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The Impact of Maize Trade on the Development of the Maize Industry in Ghana

Richard Amponsah, Ximei Kong, Simon Abendin

Zhengzhou University, Zhengzhou, China
Email: amponsahrichard49@gmail.com, xmkmg@zzu.edu.cn, aadeletaboaa@gmail.com

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Abstract

This paper examines the impact of maize trade on the development of the maize industry in Ghana using a time series dataset for 1980-2019. The study adopted the multivariate vector error correction model (VECM). We assess whether maize trade spurs development in the maize industry and hence economic growth. The study further examined whether other production variables such as fertilizer, machinery, and FDI efficiently stimulates development in the maize industry. The empirical analysis results suggest that maize trade and other variables positively impact the maize industry in the long run. Firstly, the results show that the import and export of maize positively impact maize productivity in Ghana, hence growth in the maize industry development in the long run. Secondly, the inputs of production including, Land, Machinery, Labor, have a long-run positive significant relationship with the development of the maize industry in Ghana. Thirdly, other production inputs such as fertilizer have a positive non-statically long-run effect on the maize productivity in Ghana. Based on these findings, we recommend that governments look into policy initiatives on the development of the maize industry. The policy initiatives should provide financial and non-financial incentives such as fertilizer and certified seed subsidies, complimentary service provisions on inputs, good agronomic practices. Also, marketing of outputs over an E-Agriculture platform, and reduce trade restrictions to maximize maize production.

Keywords

Maize Trade, Maize Production, Maize Industry Development, Ghana and VECM

1. Introduction

Maize production is at the center of global food security and one of the most important cereal crops in human and animal diets worldwide. Maize is the most important cereal crop on the domestic market in Ghana. It accounts for more than one-quarter of calories consumed and about twice that of cassava, the most important crop (Adu et al., 2018). However, it is only the 7th largest agricultural commodity in terms of production value over 2014-2016, accounting for 3.3 percent of total agricultural production value (FAOSTAT, 2021). Maize accounts for 50% of Ghana's total cereal production, with reported postharvest losses between 5% and 70%. About three-quarters of maize consumption is from own production, suggesting maize has limited appeal as a cash crop (Kusmec et al., 2018). Aside from providing nutrients for humans and animals, maize serves as the primary raw material for producing starch, oil, protein, alcoholic beverages, food sweeteners, and fuel. Additionally, it is one of the most widely traded agricultural commodities amongst nations. Improving food security through a reduction of postharvest losses is imperative for meeting current developmental objectives.

The Ghana maize industry contributes significantly to the economy of Ghana, both upstream to the input industries and downstream to the processing industries (MoFA, 2021). Ghana's maize industry comprises producers or farmers, governmental organizations, and agribusinesses. Agribusinesses include trading companies, co-operatives, financial institutions. Moreover, the maize industry is divided into commercial and small-scale agriculture. Hence, it is an important crop from both the food security and income generation perspectives. It is worth noting that the industry is one of the most mechanized industries in Ghana, hence requires highly skilled labor relative to industries such as the table grape industry. With the maize industry included, primary agriculture contributes about 10% to formal employment (MoFA, 2020b).

Rising globalization within the food system has given rise to the need for agricultural industries to compete in domestic markets and globally. As a result of these new challenges, competitiveness has become a key focus for many industries (Esterhuizen, 2006). Ghana has imported small amounts of both white and yellow corn from Argentina and South Africa due to scarcity and its attendant high cost that occurred in those years. Corn imports in 2014/15 and 2016/17 were 2356MT, 98,880MT, 52,000MT respectively. Post estimated imports of 100,000MT in 2017/18 were estimated to increase seed and growing demand from the domestic poultry industry.

Moreover, the maize contribution towards foreign earnings has been growing. From 2012 to 2013, Ghana's maize foreign earnings grew significantly, and in real terms (MoFA, 2019). This was on the back of increasing maize exports, from 81,681 tons to 100,848 tons (FAOSTAT, 2017). Already average maize output over 2017 to 2019 has been 40 percent higher than the average output achieved between 2013 and 2016 (MoFA, 2020a). The Government of Ghana attributed this dramatic production response to the Planting for Food and Jobs (PFJ). The uncertainty is whether the marketing of maize in Ghana can absorb this increment in the maize output without significantly impacting the market prices or the profitability of maize cultivation. This is set to change as Ghana's Planting for Food and Jobs (PFJ) initiative, launched in 2017, prioritizes maize seed and fertilizer distribution and encourages market participation by smallholders (AGRA, 2019).

Hence there is a real need for businesses and governments to assess, understand and improve their international competitiveness concerning trade. Against this background, an open economy such as Ghana, which has large imports of agricultural inputs, gives rise to a need for the maize industry to be more internationally competitive. At present, the trade environment in Ghana's maize industry is informed by the deregulation process of agricultural markets and re-submission to World Trade Organization agreements.

There have been extensive works on trade and productivity, maize productivity, and intra-Ghana regional trade in maize (Boadu, 2011; FAO, 2012; Langyintuo, 2010; USAID, 2012). However, the relationship between international trade in maize and the development of the maize industry in the context of Ghana has not yet been explored. This study's primary aim and objective are to analyze the long-term effect of the international trade of maize and its impact on the maize industry in Ghana. This article tests the long-run impacts of international trade in maize on Ghana's maize industry development. Thus, we test the hypothesis that the import and export of maize positively influence the development of the maize industry in Ghana. Moreover, we also test the hypothesis that production inputs such as land, capital, labor, fertilizers, and farm machinery influence productivity and the development of the Ghanaian maize industry positively in the long run.

While some of these countries produce sufficient maize for their populations, others rely on maize imports or donations. Hence, it becomes a critical food security risk if significant producers/exporters of maize worldwide cannot meet expected demands in other parts of the world, under the challenges of the outbreak of plant diseases, increased domestic consumption of maize, and other relations.

Maize is one of the most important cereal crops produced and consumed in West Africa, but yields are far under their potential, and the production gap leads to growing import bills. The high cost of certified improved corn seeds and fertilizer has resulted in producers using bad seeds without fertilizer, resulting in low yields. The lack of agricultural mechanization, poor agronomic practices, and lack of processing/drying facilities have also led to low corn yields. Under the PFJ campaign, Ghana (GOG) introduced a 50 percent subsidy on fertilizer and seed in 2017 to make it affordable and increase fertilizer use. The present study will benefit the government in policies initiatives on the development of the maize industry. Thus, by providing financial and non-financial incentives opportunities and packages, subsidies fertilizer and certified seeds, complimentary service provisions on the usage of inputs, good agronomic practices, marketing of outputs over an E-Agriculture platform, and reducing trade restrictions to maximize maize production. The rest of the paper is organized as follows; Section 2 deals with literature and theoretical considerations, data and methods are covered in Section 3, empirical results and discussions are dealt with in Section 4, while the study is concluded in Section 5.

2. Literature Review and Theoretical Considerations

2.1. Empirical Evidence

To date, there have been a relative number of empirical-based studies into the impact of trade on productivity but specifically few empirical studies on the effects of maize trade on the development of the maize industry. In contrast, some studies have found a negative impact of trade on the industry regarding productivity, consequently impacting the economy (Crinò & Epifani, 2008).

