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COVID-19-related Export Restrictions and Rice Market in Benin Republic

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Abstract Understanding the economic implications of staple food trade restrictions on import-dependent, low-income countries is critical for food security and poverty alleviation. In this study, we investigate the effect of COVID-19-related export restrictions on rice market in a low-income country, Benin. The equilibrium displacement modelling approach is used. The results suggest that the pandemic related trade restrictions implemented by the major rice exporting countries reduced the quantity of rice imported and consumed in Benin while increased the domestic rice production. The results also reveal that the COVID-19-related trade restrictions increased the price of rice in Benin. This study highlights the vulnerability of import dependent low-income countries to trade restrictions implemented in the rice exporting countries.

Keywords: *COVID-19, rice market, producers, consumers, elasticity*

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1. Introduction

The coronavirus pandemic (COVID-19) has reminded us how all countries are connected as one global community. With no major warnings at its onset in China, COVID-19 pandemic fast became one the worst health crisis in world history [1]. The economic costs of the pandemic globally are estimated at USD 8.5 trillion with a projected substantial increase in extreme poverty [2]. In Africa, the first case of COVID-19 was recorded in Egypt on February 14, 2020, and rapidly spread to all other countries on the continent [3,4]. Although the number of reported cases in Africa was low, the continent was projected to be hard hit by the pandemic due to its fragile health system, limited social protection schemes, and the prevalence of poverty [5].

The objective of this paper is to estimate the economic effect of COVID-19-related export restrictions implemented by major rice-exporting countries on rice market in an import dependent, low-income country—Benin. This is critical for several reasons. First, food security remains a challenge in Africa, and rice represents an important commodity for millions of households [6]. Understanding the economic implications of trade restriction policies in exporting countries on staple food market in import dependent, low-income countries is critical for food security and poverty alleviation. Second, although the impacts of COVID-19 on developed countries have been well-documented [7,8,9,10,11], little is known on low-income countries. Most of the existing estimates of COVID-19 impacts on low-income countries including Africa are based on policy opinions [5,6,12] and simulations results [13,14]. Third, Benin represents an ideal case-study to quantify the economic impact of COVID-19-related export restrictions on developing countries because it is a low-income country with an important size of the population under food insecurity.

Rice is a staple food in West Africa with imports providing about 30% of regional rice consumption and above 70% of domestic consumption in countries such as Benin, Burkina-Faso, Gambia, and Niger [15]. This high dependence of the region on imports highlights the vulnerability of the region to international trade. Thus, any changes in rice exports to West-Africa may have vital implications in terms of food security, social, and economic stability.

In response to the economic costs of COVID-19 and its potential adverse effects on food stocks, several countries, including major rice exporters (e.g., India, Thailand, Vietnam) have imposed restrictions on rice exports [16]. The extent to which these restrictions have impacted the rice market in import dependent low-income countries is yet to be understood. This is vital for informed decision making and preparedness.

The next section presents a graphical analysis, the theoretical model, and model calibration. Next, we present the results and discussion. The paper concludes with a summary of key findings and policy implications.

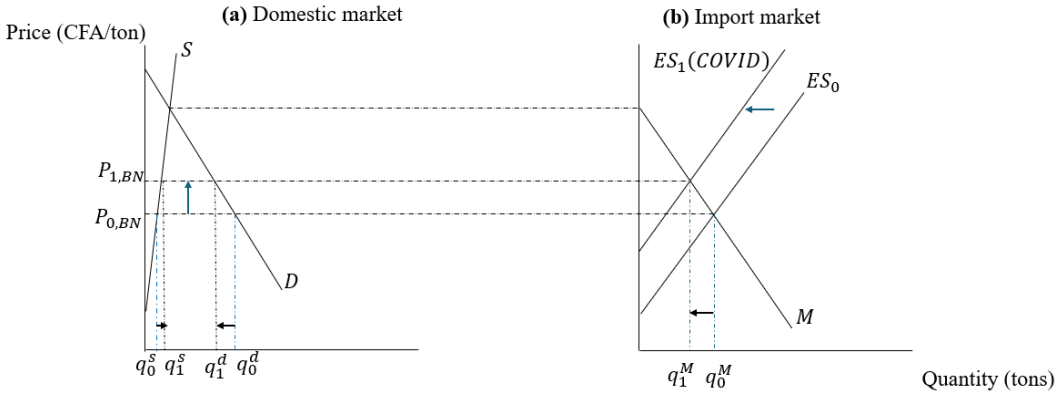

Figure 1. The effects of COVID-19-related export restrictions on rice market in Benin

2. Graphical Analysis

The effects of COVID-19-related export restrictions implemented by major rice-exporting countries on the rice market in Benin can be explained with the aid of Figure 1. In this figure, we abstract from complexities such as product differentiation and imperfect competition. Panel (a) shows the rice market in Benin. Panel (b) shows the rice import market. The demand curve (D) and the supply curve (S) represent the demand and domestic production of rice in Benin, respectively (Panel a). The demand curve (D) is the horizontal sum of the individual rice demand functions in Benin. Similarly, the supply curve (S) is the horizontal sum of the individual rice supply functions in Benin.

