and Fariditavana \(2015\)](#) carefully cover the normalization procedure and note other applications of this procedure such as [Narayan et al. \(2007\)](#), [Wong and Tang \(2008\)](#), [De Vita and Kyaw \(2008\)](#), [Chen and Chen \(2012\)](#), and [Tayebi and Yazdani \(2014\)](#).
- <sup>2</sup> The estimate of  $\psi_0$  must be negative, see [Bahmani-Oskooee \(2020\)](#).
- <sup>3</sup> Generally, when a series is stationary at d’th difference, then it is known as I(d). A series with a unit root is known as integrated of order one, I(1), without a trend is integrated of order 0, I(0).

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