Some empirical studies have confirmed a positive correlation between trade and income. Lewer & Van den Berg (2003), in a comprehensive literature survey, find a surprisingly robust result in many cross-sections and time-series studies: "A one percentage point increase in the growth of exports is associated with a one-fifth percentage point increase in economic growth" (Lewer & Van den Berg, 2003: p. 363). However, endogeneity concerns and the absence of convincing instruments have cast doubts on whether this observed correlation reflects a causal relationship.

Melitz (2003) while examining the impact of trade on intra-industry reallocations and aggregate industry productivity. She finds that these reallocations significantly contribute to productivity growth in the tradable sectors. In a related study, Bernard & Jensen (2001) find that within sector market share reallocations towards more productive exporting plants account for 20% of US manufacturing productivity growth. Berthou et al. (2019) examined productivity, misallocation, and trade in the Asian zone. They found that bilateral and unilateral export liberalization numerically increase aggregate productivity and welfare. They further note that unilateral import liberalization can either raise or reduce them. However, all three trade reforms have ambiguous sects in the presence of resource misallocation. Trade is a veritable instrument for organizing economic activities and moving food efficiently from surplus regions to deficit regions. It can smooth out the fluctuations and uncertainties inherent in local food production (Runge et al., 2003).

A concern about informal trade has gained precedence in the literature. According to Soule et al. (2001), informal trade highlights the gap between actors' real needs and the needs of public authorities caught up in an international environment that is even harder to manage. Cross-border trade can be a formal or informal, legal or illegal exchange of goods. It can be unlawful because it avoids official procedures and channels, but it does not mean that the traded products themselves are illegal. It can involve small amounts of food products moved over a short distance or large volumes moved over a vast distance.

Export bans can reduce domestic grain prices if the export is profitable. However, there are diverging views on the impact of export bans on commodity market prices in Africa. Porteous (2020) and Kizito et al. (2012) found no significant relationship between an export ban and domestic prices. The literature acknowledged that international trade could offer great opportunities for economic growth (Abendin & Duan, 2021). However, the potential benefits of international trade on growth are influenced by the production systems' environmental conditions. These, among others, include the skilled resources, technological intensity, degree of openness of the production structure, and employment distribution between tradable and non-tradable sectors. The innovation opportunities differ between industries due to differences in technological change (Pavitt, 1984) but could also result from sectorial interdependence. Regarding this last aspect, services are key activities in promoting market integration. The globalization of the production process has taken place, and the relationships among manufacturing companies have been scattered internationally, accompanied by a three-level process. On the contrary, it reflects the prevailing domestic supply.

Despite these government restrictions on formal cross-border trade, data collected in recent years show a considerable number of staple grains are traded across borders throughout the South African region through informal channels (Haggblade & Dewina, 2010). Informal traders deal in small quantities (usually just 50 - 100 kg at a time) without a trading license and with no official records in their transactions. With hundreds or sometimes thousands of small informal traders operating daily, however, the aggregate volume of informal trade can be substantial. Reliable high-frequency data on total informal trade throughout the region are not available. However, estimated figures confirm the quantity of informally traded maize across borders far exceeds that traded formally in recent years. Thus, the relationship between cross-border markets connected by informal trade may be very different than would be suggested by examining official trade data. The fact that informal transactions are difficult to regulate and occur outside the sphere of policy influence indicates the relationship between informal import and export markets can provide insights into how international markets within the region might perform in the absence of governance (Sihlobo, 2016).

While trade brings about stabilization of food supply by moving food from surplus to deficit areas, trade barriers limit agribusiness participation and the volume of the grain trade. Scholars including, Portugal-Perez & Wilson (Portugal-Perez & Wilson, 2012), and Odozi (2015), documented that barriers such as regulatory constraints that increase the price and limit access to key inputs such as seeds and fertilizers, high transport costs reflecting limited competition among providers of transport and logistics services, the costs of getting goods across borders and opaque and unpredictable trade policies, including export bans. The implication on the welfare of producers and urban consumers is well known in the literature. In 2011, more than 5,458,000 people (34.9% of the population) lived under food insecurity in Niger (Wongnaa & Awunyo-Vitor, 2017). An impact evaluation study made in Malawi (2005/06 to 2008/09) confirmed that the participation of households in the fertilizer and seed subsidy program/policies supports households to raise maize production and productivity (Dorward & Chirwa, 2011).

Similar findings have been found from a panel data analysis from Kenya. From the year 1997-2007, the productivity growth in maize is determined by an increase in fertilizer use, changes in the adoption of high-yielding seed varieties, and an increase in the fertilizer distribution outlets (Teka & Lee, 2017). Supporting this finding is also found in a study made in Southern Ethiopia. Labor, fertilizer use and oxen power are the significant variables affecting the productivity of maize cultivated by farm households (Geta et al., 2013).

2.2. Theoretical Framework

The traditional schools of thought have argued that exports lead to productivity. The Comparative advantage theory states that production will be maximized, and therefore, everyone will be better off if all parties only produce what they have a competitive advantage in. Essentially the argument is again coming from the specialization and trading argument point of view. In Ricardo's theory (David Ricardo, 1817), which was based on the labor theory of value (in effect, making labor the only factor of production), the fact that one country could produce everything more efficiently than another was not an argument against international trade. Mankiw offers the following: Differences in opportunity cost and comparative advantage create trade gains. One of the essential concepts in economic theory, comparative advantage, is a fundamental tenet of the argument that all actors, at all times, can mutually benefit from cooperation and voluntary trade. It is also a foundational principle in the theory of international trade. The theory of comparative advantage provides a strong argument in favor of free trade and specialization among countries. However, the issue becomes much more complex as the theory's simplifying assumptions a single factor of production, a given stock of resources, full employment, and balanced exchange of goods are replaced by more realistic parameters.

On the other hand, absolute advantage theory is the ability of any economic agent either, individual, company, region, or country, to produce a greater quantity of a good or service with the same quantity of inputs per unit of time. Also, to produce the same quantity of a good or service per unit of time using a lesser quantity of inputs than another entity that produces the same good or service—introduced by Scottish economist Adam Smith in his 1776 work, "An Inquiry into the Nature and Causes of the Wealth of Nations." The concept of absolute advantage was developed to show how countries can gain from trade by specializing in producing and exporting the goods they can produce more efficiently. Countries with an absolute advantage can decide to produce and sell a specific good or service and use the funds that good or service generates to purchase goods and services from other countries. By Smith's argument, specializing in the products they each have an absolute advantage in and then trading products can make all countries better off, as long as they each have at least one product for which they hold an absolute advantage over other nations.

Intra Industry theory is the trade of goods within the same industry from one country to another. We conduct a theory-based empirical study of intra industry trade homogeneous products. We derive an oligopolistic intra-industry trade model, which is an extension of the segmented market model of trade initially proposed by (Brander, 1981). The practical implementations of the model are investigated in the context of the petrochemical industry. Intra-industry trade reduces the demands for protection because there are both exports and imports in any industry, making it difficult to achieve unanimity among those demanding protection (Marvel & Ray, 1987).