The intersection of the demand curve (D) and the supply curve (S) determines the price of rice in Benin under a closed economy. The market curves (ES_0) and (M) represent the excess supply of rice from the exporting countries and Benin's rice import demand, respectively (Panel b). The excess supply curve of rice (ES_0) is the horizontal difference between the rice supply and demand in the exporting countries while Benin's import demand curve for rice (M) is the horizontal difference between the production and consumption of rice in Benin. The intersection of the rice excess supply (ES_0) and demand (M) curves determines the initial price of rice in the import market when no COVID-19-related export restriction is enacted in the exporting countries. The price of rice on the import market is lower than the price of rice in Benin in a closed economy. When trade occurs with no COVID-19-related rice export restrictions, the price of rice ($P_{0,BN}$) on the import market is available to all buyers and producers in Benin. At this price ($P_{0,BN}$), the production and consumption of rice in Benin are $\left(q_0^s\right)$ and $\left(q_0^d\right)$. Under COVID-19-related export restrictions, the excess supply curve of rice (ES_0) shifts to the left due to the reduction in rice exports from the exporting countries. (ES_1) represents the excess supply of rice under the COVID-19-related export restrictions. This reduction in rice exports raises the price of rice in Benin ($P_{1,BN}$). At this price ($P_{1,BN}$), rice consumption in Benin decreases due to the reduction in rice imports, while the supply of rice increases because of the higher price.

3. Theoretical Model

A formal analysis of the impact of COVID-19-related export restrictions on Benin's rice market is provided here using a set of demand and supply framework. This framework has been used in the areas of agricultural economics [17,18,19,20], forest economics [21,22,23,24], wildlife economics [25], and energy economics [24]. A key strength of this framework is its consistency with economic theory and the generation of relevant hypotheses. The demand curve (Q_d) is assumed to be a function of the price of rice $\left(P_{BN}\right)$ in Benin and describes the behavior of rice consumers in Benin. The demand for rice is a decreasing function of its own price ($\eta_{BN} < 0$) —an increase in the price of rice decreases the quantity of rice demanded. The supply curve ($Q_{s,BN}$) represents the behavior of producers of domestic rice in Benin and is assumed to be a function of its own price. The supply curve for rice is upward sloping ($\varepsilon_{BN} > 0$) — an increase in the price of rice increases the quantity of rice supplied. Benin is a net importing country of rice from the world with an import demand ($Q_{M,W}$) from the world defined as a function of the price of rice in Benin. COVID-19-related exports restriction in rice major exporting countries is defined as an import supply shift variable that reduced rice exports to Benin. The model assumes that rice is a homogenous commodity, and in the equilibrium the law of one price holds. Equations (1) – (4) present the structural equations defining rice market in Benin.

$Q_{d,BN} = D\left(P_{BN}\right)$ Benin demand for rice (1)

$Q_{s,BN} = S\left(P_{BN}\right)$ Benin domestic production for rice (2)

$Q_{M,W} = M\left(P_{BN}, COVID\right)$ Import supply of rice to Benin (3)

$Q_d = Q_{s,BN} + Q_{M,W}$ Market clearing conditions (4)

To identify the impact of COVID-19-related export restriction on rice market in Benin, we convert the above equations in proportionate changes.

$Q_{d,BN}^* = \eta_d P_{BN}^*$ ($\eta_d < 0$) (5)

$Q_{s,BN}^* = \varepsilon_s P_{BN}^*$ ($\varepsilon_s > 0$) (6)

$$Q^*_{M,W} = \varepsilon_M P^*_{BN} + \alpha_{covid} COVID^* \quad (\varepsilon_M > 0, \alpha_{covid} < 0) \quad (7)$$

$$Q^*_{d,BN} = k_s Q^*_{s,BN} + k_M Q^*_{M,W} \quad (8)$$

where $Z^* = dZ/Z$ and $k_j = Q_j/Q_{d,BN}$ is the share of rice consumption from the j th source. η and ε are the elasticities of demand and supply, respectively.

Next, we solve for Benin import demand for rice from the world using Equations (5), (6), and (8):

$$Q^*_{M,W} = \eta_M P^*_{BN} \quad (9)$$

where $\eta_M = \left(\frac{\eta_d - k_s \varepsilon_s}{k_M}\right) < 0$. Benin import demand function is downward sloping as expected ($\eta_M < 0$).

