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Contents

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Foreword

August is the main vacation season for most of us, however, this year's summertime is still not conventional. Due to perhaps eased but still existing travel restrictions, many of us are planning this summer within our own national borders. This year's summer is also unconventional in terms of conferences: this is the first time EAAE & IAAE Congresses go online! With more time spent at home, I hope you will find more time to read our current issue as well!

We have five papers and a book review in this issue. The first paper, written by Hamulczuk and Skrzypczyk, examines the impact of COVID-19 on producer prices in the EU-27 in Q2 and Q3 of 2020. The study is based on monthly data on trade in agri-food commodities according to the SITC classification in 2015-2020 and the monthly producer prices index of food (2015 = 100) in the EU countries. The theoretical background for empirical research is provided by a spatial partial equilibrium model and the concept of spatial market integration. The results of the study reveal that there is a negative and statistically significant relationship between an export-import ratio (which illustrates the country's self-sufficiency level) in the pre-COVID-19 period and price changes in Q2 of 2020 as well as Q3 of 2020. However, no statistically significant results were obtained for the regression models explaining the relationship between changes in the export/import ratio and price changes in second and third quarters of 2020.

The second paper, written by Pacho and Batra, contributes to the debate about factors influencing consumer behaviours that lead to the actual purchase of organic food in both developed and developing countries. Accordingly, authors seek to understand how consumers' knowledge about organic food and consumers' overall health consciousness play out as mechanisms for consumers' behaviours leading to actual purchase. Samples from Tanzania as a developing country and Denmark as a developed country are used. A total of 1393 consumers filled the questionnaire. The study found that the consumer knowledge and health consciousness function as underlying mechanisms in the relationship of attitude and subjective norms with actual purchase of organic food behaviour in Tanzania. In addition, consumer knowledge and health consciousness function as an underlying mechanism in the relationship of attitude and perceived behaviour control with actual purchase of organic food in Denmark. The study argues for enhancing consumers' knowledge of organic food as the latter has advocated health benefits in both developed and less developed countries.

The third paper, written by Islam, Ema, Chakrobortty, Jahan and Hossain, analyses tea export competitiveness and the nexus between tea export and economic growth through the cases of Bangladesh, India and Sri Lanka. The paper explores the tea export competitiveness by employing the Revealed Symmetric Comparative Advantage (RSCA) index and analyses the interlinkages between tea export and economic growth using several dynamic econometric approaches over the period 1980 to 2018. Results suggest that Bangladesh has lost its tea export competitiveness over the last decade. India posted moderate performance, while Sri Lanka consistently kept its dominant position. Further, the Johansen Cointegration test outcomes reported no long-run relationship between tea exports and economic growth across all three countries. The Granger Causality outcomes illustrated that only in Sri Lanka is it the case that tea exports cause short-run economic growth. Lastly, the impulse response function projected tea exports and economic growth with the response to shocks from each other. Results extrapolated that, unlike in the cases of Bangladesh and India, tea exports and economic growth are intimately interlinked in Sri Lanka. This article further recommends effective policies so that economic growth in these countries remains steady and tea industries can thrive.

The fourth paper, written by Gálvez-Soriano and Cortés, analyses the transmission of coffee prices from the international market to the Mexican market for the period 2004-2019. The estimates are obtained from a single equation conditional Error Correction Model (ECM) and two overlapping periods are analysed: before a hypothesised break (2004-2013), and full sample (2004-2019). The results of the first estimation suggest that given a 1% increase in the international price of coffee, the Mexican price increases by 0.9%, which is larger than previous estimates in the literature, but consistent with the idea of more market integration due to free trade agreements. Furthermore, the authors find no effect of Mexican coffee production in the determination of local coffee prices. Their model also implies a no previously documented break in the long-run relationship between international and national prices, which started in 2015 but was statistically significant until 2017. This latter suggests the end of the international coffee price pass-through in the Mexican economy.

The fifth paper, written by Mitsopoulos, Tsiouni, Pavloudi, Gourdouvelis and Aggelopoulos, examines the current state of dairy cattle farming in Greece to identify factors that affect its profitability and analyse the efficiency of farms, with the use of the non-parametric method of Data Envelopment Analysis (DEA). Moreover, the paper examines the processes and economic viability of dairy cattle farms and quantifies their technical efficiency, with a view to suggesting measures that can make Greek dairy cow farming more competitive. Results have shown that the mean technical efficiencies estimated for the CRS and VRS DEA approaches are 0.693 and 0.754 respectively, indicating that 30.7% and 21.6% equiproportional decreases of inputs are possible, given the level of outputs and the production technology.