Another strand of thought is the infant-industry theory. It states that new industries in developing countries need protection against competitive pressures until they mature and develop economies of scale that can rival their competitors by Alexander Hamilton and Friedrich 19th century. The infant industry argument is often cited as a rationale for protectionism. Infant-industry theorists argue that industries in developing sectors of the economy need to be protected to keep international competitors from damaging or destroying the domestic infant industry. Infant industries, they argue, do not have the economies of scale that older competitors in other countries may have and should be protected just until they have built a similar economic scale. In response to these arguments, governments may enact import duties, tariffs, quotas, and exchange rate controls to prevent international competitors from matching or beating an infant industry's prices, thereby giving the infant industry time to develop and stabilize. The infant-industry theory holds that once the emerging industry is stable enough to compete internationally, any protective measures introduced, such as tariffs, are intended to be removed. In practice, this is not always the case because e the various protections that were imposed may be challenging to remove. All the theories discussed above remain relevant even today. They serve as a guideline in many nations when they engage in trade policies. However, with globalization and trade liberalization, today's world is more complex, hence cannot be simplified by a single theory.

3. Research Methodology

3.1. Description of Variables and Sources of Data

We employed annual data from 1980 to 2019 in the study. The availability guided this option during the study period regarding the overarching benefit of employing annual time series data, which are immune to short-run transitive and recurrent shocks (Beetsma et al., 2008). The data were sourced from the United Nations Conference on Trade and Development Statistics (UNCTADSTAT), Food and Agricultural Organization (FAO), and the World Bank Development Indicators (WDI). With the view to removing the likely heteroskedasticity and obtaining non-linear properties in the data, all the variables (PROD, EXP, IMP, FERT, MACH, LAND, LABOR, and ECOGTH) were transformed into their natural logs before the estimations.

3.2. Model Specification

The present study adopted the multivariate Vector Error correction Model (VECM) to investigate the impact of maize trade on the development of the maize industry in Ghana. A common advantage of the VECM estimation model is that it helps avoid errors in the model specifications. This is true because it does not require a functional form relationship of the employed variables in the priori. In a VECM, a short-run dynamic change is allowed after an innovation or a shock since all the variables would eventually revert to their long-run values.

In this study, the multivariate VECM specifications of the variables employed in the study are presented in eight (8) endogenous variables:

$$\begin{aligned}&\Delta \ln \mathrm{PROD}_t \\ &= \alpha_1 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m} \\ &+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k} \\ &+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_1 \mathrm{ECT}_{t-1} + \mu_{1t}\end{aligned} \tag{1}$$

$$\begin{aligned}&\Delta \ln \mathrm{IMP}_t \\ &= \alpha_2 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m} \\ &+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k} \\ &+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_2 \mathrm{ECT}_{t-1} + \mu_{2t}\end{aligned} \tag{2}$$

$$\begin{aligned}&\Delta \ln \mathrm{EXP}_t \\ &= \alpha_3 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m} \\ &+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k} \\ &+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_3 \mathrm{ECT}_{t-1} + \mu_{3t}\end{aligned} \tag{3}$$

$$\begin{aligned}&\Delta \ln \mathrm{FERT}_t \\ &= \alpha_4 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m} \\ &+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k} \\ &+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_4 \mathrm{ECT}_{t-1} + \mu_{4t}\end{aligned} \tag{4}$$

$$\begin{aligned}&\Delta \ln \mathrm{MARCH}_t\\&= \alpha_5 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m}\\&+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k}\\&+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_5 \mathrm{ECT}_{t-1} + \mu_{5t}\end{aligned} \tag{5}$$

$$\begin{aligned}&\Delta \ln \mathrm{LAND}_t\\&= \alpha_6 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m}\\&+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k}\\&+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_6 \mathrm{ECT}_{t-1} + \mu_{6t}\end{aligned} \tag{6}$$

$$\begin{aligned}&\Delta \ln \mathrm{LABOR}_t\\&= \alpha_7 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m}\\&+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln LAND_{t-k}\\&+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_7 \mathrm{ECT}_{t-1} + \mu_{7t}\end{aligned} \tag{7}$$

$$\begin{aligned}&\Delta \ln \mathrm{ECOGTH}_t\\&= \alpha_8 + \sum_{i-1}^{k-1} \beta_i \Delta \ln \mathrm{PROD}_{t-i} + \sum_{j-1}^{k-1} \phi_j \Delta \ln \mathrm{IMP}_{t-j} + \sum_{j-1}^{k-1} \varphi_m \Delta \ln \mathrm{EXP}_{t-m}\\&+ \sum_{n-1}^{k-1} \psi_n \Delta \ln \mathrm{FERT}_{t-n} + \sum_{h-1}^{k-1} \gamma_h \Delta \ln \mathrm{MACH}_{t-h} + \sum_{k-1}^{k-1} \upsilon_k \Delta \ln \mathrm{LAND}_{t-k}\\&+ \sum_{g-1}^{k-1} \pi_g \Delta \ln \mathrm{LABOR}_{t-g} + \sum_{w-1}^{k-1} \delta_w \Delta \ln \mathrm{ECOGTH}_{t-w} + \lambda_8 \mathrm{ECT}_{t-1} + \mu_{8t}\end{aligned} \tag{8}$$

where: $\ln\mathrm{PROD}_t$ measures maize productivity of the industry, $\ln\mathrm{IMP}_t$ and $\ln\mathrm{EXP}_t$ represent maize trade by the industry; $\ln\mathrm{FERT}_t$ measures the consumption of various types of fertilizers consumed; $\ln\mathrm{MACH}_t$ represents the farming types of equipment in the maize industry; $\ln\mathrm{LAND}_t$ measures as a percentage of the land area represent agricultural land available to the industry; $\ln\mathrm{LABOR}_t$ takes care of skilled and unskilled labor in the industry; lnECOGTH as gross domestic product per capita, which measures the economic growth. Also, β_i; ϕ_j; φ_m; ψ_n; γ_h; υ_k; π_g and δ_w represent the short-run coefficient of the model's adjustment long-run equilibrium. $K - 1$ is the lag length reduced by 1; λ (1 - 8) represents the speed of adjustment parameter with a negative sign. ECT_{t-1} is the error correction term lagged value of the residuals obtained from the dependent variable's cointegration regression on the regressors. It contains long-run information derived from the long-run cointegrating relationship; α (1 - 8) is the constant term. Finally, μ_{it} (1 - 8) represents the stochastic terms often called impulses, innovations, or shocks.

4. Results and Discussion

4.1. Summary Statistics

The descriptive statistics of the explained variable production activity (PROD) and the explanatory variables, labor (LABOR), machinery (MACH), land (LAND), maize exports (EXPORT), maize imports (IMPORT), fertilizer (FERT), gross domestic product per capita (ECOGTH), from the time-series data generated for the periods 1980-2019 are presented in Table 1. Since the mean is prone to outliers, the discourse now focuses on the median of the distribution, skewness, kurtosis, and the Jarque-Bera estimates.