The reduced form equation for the price of rice in Benin is obtained by equating Equations (7) and (9):

$$P^*_{BN} = \delta_{covid} COVID^* \quad (10)$$

where $\delta_{covid} = \frac{\alpha_{covid}}{\eta_M - \varepsilon_M} > 0$. COVID-19 exports restriction increased the price of rice in Benin, as less rice is imported. Furthermore, the price effect of COVID-19-related export restrictions depend on the import demand and supply elasticities.

Substituting Equation (10) into (9) yield the reduced form for Benin's rice import:

$$Q^*_{M,W} = (\eta_M \delta_{covid}) COVID^* \quad (11)$$

Similarly, the reduced form equations for Benin domestic production and consumption for rice are obtained by substituting Equation (10) into Equations (6) and (5), respectively.

$$Q^*_{s,BN} = (\varepsilon_s \delta_{covid}) COVID^* \quad (12)$$

$$Q^*_{d,BN} = (\eta_d \delta_{covid}) COVID^* \quad (13)$$

Table 1. Reduced form elasticities

Endogenous variables	Reduced form elasticity	Equation
P_{BN}	$\frac{\alpha_{covid}}{\eta_M - \varepsilon_M} > 0$	(10)
$Q_{M,BN}$	$\eta_M \delta_{covid} < 0$	(11)
$Q_{s,BN}$	$\varepsilon_s \delta_{covid} > 0$	(12)
$Q_{d,BN}$	$\eta_d \delta_{covid} < 0$	(13)

Equations (11), (12), and (13) show the effect of COVID-19-related export restrictions from the trade partners on Benin rice imports, domestic production, and consumption. Particularly, COVID-19 trade restrictions reduced both rice import and consumption in Benin as imports account for a substantial share of rice consumption in the country. However, the production of domestic rice increased. This could be explained for two reasons. First, the exports restriction decreased imports. Second, with the fall in import supply from exporting countries, the price of rice in Benin is higher providing more incentive to domestic rice producers to increase production. Table 1. summarizes the reduced form elasticities of the effect of COVID-19-related export restrictions implemented by exporting countries on the rice market in Benin.

4. Model Calibration

The parameters for the reduced form elasticities estimation are usually taken from the literature [18,24,26]. Codjo et al. [25] estimated the price elasticity of demand for high and standard quality domestic rice in Benin at –2.90 and -3.01, respectively. Thus, the demand elasticity of rice is set at -2.95. Codjo et al. [27] also estimated the price elasticity of demand for imported rice in Benin at -4.65. The price elasticity of supply of Benin domestic rice is set at 0.65[1]. In 2020, Benin imports of rice decreased by 42 percent (Table 2). Thus, the shift parameter of COVID-19 trade restrictions on rice import supply is set at -0.42. The import supply elasticity is set at 1.30[2]. Table 3 summarizes the parameters definition.

The above approach assumes that the model parameters are known with certainty. However, to account for possible uncertainty associated with the parameters, the stochastic simulation is also used for the estimation of the reduced form elasticities. Particularly, the demand price elasticity, import demand price elasticity, domestic supply price elasticity, and import supply price elasticity are assumed to follow a triangular distribution with the minimum, most likely, and maximum values given in square brackets [.]:

$$\eta_d = [-3.90, -2.90, 1.90]$$

$$\eta_M = [-5.65, -4.65, -3.65]$$

$$\varepsilon_s = [0.55, 0.65, 0.75]$$

$$\varepsilon_M = [1.10, 1.30, 1.50]$$

Table 2. Benin production and imports of rice, 2019-2020

Year	Production (tons) [a]	Import (tons) [b]	Import share (percentage)
2019	406083	1525130.44	78.97
2020	411578	883009.04	68.21

a. Production data is obtained from FAOSTAT database (accessed on February 2, 2024)
b. Import data is obtained from UN Comtrade database (accessed on February 2, 2024)

Table 3. Definition and baseline parameters

Parameters	Definition	Value
η_d	Benin demand elasticity for rice	-2.90
η_M	Benin Import demand for rice	-4.65
ε_s	Benin supply elasticity for domestic rice	0.65
ε_M	Import supply elasticity for rice	1.30
α_{covid}	Import supply elasticity with respect to COVID19	-0.42
k_s	Share of Benin rice consumption from domestic source	0.32
k_M	Share of Benin rice consumption from import source	0.68

[1] From Equation (9), $\varepsilon_s = (\eta_d - k_M . \eta_M) / k_s$.

[2] This value assumes that Benin is a small country on the global rice import market with a negligeable market power—that is Benin faces an elastic import supply curve for rice from the world.

In 2020, Benin imported 883,009 tons of rice consumption which accounted for 68.21 percent of rice consumption in the country (Table 3). Hence, we set the shares of rice consumption in Benin from domestic and import sources at 0.32 and 0.68, respectively.