The book review, written by Ferenczi, offers a guide for potential readers of the recent book published by Professor Koester entitled "Foundations of Agricultural Market Analysis and Agricultural Policy". Overall, I hope this issue once again succeeds in providing new and useful insights to those studying the economics of European and Central Asian agriculture.

Attila JÁMBOR

Budapest, August 2021

Mariusz HAMULCZUK* and Marta SKRZYPCZYK*

COVID-19, spatial market integration and producer prices: A case study of EU agri-food markets

The spread of COVID-19 has had a significant impact on economic and social activities, with the agri-food sector being no exception. Since the COVID-19 outbreak, numerous studies investigating its sectoral influence have been carried out, putting emphasis on demand and supply shocks and changes in trade volumes. However, there has not been much research into the implications of the pandemic for prices. To fill the research gap, this paper is an attempt to examine the impact of COVID-19 on producer prices in the EU-27 in Q2 and Q3 of 2020. The study is based on monthly data on trade in agri-food commodities according to the SITC classification in 2015-2020 and the monthly producer prices index of food (2015 = 100) in the EU countries. It was assumed that the agri-food trade balance is the key factor determining the level and changes of domestic prices. The theoretical background for empirical research is provided by a spatial partial equilibrium model and the concept of spatial market integration. The results of the study reveal that there is a negative and statistically significant relationship between an export-import ratio (which illustrates the country's self-sufficiency level) in the pre-COVID-19 period and price changes in Q2 of 2020 as well as Q3 of 2020. However, no statistically significant results were obtained for the regression models explaining the relationship between changes in the export/import ratio and price changes in second and third quarters of 2020.

Keywords: COVID-19, agri-food prices, international trade, market integration, European Union
JEL classifications: Q02; Q11, Q13; Q17

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Introduction

Agricultural production is not distributed evenly worldwide, hence there is a need to conduct trade between regions with surpluses and those characterised by deficits. The transfer of demand and supply shocks among regions, which facilitates balancing surpluses with shortages, is called the spatial integration of markets (Fackler and Goodwin, 2001). Spatial market integration is a pre-condition for the efficient allocation of production factors and the maximisation of economic welfare. Without spatial market integration, no signals would be transmitted between the surplus and deficit regions, prices would be more volatile, specialisation would not take place according to the comparative advantage theory, while no potential benefits of trade would be gained. The integration with external markets is also an opportunity for increased production and consumption, without a need to influence prices in the local market (Donaldson, 2015). Increased spatial market integration is evidenced by the intensification of trade, a reduction in trade costs and an increase in price co-movement (Barrett and Li, 2002). In this context, the COVID-19 pandemic together with the accompanying supply and demand shocks may be considered as an important factor affecting the degree of spatial market integration.

The COVID-19 pandemic has had a significant impact on all spheres of human activity. Its course and socio-economic effects are the subject of daily news reports as well as science and policy debates. Several facts can be mentioned to illustrate the socio-economic consequences of the pandemic. According to IMF (2021), the global economy contracted by 3.5% in 2020, more than during the global financial crisis in 2009, when GDP fell by 0.1% year-on-year. Weak final demand from consumers and firms led to a 10% decrease in global trade. The unemployment rate in advanced economies, which had been gradually declining since 2012 and reached 4.8% in 2019, rose to 7.3% in 2020. Economic contraction and elevated fiscal support resulted in the global public debt approaching 98% of GDP compared to 83.5% in 2019.

The agri-food sector has not been immune to the impacts of the pandemic. There are many reports and papers that analyse the sectoral effects of the crisis (e.g. Aday and Aday, 2020; Nakat and Bou-Mitri, 2021; OECD, 2020). The primary source of observed changes was associated with the reduced demand in the food service sector and its shift to retail. Supply chain disruptions, such as labour shortages, plant closures and logistical constraints played rather limited and temporary roles. However, the situations vary across food commodities and countries. Lack of seasonal workers impacted fruit harvest, whereas demand and supply market disruptions led to a decrease in world meat production (FAO, 2020).

Despite the visible impact of COVID-19 on the volume of agri-food commodity production, trade, and employment in the sector, its effects on agri-food commodity prices are rarely addressed. In fact, there are only a few studies that aim to identify price implications of the crisis. This is due to the unavailability of data, national and market specificities, or the strength with which COVID-19 affected individual countries. Most of the studies have so far focused on retail prices, covering the first phase of the pandemic, which was characterised by panic purchases of food, especially long shelf life products. Research by Akter (2020) for the European market, Imai *et al.* (2020) for India and Yu *et al.* (2020) for China showed a positive relationship between the severity of the pandemic and/or the strength of imposed restrictions and changes in retail prices. In addition, Imai *et al.* (2020) pointed to an increase in the price gap between retail and wholesale prices in one of the Indian states most affected by the pandemic. On the other hand, Varshney *et al.* (2020)

in a study of wholesale prices and Hillen (2020) in a study of online prices for food found no relationship between the magnitude of price changes and the nature of the product (non-perishable vs. perishable, most demanded compared with less demanded).