PROD, a measure of productivity, has a median of 705,101.5 and the second-highest value among the variables for the median. The analysis shows that Imports as a measure of trade has the median value of 439,118.5, putting it in the third position as the highest value in terms of median value in this study. It can also be observed from Table 1 that export as a measure of trade provides a median value of 26,311.5, indicating the fourth-highest value median. This implies that the Ghanaian maize industry imports more maize than they export to other countries. The results reported in Table 1 show that LAND has the highest median among the variables of 746,183.5. The rest of the variables, including MARCH, LABOR, and ECOGTH, have median values of 49.5, 466.0, and 2.0, respectively, suggesting economic growth with the least median value.

Regarding skewness, it is also apparent from Table 1 indicates that only ECOGTH is negatively skewed, which implies that the actual values are more significant than the mean. However, PROD, IMPORT, EXPORT, FERT, LAND, MACH, and LABOR are positively skewed, showing that actual values are smaller than the mean values of the variables.

Table 1. Summary statistics.

	PROD	IMP	EXP	FERT	LAND	MACH	LABOR	ECOGTH
Mean	743,073.4	421,080.4	35,794.1	11,485.2	807,680.8	50.1	529.9	1.9
Median	705,101.5	439,118.5	26,311.5	1415.8	746,183.5	49.5	466.0	2.0
Maximum	1,400,000.0	941,159.0	100,848.0	43,540.0	1,246,199.0	52.7	1397.0	11.3
Minimum	372,000.0	135.0	31.0	215.3	432,443.0	48.3	113.0	−9.5
Std. Dev.	228,138.2	275,850.0	28,940.6	13,880.8	233,111.6	1.4	288.2	3.6
Skewness	0.6	0.0	0.4	0.7	0.4	0.7	0.9	−0.9
Kurtosis	3.3	1.9	1.9	2.0	1.9	2.0	3.4	6.1
Jarque-Bera	2.2	2.1	2.8	5.4	2.9	4.6	5.3	21.7
Prob. Value	0.3	0.4	0.2	0.1	0.2	0.1	0.1	0.0
Obs.	40	40	40	40	40	40	40	40

Source: Authors' estimate from research data.

The kurtosis values in Table 1 for PROD (3.3), LABOR (3.4), and ECOGTH (6.1) are greater than three, indicating their values are not normally distributed for the sampled and are leptokurtic, which means that the variables are at peak-flatted with higher values above the mean average. On the other hand, IMPORT (1.9), EXPORT (1.9), FERT (2.0), LAND (1.9), and MACH (2.0), has kurtosis values less than three suggesting that the value of the variables mirrors a normal distribution and has well-behaved tails.

Concerning the Jarque-Bera, except ECOGTH, all the statistics are not significant, indicating that variables are normally distributed because the null hypothesis could not be accepted. However, with the case of ECOGTH, the null hypothesis could not be rejected suggest that the variable is not normally distributed.

4.2. Time Series Unit Root Test (ADF)

The unit root test results of the time series data for augmented Dickey-Fuller (ADF) are reported in Table 2. Table 2 indicates that all the variables are non-stationary at level but stationary in the first difference. This implies that the null hypothesis that the variables are non-stationary at level could not be rejected. Therefore, all the variables used in the study follow a unit root process. We, thus, used the first difference of the variables that are integrated of order one I (1) in the analysis.

4.3. Johansen Cointegration Test

The results of the cointegration tests are presented in Table 3. Results in Table 3 show that the maximum eigenvalues and trace test statistics imply that the hypothesis of no cointegration among the variables is dismissed at the 5 percent significance level. The results indicate one cointegrating vector among the variables of interest-based on both the max-eigenvalues and trace test statistics.

Table 2. Time series unit root test (ADF) results.

variables	Level		Difference	
	t-statistic	Probability value	*t*-statistic	Probability value
lnPROD	3.7259	0.9998	−6.9378	0.0000
lnIMP	0.4987	0.8177	−3.6383	0.0007
LNEXP	0.1881	0.7355	−6.7783	0.0000
lnFERT	−1.1204	0.6978	−10.1610	0.0000
lnLAND	3.8894	0.9999	−8.8317	0.0000
lnMACH	−0.3561	0.5499	−9.2745	0.0000
lnLAND	−1.6268	0.4597	−4.0073	0.0036
lnECOGTH	−1.4252	0.1412	−9.9340	0.0000

Source. Authors' estimate from research data.

Table 3. Johansen Cointegration test results.

Null Hypothesis	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
Ho: r = 0	185.987***	159.530	78.023***	52.363
Ho: r ≤ 1	107.964	125.615	41.367	46.231
Ho: r ≤ 2	66.597	95.754	28.303	40.078
Ho: r ≤ 3	38.294	69.819	18.084	33.877
Ho: r ≤ 4	20.210	47.856	11.895	27.584
Ho: r ≤ 5	8.315	29.797	4.821	21.132
Ho: r ≤ 6	3.494	15.495	3.484	14.265
Ho: r ≤ 7	0.010	3.841	0.010	3.841

Source: Authors' estimate from research data; r denotes the number of cointegrating vectors; and ***, **, * indicates statistically significant at 1% and 5%, 10%, respectively.

In the presence of long-term relationships among the variables, it is imperative to use the VECM.

4.4. Long-Run Estimates

The results reported in **Table 4** show that in the long run, imports have a positive effect on the maize industry development in Ghana, measured as productivity. Similarly, it is observed from **Table 4** that exports also impact positively on the maize industry development in Ghana on average, ceteris paribus, and the coefficients are statistically significant at 5% and 1% significance levels, respectively. The implications are that imports and exports of maize in Ghana tend to support the development of the maize industry. Specifically, a one percentage change in imports and exports increases the growth of the maize industry in Ghana by 0.22% and 0.37%, respectively. Our results support the evidence provided by (Casas-Lozano et al., 2015; Cassiman et al., 2010; Kasahara & Lapham, 2013; Olper et al., 2014).

Moreover, from **Table 4**, it is observed that the coefficients of the relationship between maize productivity and fertilizer suggest that there exists a positive non-statistically significant relationship. **Table 4** indicates that land impact positively on maize production in Ghana at a 1% statistical significance level. This finding is consistent with the economic theory that land is a major determinant of agricultural investment and productivity. The results tend to support the view that farmland availability promotes agricultural activities and increases maize productivity—specifically, an increase in the size of farmland in maize productivity by 2.3424% ceteris paribus. The coefficient of farming equipment (machinery) is positively statistically significant at a 1% significance level. Our results are in line with Melesse and Bulte (2015) findings, who found positive effects of land on agricultural productivity. It can be observed from **Table 4** that a 1% increase in capital endowment (Machinery) increases maize output by 1.8131%

Table 4. Long-run estimates.

Constant	lnIMP	lnEXP	lnFERT	lnLAND	lnMACH	lnLABOR	lnECOGTH
357.2151	0.2204	0.3708	0.0131	2.3424	1.8131	75.0926	−0.9429
	0.1069	0.0920	0.1111	0.8188	0.2027	10.0975	0.1740
	[2.0618]	[4.0304]	[0.117]	[2.8609]	[8.9437]	[7.4368]	[−5.4181]

Source: Authors' estimate from research data.

ceteris paribus. This result supports the economic theory as it is expected that as capital endowment increases, output increases. The explanation is that as there is the availability of farming machinery to maize producers in Ghana, all things being equal leads to an increase in maize productivity in the country and, as a result, an increase in the export of maize. The increase in the export of maize tends to promote the development of the maize industry in Ghana. Our findings are in line with the results documented by (Mahadevan & Suardi, 2011).