5. Results and Discussion

Rice imports represent a major source of rice consumption in Benin (Table 3). In both 2019 and 2020, Benin's domestic rice production covered less than 30 percent of the rice consumption in the country. India, Thailand, United Arab Emirates, Pakistan, and Singapore were the largest exporters of rice to Benin in both 2019 and 2020 (Table 4).

Table 4. Benin imports of rice (tons) by major sources, 2019-2020

Country	Quantity (tons)		Share (percentage)	
	2019	2020	2019	2020
India	701235.12	527076.05	45.98	59.69
Thailand	457984.64	140314.69	30.03	15.89
United Arab Emirates	251804.11	80321.80	16.51	9.10
Pakistan	76059.29	53737.47	4.99	6.09
Singapore	7614.97	31066.95	0.50	3.52
Others	30432.31	50492.09	2.00	5.72
Total	1525130.44	883009.04	100.00	100.00

Table 5 presents the estimates of the reduced form elasticities of the effect of COVID-19-related export restrictions implemented by the major rice exporters on rice market in Benin using the deterministic approach. The deterministic approach assumes that the model parameters are known with certainty. The results revealed that COVID-19-related trade restrictions decreased rice imports in Benin by 39 percent and rice consumption by 24 percent. As for the domestic rice production in Benin, COVID-19-related trade restrictions increased rice production in Benin by 5 percent while increased the price of rice by 8 percent.

Table 5. Reduced form elasticities of COVID-19-related export restriction on rice market in Benin using the deterministic approach

Endogenous variable	Reduced form elasticity
P_{BN}	0.08
$Q_{M,W}$	-0.39
$Q_{s,BN}$	0.05
$Q_{d,BN}$	-0.24

Table 6 presents the effect of COVID-19-related export restrictions on the rice market in Benin using the stochastic approach. This approach accounts for the uncertainty in the model parameters. The mean and 95% confidence intervals are generated from 1000 random draws from a triangular distribution. The results in the stochastic approach are consistent with those in the deterministic approach. That is, COVID-19-related export restrictions decreased the quantity of rice imported and consumed in Benin while induced an increase in the quantity of domestic rice produced. Similarly, the price of rice increased in Benin due to the export restrictions implemented in the rice exporting countries.

Table 6. Reduced form elasticities of the effect COVID-19 export restrictions on rice market in Benin using the stochastic approach

Endogenous variable	Reduced form elasticity		
	5% limit	Mean	95% limit
P_{BN}	0.07	0.08	0.10
$Q_{M,W}$	-0.41	-0.39	-0.37
$Q_{s,BN}$	0.05	0.06	0.07
$Q_{d,BN}$	-0.32	-0.24	-0.17

This rise in the price of rice in Benin could be explained by the shortage of rice resulting from the reduction in rice exports to Benin by the major rice exporters due to export restrictions. Similar results have been reported in the literature [28,29,30]. The impact of export restrictions in importing countries is influenced by both the market share of the exporting and importing countries. Export bans from large exporters are susceptible to influence the price of rice in importing countries compared to small economies. Headey [31] and Anderson and Nelgen [32] noted that export restrictions from major rice producers influence the international price of rice due to their share in the export markets. Similarly, Childs and Kiawu [33] pointed out a similar price impact in 2008 on the global rice market of export bans and restrictions implemented by major rice exporters. The reduction of exports from large rice exports creates a supply shortage in importing countries that induces price increase. As the price of rice is higher, domestic producers have more incentive to increase their production capacity to raise revenues and profit. This could explain the increase in the domestic production of rice in Benin. However, the modest increase in the domestic production level could be explained by the institutional constraints and the limited access to production factors by farmers such as technology and financial resources [34,35,36,37,38].

6. Conclusions and Policy Implications

In this paper, we analyze the impact of COVID-19-related export restrictions on rice market in Benin. We used the equilibrium displacement modelling framework. The reduced form model indicates that COVID-19 related trade restrictions decreased the quantity of rice imported and consumed in Benin while increased domestic rice production. As for the price effect, COVID-19-related export restrictions increased the price of rice in Benin. Using both the deterministic and stochastic approaches, the results suggest that COVID-19 export restrictions imposed by rice exporting countries decreased the quantity of rice imported in Benin by 39 percent while the domestic production of rice increased by 6 percent. Overall, rice consumption in Benin decreased by 24 percent. The price effect of COVID-19-related export restrictions is estimated at 8 percent.

This study highlights the vulnerability of rice import dependent developing countries to export restrictions from their major trade partners. Rice export restrictions from major trade partners may have significant food security implications for importing countries with limited production capacity. Thus, to reduce the negative impact of rice export restrictions on import dependent developing

countries, investment in production capacity improvement through agricultural research and infrastructures such as storage facilities may play a critical role. Additionally, promoting the economic diversification and the consumption of other locally produced crops can limit the reliance on a single crop and improve the economic resilience of the countries.

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