The purpose of this paper is to determine the impact of COVID-19 on producer prices for agri-food products in the EU in Q2 and Q3 of 2020. The study assumes that under the conditions of an open economy, the key determinant of the level and changes in domestic prices is the trade balance of agri-food commodities. It reflects all demand and supply factors domestically and abroad, including the disruption of global supply chains. Since the trade balance depends, among other things, on the size of the country, for the econometric calculations the export to import ratio is used in this paper. To the best of our knowledge, no one has so far addressed the issue of agri-food price changes in this respect.

Literature review

This section presents a brief discussion of the recent literature analysing the impact of the COVID-19 pandemic on the whole food chain with particular emphasis on prices. The vast majority of the papers have focused on demand and supply shocks, which were the result of the spread of the Sars-Cov-2 virus and restrictions imposed both on economic activity and human mobility. In the first phase of the pandemic, changes on the demand side were particularly evident. As emphasised in the literature, purchases of long shelf life products such as flour, pasta, dried, canned or frozen foods increased significantly, which often led to shortages. Moreover, the closure of restaurants, bars and hotels translated into a shift from out-of-home to at-home food consumption and thus in a demand shift from food service to retail (Aday and Aday, 2020; Dong and Zeballos, 2021; Weersink *et al.,* 2021). As a result, retail sales of food and beverages grew markedly. For example, in the EU-27 in March 2020, it was 4.8% higher than in February 2020 (Eurostat, 2021). In addition, due to the lockdown measures and as an attempt to decrease personal physical interactions, online sales have soared (Hillen, 2020). For the most part, the above surge in demand seems to be a short-term problem (in April 2020, retail sale of food and beverages in the EU-27 declined by 6.0% m/m - Eurostat, 2021). Long-term demand-driven effects on food supply chains will come rather from declining consumer incomes as well as shifts in product categories (Hobbs, 2020).

Supply-side disruptions being a result of COVID-19 included labour shortages, temporary plant closures and logistical constraints (Aday and Aday, 2020; Varshney *et al.,* 2020). Given the nature of the restrictions put in place, labour-intensive food processing plants were particularly vulnerable to production downtime (Hobbs, 2020). Furthermore, as emphasised by Weersink *et al.* (2020), factories, often specialised and operating on production schedules based on well-known customer requirements, needed time to adapt their production lines to the sudden shift in the volume and form of food demanded. Adapting to these changes was an even greater challenge for agriculture, which, due to its biological nature, is less flexible, especially in the case of highly perishable products. Thus, there were incidents of some commodities being disposed of while systems adjusted. However, most authors conclude that the food sector has proven to be relatively resilient to supply shocks caused by the COVID-19 pandemic. Cranfield (2020) claimed that in the long run, demand-side rather than supply-side factors will determine most of the changes in food markets.

Supply and demand shock impacted not only local markets, but also aggregate trade flows (Baldwin, 2020). The above changes together with additional border controls, sanitary measures (such as temperature checks), the limited availability of drivers as well as workers at ports and import/export inspectors (particularly in the first phase of the pandemic) disrupted the flow of goods, including food and agricultural commodities (OECD, 2020; WTO, 2020). At the same time, trade protocols were changed, with additional documentation and quarantine measures being introduced. Moreover, some governments imposed export restrictions to ensure the uninterrupted supply of a number of products in the domestic market. The above (especially in the short term) was reflected in the availability and prices of agricultural and food commodities. For instance, due to global trade disturbances, farmers were facing a shortage of agricultural inputs such as seeds, fertilisers and pesticides (Poudel *et al.,* 2020). Export restrictions increased world prices of cereals such as wheat, maize and rice (Aday and Aday, 2020), whereas transport and logistics problems were most pronounced for perishable high-value products, such as fruits and vegetables (OECD, 2020). The above has primarily a bearing on the situation in countries with shortages of domestic food supply (Yu *et al.,* 2020).

Although trade in agriculture and food products relatively quickly returned to near-normal operations (OECD, 2020), long-term repercussions could be significant. Anti-globalisation movements are expected to intensify and some governments may wish to increase self-sufficiency to reduce dependence on other countries. On the other hand, there may be a desire to strengthen international cooperation to aid in keeping supply chains operating in times of crisis (Kerr, 2020).