Also, the estimated coefficients in Table 4 suggest that labor positively promotes maize productivity in Ghana. The possible explanation that we can give to the positive impact of labor on productivity is the knowledge transfer through trade, thus importing is significant to the development of labor skills in Ghana's maize industry. The estimated coefficients indicate that a 1% increase in labor and skilled labor availability increases maize productivity by 75.0926%, all else remaining constant.

4.5. Causality Test Results

The study conducted two causality tests, thus the short run and the long-run tests. The results are documented in Table 5(a) observed a bidirectional relationship between productivity and other variables in the long run and is statistically significant at a 1% significance level. This implies, the null hypothesis that all the variables in the VECM system do not granger cause maize productivity in the maize industry in Ghana is rejected at a 1% statistical significance level. The short-run results in Table 5(a) indicate that all the system variables do not Granger-cause maize productivity in the Ghanaian maize industry.

In Table 5(b), the results support the hypothesis that productivity does not Granger-Cause other variables in the VECM system. Thus, there is no causality between maize productivity in Ghana and the other variables (lnIMP, lnEXP, lnFERT, lnLAND, lnMACH, lnLABOR, and lnECOGTH). The results indicate a flow of causality from maize productivity to maize imports and exports, farm machinery, and economic growth in Table 5(b) at a 1% level of significance in the long run. The causality between productivity and the other variables in the short run is not significant.

4.6. Estimated VECM

The VECM estimates reported in Table 6 are additions to the causality test

Table 5. Causality test results. (a) Causality from other variables to productivity; (b) Causality from productivity to other variables.

(a)

Hypothesis	Long run	Short-run
lnIMP → lnPROD	−0.0664***	0.6049
lnEXP→ lnPROD		0.8130
lnFERT → lnPROD		0.7391
lnLAND → lnPROD		0.4635
lnMACH → lnPROD		0.5944
lnLABOR → lnPROD		0.7071
lnECOGTH → lnPROD		0.6800

(b)

Hypothesis	Long run	Short-run
lnPROD → lnIMP	−1.1071***	0.624848
lnPROD → lnEXP	−0.5988***	
lnPROD → lnFERT	−0.1832	
lnPROD → lnLAND	−0.0055	
lnPROD → lnMACH	−0.2783***	
lnPROD → lnLABOR	−0.0007	
lnPROD → lnECOGTH	−0.3757***	

Source: Authors' estimate from research data; Notes: The degree of freedom for the chi-square statistics is 1 for long- and short-run causality. → denotes "Granger-causes." *** significance at 1% level. ** significance at 5% level. * Significance at 10% level.

Table 6. Estimated VECM.

Dependent Variable	ΔlnPROD	ΔlnIMP	ΔlnEXP	ΔlnFERT	ΔlnLAND	ΔlnMACH	ΔlnLABOR	ΔlnECOGTH
CointEquation (1)	−0.0664***	−1.1071***	−0.5988***	−0.1832	−0.0055	−0.2783***	−0.0007	−0.3757***
	(0.0271)	(0.1778)	(0.1960)	(0.1151)	(0.0141)	(0.0986)	(0.0007)	(0.1540)
lnPROD (−1)	−0.0123	0.7719	0.3890	0.3216	0.0868	0.4404	−0.0022	0.5330
	(0.2277)	(1.4920)	(1.6444)	(0.9655)	(0.1184)	(0.8271)	(0.0059)	(1.2923)
lnIMP (−1)	−0.0150	−0.5528**	0.2031	−0.0427	−0.0019	0.0870	−0.0001	−0.0213
	(0.0190)	(0.1247)	(0.1375)	(0.0807)	(0.0099)	(0.0692)	(0.0005)	(0.1080)
lnEXP (−1)	−0.0052	0.3778	0.2043	−0.0229	−0.0179	0.1901	0.0006	−0.0040
	(0.0351)	(0.2302)	(0.2538)	(0.1490)	(0.0183)	(0.1276)	(0.0009)	(0.1994)
lnFERT (−1)	0.0112	−0.1787	−0.0168	−0.4241*	0.0081	−0.0482	0.0004	0.0615
	(0.0370)	(0.2426)	(0.2674)	(0.3570)	(0.0193)	(0.1345)	(0.0010)	(0.2102)
lnLAND (−1)	−0.4991	2.1766	−4.0040	−1.4576	−0.2749	1.1864	−0.0161**	−0.9001
	(0.3386)	(2.2187)	(2.4453)	(1.4358)	(0.1761)	(1.2299)	(0.0088)	(1.9217)
lnMACH (−1)	0.0368	1.1614***	0.0289	0.2808	−0.0056	−0.2589	−0.0001	0.3254
	(0.0560)	(0.3672)	(0.4047)	(0.2376)	(0.0291)	(0.2035)	(0.0015)	(0.3180)

Continued

lnLAND (−1)	7.6651	33.7850	53.9833	26.8305	−0.6360	0.5227	0.4505**	45.1739
	(7.0201)	(45.9949)	(50.6919)	(29.7653)	(3.6502)	(25.4971)	(0.1822)	(39.8386)
lnECOGTH (−1)	0.0420	0.3500	0.5511**	0.3008**	−0.0060	0.0629	0.0013	−0.3035
	(0.0347)	(0.2274)	(0.2506)	(0.1471)	(0.0180)	(0.1260)	(0.0009)	(0.1969)
C	0.0686	0.0802	0.2795	−0.0670	0.0283*	−0.0946	−0.0008	0.1772
	(0.0298)***	(0.1952)	(0.2151)	(0.1263)	(0.0155)	(0.1082)	(0.0008)	(0.1691)
				Diagnostic statistics				
R-squared	0.3487	0.6652	0.4329	0.4116	0.2595	0.4605	0.2628	0.4074
Adj. R-squared	0.1393	0.5576	0.2506	0.2225	0.0215	0.2871	0.0258	0.2170
Sum sq. resids	0.5164	22.1656	26.9239	9.2829	0.1396	6.8115	0.0003	16.6291
S.E. equation	0.1358	0.8897	0.9806	0.5758	0.0706	0.4932	0.0035	0.7706
F-statistic	1.6656	6.1824	2.3746	2.1767	1.0903	2.6559	1.1090	2.1391
Log likelihood	27.7529	−43.6778	−47.3728	−27.1407	52.6050	−21.2591	166.5065	−38.2175

Source: Authors' estimate from research data; The standard errors in parentheses, ***significance at 1% level. **significance at 5% level. *Significance at 10% level.

results documented in Table 5. The productivity model shows that one-lagged period long-run causality of lnPROD, lnIMP, lnEXP lnFERT, lnLAND, lnMACH, lnLAND, and lnECOGTH on lnPROD. The estimated ECM coefficient −0.664 shows a long-run causality of a 1% level of significance. Results of the lnIMP, lnEXP, lnMACH, and lnECOGTH models document evidence of long-run causality from the other variables in the VECM system. This implies that that lnIMP, lnEXP, lnMACH, and lnECOGTH are responsive to the changes in lnPROD, lnFERT, lnLAND, and lnLABOR. The lnImports model results indicate that the import of maize in Ghana is statistically influenced by variation in farm machinery. However, the maize industry's level of farm machinery availability is not influenced by variation in maize importation by the Ghanaian maize industry, as indicated in the lnMACH model.

The results of the lnEXP model provide evidence that the changes in the exportation of maize by the Ghanaian industry are stimulated by the changes in the economic growth of the importing country. The implication of this is that a percentage change in the importing country's economic growth is associated with a 0.5511% change in Ghana's maize export in the short-run ceteris paribus. The lnFERT, lnLAND, and lnLABOR models' results indicate that the other variables in the system do not statistically significant determinants of lnFERT, lnLAND, and lnLABOR. This implies that the demand for fertilizers, land, and labor in Ghana's maize industry is not influenced statistically by changes in the other variables identified in the VECM system.

Refer to the diagnostic tests related to serial correlation and heteroscedasticity in the Appendix. The residual serial correlation tests (Table A1) show that the residuals do not correlate. The model meets the Heteroskedasticity testing requirements, as shown in Table A1. The estimated model follows the characteristic polynomial convergence criterion, as deduced from the estimated roots in Table A2.

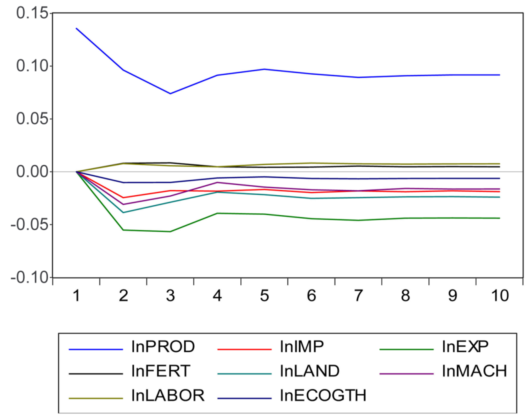
4.7. Generalized Impulse Response Function and Variance Decomposition

Figure 1 displays all the variables of the VECM model of the sample's impulse response functions. The accumulated impulse responses are presented over time. The response of lnPROD to lnIMP and lnEXP shocks is positive and statistically significant. This seems to be consistent with our findings. Consequently, in the earlier stages, there is a decrease in productivity from period one to period, then rise again in period and at a stable stage from period four. From (b), it can be observed that imports react positively to the one standard deviation shocks in productivity and exports of maize. The implies that both productivities have helped import maize into Ghana throughout the forecast time horizon even though there were some fluctuations throughout the forecast period. Also, from (c), the accumulated response of exports to productivity and import shocks is positive and statistically significant. This means that increase in the production of maize can induce maize export in Ghana.

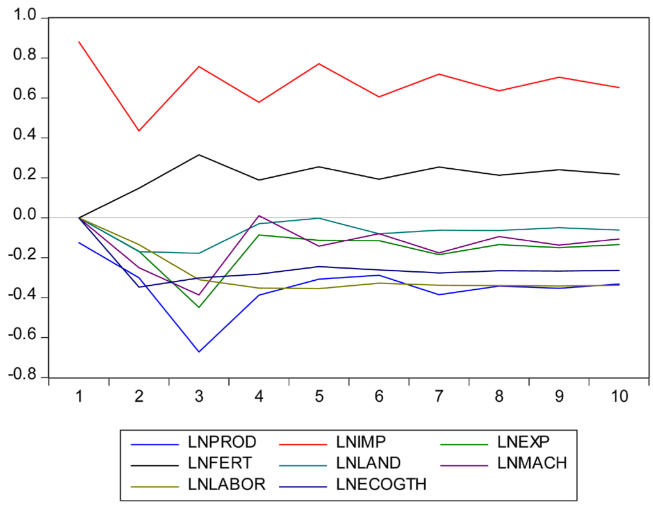
Tables 7(a)-(c), summarize the variance decompositions of the primary variables of interest, specifically lnProd, lnImports, and lnExports after 10 years respectively: (the results of other variables are not reported here to conserve space, but are provided in Panel A1 in the Appendix). We have categorized the period of our forecast in the short (period 1), medium (period 5), and long-run (period 10).

Table 7(a), in the short-run (period 1), 100% of the forecast error's variance in lnProd is explained by lnProd own shocks. Thus, lnPROD, lnIMP, and lnEXP are strongly exogenous, implying that they are fragile to influence the prediction of lnPROD in the future. It can be observed that as we move into the medium term (period 5), the variations of lnProd from its shock are dwindling. In contrast, the shocks of imports and exports on lnProd variations have increased to about 2% and 14%, respectively. This means imports and export are exhibiting endogenous characteristics on productivity as we move into the future. In the long run, that is, after ten years, lnIMP and lnEXP explained about 3% and 15%, respectively, the forecast variance of lnPROD. The results imply that maize productivity in Ghana has not been highly influenced by maize imports but rather by its export over the years.

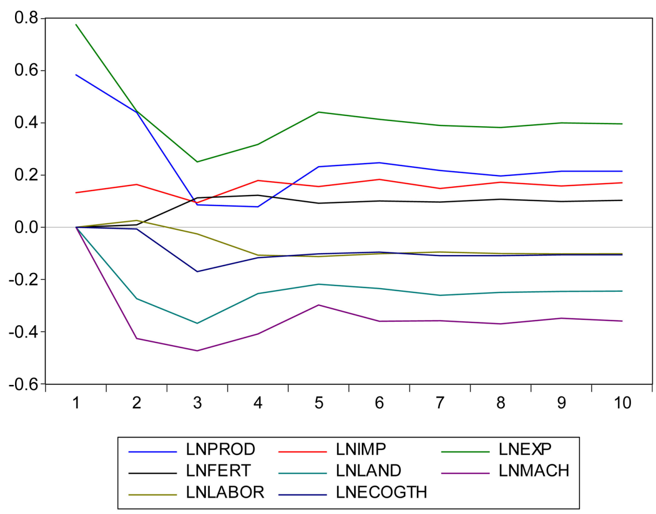
The results in (b) show evidence that in the short-run (period), 98% of the variable in the variable lnIMP is explained by its own shocks. In comparison, the variable lnPROD explained only 2%, and the variable lnEXP is strongly exogenous. This suggests that the variables lnProd and lnEXP weakly predict the significant variation in the maize industry's import of maize in Ghana. Moving into the medium term (period 5), the percentage of the variations in lnIMP explained



(a)



(b)



(c)

Figure 1. Impulse response functions. Source. Authors' estimate from research data. Note: (a) Accumulated response of lnPROD to generalized one S.D. innovations; (b) Accumulated response of lnIMP to generalized one S.D. innovations; (c) Accumulated response of lnEXP to generalized one S.D. innovations.

Table 7. Variance decomposition. (a) Variance decomposition of lnProd; (b) Variance decomposition of lnImports; (c) Variance decomposition of lnExports.

(a)

Period	S.E.	lnPROD	lnIMP	lnEXP	lnFERT	lnLAND	lnMACH	lnLABOR	lnECOGTH
1	0.1358	100.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1845	81.4056	1.7597	8.9416	0.1915	4.4049	2.8070	0.1795	0.3102
3	0.2112	74.3921	2.0528	14.0408	0.3047	5.2199	3.3193	0.2082	0.4622
4	0.2354	74.9887	2.2605	14.0916	0.2855	4.8727	2.8569	0.2085	0.4356
5	0.2598	75.5183	2.2675	13.9601	0.2620	4.6995	2.6591	0.2424	0.3910
6	0.2820	74.9215	2.4135	14.3337	0.2465	4.7897	2.6208	0.2904	0.3839
7	0.3017	74.2381	2.4716	14.8442	0.2475	4.8504	2.6450	0.3173	0.3860
8	0.3202	73.9849	2.5448	15.0651	0.2413	4.8562	2.5918	0.3336	0.3822
9	0.3378	73.8327	2.5720	15.2201	0.2381	4.8493	2.5634	0.3473	0.3772
10	0.3546	73.6723	2.6155	15.3498	0.2335	4.8585	2.5366	0.3602	0.3736

(b)

Period	S.E.	lnPROD	lnIMP	lnEXP	lnFERT	lnLAND	lnMACH	lnLABOR	lnECOGTH
1	0.8897	1.9550	98.0450	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.1620	7.8184	71.5130	2.0796	1.6144	2.1306	4.6202	1.3355	8.8882
3	1.7446	18.2812	50.6009	7.5487	3.9754	1.9866	6.9411	3.7431	6.9231
4	1.9431	18.6973	49.6601	6.2832	4.1546	1.6238	5.5982	6.3033	7.6795
5	2.1793	16.8487	52.0204	5.2635	4.6711	1.2909	4.8734	7.6627	7.3693
6	2.3318	16.2376	52.1879	4.8378	4.7708	1.2460	4.3729	8.6571	7.6900
7	2.5350	16.0466	52.2107	4.6266	5.0440	1.1148	4.1776	9.0922	7.6875
8	2.6850	15.9214	52.1515	4.3745	5.1240	1.0505	3.8462	9.7003	7.8317
9	2.8494	15.6684	52.4121	4.1608	5.2641	0.9622	3.6445	10.0529	7.8349
10	2.9864	15.4951	52.4866	3.9901	5.3236	0.9184	3.4439	10.4294	7.9129

(c)

Period	S.E.	lnPROD	lnIMP	lnEXP	lnFERT	lnLAND	lnMACH	lnLABOR	lnECOGTHowth
1	0.9806	35.4605	1.8231	62.7163	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.2799	32.6296	2.7132	48.9356	0.0050	4.5700	11.1032	0.0407	0.0028
3	1.4557	25.5717	2.5119	40.7916	0.5998	9.9358	19.1620	0.0616	1.3657
4	1.5905	21.6635	3.3738	38.1473	1.0955	10.8826	22.6523	0.5012	1.6838
5	1.7237	20.2594	3.6904	39.0495	1.2173	10.8701	22.2788	0.8485	1.7859
6	1.8577	19.2121	4.1510	38.5718	1.3428	10.9560	22.9382	1.0274	1.8007
7	1.9747	18.2179	4.2404	38.0439	1.4275	11.4403	23.5935	1.1397	1.8968
8	2.0849	17.2311	4.4891	37.4938	1.5458	11.6925	24.3164	1.2569	1.9745
9	2.1888	16.5929	4.5929	37.3539	1.6045	11.8741	24.6007	1.3569	2.0241
10	2.2900	16.0375	4.7503	37.1176	1.6690	11.9915	24.9378	1.4356	2.0608

Source. Authors' estimate from research data.

by its own shocks decreased to 52%, while those of lnPROD and lnEXP increased to 17% and 5%, respectively. However, in the long run, the forecast error variance in lnImports is still explained by 52% of its own shocks as in the medium term.

In contrast, lnPROD and lnEXP explained 16% and 4% variations in lnImports, respectively. The results suggest that maize productivity level might have caused the level of maize imports into the country. This is because the shocks emanating from lnPROD in the medium and the long-run is more than the combined of all the three periods for lnImports. (c) represents the variance decomposition of the lnEXP variable in the VECM estimations. It shows that in the short-run, lnPROD shocks and lnEXP own shocks contribute significantly to the variation in lnEXP, that is, after one year at 35% and 63%, respectively. However, lnImports exhibit a minimal contribution to the variation in lnEXP in the short-run at only 1.8%. In the medium period (period 5), the results indicate that the shocks of lnProd and lnImports contribute 20% and 4% to the variations in lnEXP. In the long run, after ten years, lnPROD and lnIMP shocks explain about 16% and 5%, respectively, of the variation of lnEXP. Again, these results are similar to the results of lnImports variance decomposition in (b), suggesting maize productivity level in Ghana's maize industry influences the level of maize export by the industry.

5. Conclusion

The study aims to estimate the impact of maize trade on the development of the maize industry in Ghana for 1980-2019. A fully modified multivariate Vector Error correction Model (VECM) is used to examine these effects. The results of this study contribute to the literature regarding the relationship between maize trade and the development of the maize industry in Ghana. This study found that the maize trade can promote the development of the maize industry in Ghana in the long run. Further, the results agreed with the investigations by the following authors; (Casas-Lozano et al., 2015; Cassiman et al., 2010; Kasahara & Lapham, 2013; Olper et al., 2014).

In detail, the study revealed that international trade has an economically significant and statistically robust positive effect on productivity. The study's trade measure is imports plus exports relative, which we argue is preferable on theoretical grounds towards the nominal measure conventionally used. Our analysis for the channels through which trade and scale affect productivity yields that they both worked through total factor productivity. Many empirical studies have been conducted to analyze the effect of international trade on production. Significant productivity growth in the agricultural sector can lead to significant increases in national income, increasing domestic demand for agricultural products. Low-income countries are most likely to have significant increases in demand for agricultural products when productivity increases. Outward shifts in the demand for agricultural products could offset productivity-induced shifts in the agricultural supply. This is one possible explanation for the empirical results. This explanation, coupled with the empirical results reported, can argue against the recent trade theories, suggesting that a "technology gap" between countries constitutes the fundamental basis for trade. The study used descriptive time series multivariate Vector Error Correction Model (VECM) techniques to determine the maize trade trend and evaluate the impact of the maize trade on the development of the maize industry, respectively. The major findings of the present study were that there is a long-term relationship between the maize trade and the development of the maize industry in Ghana. Also, the InIMP and LNEXP, which are proxies for trade, have a significant positive relationship at 1% and 5% significance levels, respectively, with maize industry development in Ghana.

In addition, the study documented that InIMP, LNEXP, and the other control variables InLAND, InMACH, and lnLABOR have a long-run positive significant relationship with the development of the maize in Ghana. However, variables including lnFERT have positive non-statistically significant long-run effects on productivity 1% statistical significance level, and lnECOGTH has an adverse long-run effect on the development of the maize industry at a 5% significance level. The empirical findings of this study further showed that other variables in including InLAND, InMACH, and lnLABOR, have a significant positive effect on maize productivity. In contrast, lnFERT has a positive non-statistically significant, and lnECOGTH has a negative effect on maize productivity.

Several policy implications have emanated from this study. One of the policy implications from the present study's findings is that maize trade has become an important determinant of maize production, which is linked to the objective of this study. Therefore, it is recommended that the government of Ghana play a role in ensuring that trade barriers and restrictions are reduced to increase maize production. Since fertilizer and machinery combined effectively with land and labor in developing the maize industry. Governments should look into policies initiatives on the development of the maize industry by providing financial and non-financial incentives opportunities and packages, subsidies fertilizer, certified seeds, complimentary service provisions on the usage of inputs, good agronomic practices, marketing of outputs over an E-Agriculture platform to maximize maize production.

Notwithstanding the efforts put in this study, the specific limitation cannot be avoided. First, the scope of the study is narrow, specifically to maize trade and production in Ghana (West Africa), which may not be sufficient for the general conclusion that trade affects productivity. Therefore, widening the research scope in the future to cover other continents for comparative analysis will be a source of significant research contribution to the literature. This study has included other determinants of maize productivity that provided further insight into the determinants of maize industry development in Ghana. However, we were unable to assess the interaction effect between these other determinants development of the maize industry in the present study. Further research in this regard is required to fill this research gap.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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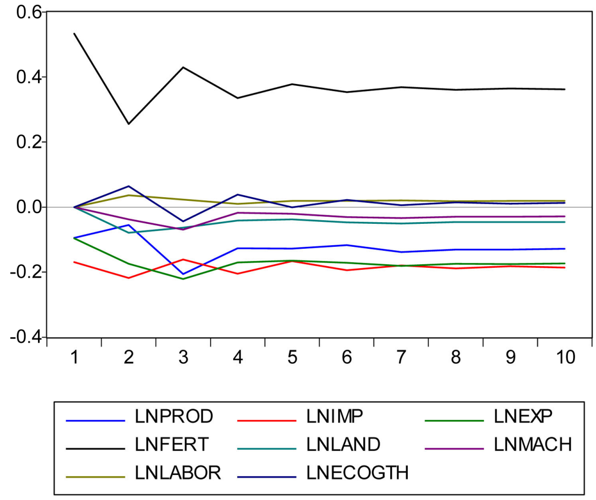
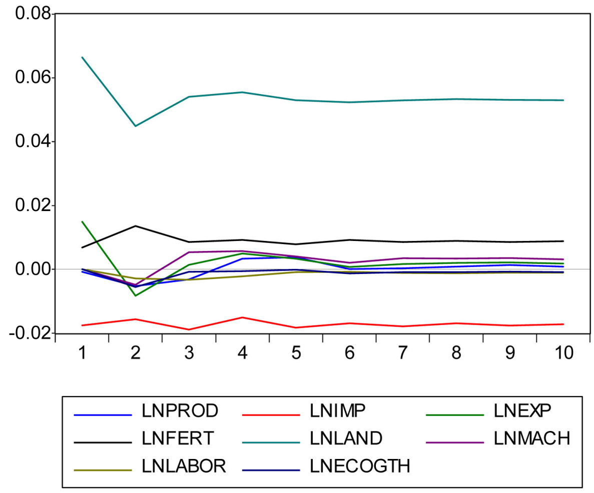
Appendix



(a)



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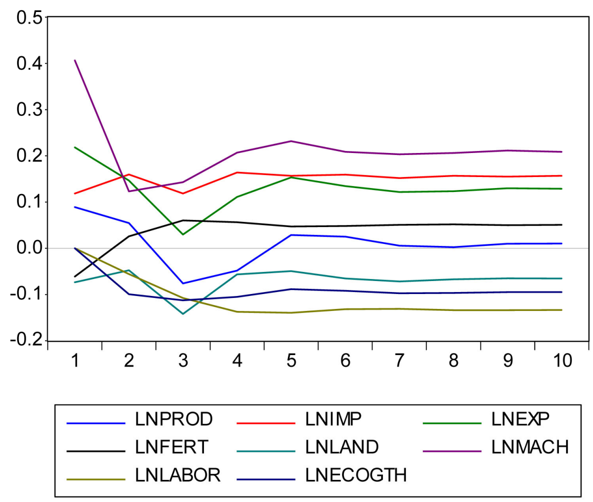

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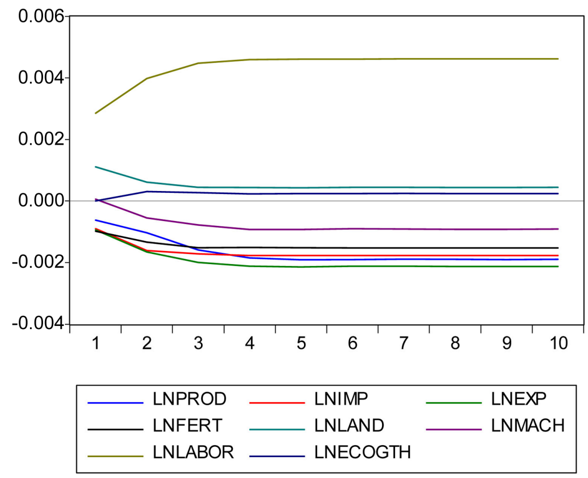

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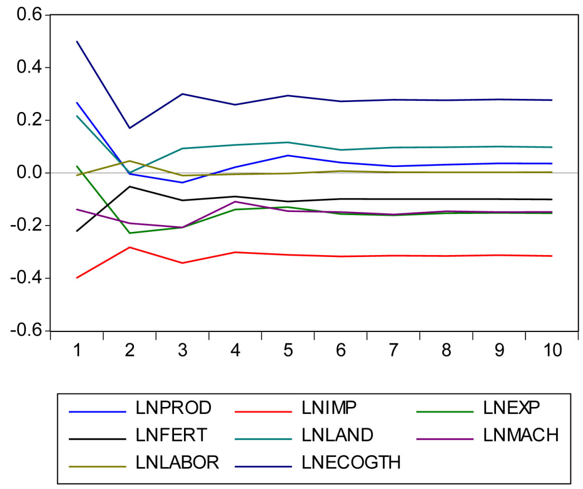

(e)

Panel A1. Generalized impulse response function and variance decomposition.

Table A1. VEC residual serial correlation L.M. tests and VEC residual heteroskedasticity tests.

VEC Residual serial correlation L.M. tests	Lags	LM-stat.	Prob.
	1	70.39762	0.2722
	2	63.00432	0.5117
VEC Residual heteroskedasticity tests (Joint test): No cross terms			
	Chi-sq	df	Prob.
Without Cross-terms	659.7478	648	0.3658

Table A2. Roots of characteristic polynomial.

Root	Modulus
0.0623 − 0.5608i	0.56422
0.0623 + 0.5608i	0.56422

Continued

−0.5402	0.54023
−0.338262 − 0.141623i	0.36671
−0.338262 + 0.141623i	0.36671
0.2188	0.21877
−0.1737	0.17369
0.1624	0.16243

Notes: None of the roots lies outside the unit circle; hence the VAR satisfies the stability condition.