The changes described above were reflected, to a greater or lesser extent, in food and agricultural products prices. In the short-term, the combined effect of supply disruption and demand surge led to retail food price inflation (Akter, 2020). However, the impact of COVID-19 on food prices is ambiguous. After an initial period of panic buying, with food stocks built up and restrictions placed on the hospitality industry (often referred to as HoReCa sector), demand for food has eased. The long-term situation will depend on income effects. A prolonged pandemic and the resulting recession will translate into lower incomes, which in turn may reduce food consumption (OECD, 2020). If the demand drops more than the supply, the market prices will fall, and conversely a stronger decrease in supply will translate into higher prices (Yu *et al.*, 2020).

The vast majority of studies dedicated to the issue of price changes have focused on retail prices having regard to the three aspects of the pandemic's impact on the agri-food sector: (1) the severity of the pandemic and/or the strength of imposed restrictions; (2) the different nature of food products

(staple vs. more nutritious; perishable vs. non-perishable) and (3) time effects. The studies mainly concerned the first phase of the pandemic, i.e. March-June 2020.

Akter (2020) assessed the impact of COVID-19 related 'stay-at-home' restrictions on food prices in 31 European countries (25 EU countries and the United Kingdom, Norway, Iceland, Switzerland, Serbia and Turkey) using a difference-in-difference regression. She combined the Harmonised Index of Consumer Prices (HICP) for January-May 2020 with the Stay-at-Home Restriction Index from the Oxford Covid-19 Government Response Tracker dataset. Research findings reveal that relatively stringent restrictions had a positive impact on retail food prices – they translated into an almost 1% increase in overall food prices in March 2020, compared to January and February 2020. The food categories that showed the most significant surges in prices included meat, fish and seafood, and vegetables. However, prices of bread and cereals, fruits, milk, cheese and eggs, or oils and fats were not significantly affected.

The correlation between the severity of the pandemic and price changes has been confirmed in a study by Imai *et al.* (2020). Those authors examined in detail the wholesale and retail prices of selected food commodities in three states in India, using static and dynamic panel models, i.e. the Hausman-Taylor panel model with fixed or random effects and a dynamic panel SGMM model, which allows to establish causality between the severity of the COVID-19 pandemic and prices. The state-level weekly data from March to June 2020 on commodity prices as well as the weekly panel data of the COVID-19 cumulative severity ratio were used. The conclusion was that in the states most affected by the pandemic retail prices of commodities as well as the gap between retail and wholesale prices increased significantly, which was not necessarily seen in the other states.

In turn, Yu *et al.* (2020) examined the Chinese market. Daily price series for four major food products (rice, wheat flour, pork and Chinese cabbage) were collected from three provinces of China for the period from January 1, 2020 to April 8, 2020 (and 2019 as a comparison) and an iGARCH model was applied. Research findings reveal no significant changes in prices of staple foods, such as rice and wheat flour, a slight increase in prices of vegetables proxied by the Chinese cabbage, and various changes in prices of pork. In the Hubei Province, the epicenter of COVID-19, the outbreak of the COVID-19 pandemic resulted in an increase in pork prices, which according to those authors may have been an effect of both consumer panic and the lockdown policy. However, in Beijing pork prices dropped slightly after the COVID-19 outbreak probably due to reduced demand.

Another issue addressed in the studies was whether the price implication of a pandemic depends on the nature of the product and the time of analysis. Varshney *et al.* (2020) compared wholesale prices and quantities traded of non-perishable (wheat) and perishable commodities (tomato and onion). A dataset comprising daily observations for April-June 2020, relative to the same period in 2019, from nearly 1000 markets across five states of India was used and a double- and triple-difference estimation strategy was adopted. The study revealed that the immediate (within a month) effect differs from the short-term (over 3 months) effect. While all prices spiked initially in April, they recovered relatively quickly and in the case of wheat in May-June 2020 they were significantly lower compared to 2019. Nevertheless, regardless of the nature of the product (perishable vs. non-perishable), the impact of the pandemic on price changes was not statistically significant. On the other hand, its influence on quantities traded of all surveyed products was positive and significant, especially for the two perishable goods.

An interesting study in the context of price changes is the analysis of prices of food products sold online (Hillen, 2020). The data consisted of daily price quotes collected from the Amazon Fresh website for the customer location Los Angeles from December 2, 2019 to June 18, 2020. The main conclusion was that despite rising food price indices in the USA and a strong demand surge, Amazon Fresh's online price level did not increase during the COVID-19 pandemic. In addition, no difference was found in the price setting of storable goods compared with perishable, or highly demanded compared with less demanded products.

Methodology

The theoretical background for empirical research adopted in this study is a spatial partial equilibrium model (Figure 1). Under the assumption of an open economy, the difference between the prices of homogeneous goods in two countries (*A* and *B*) equals the trade costs τ_{AB}. Trade costs include transportation, insurance, information search, or costs of breaking down the trade barriers. Therefore, trade flow is equal to $Q_1 = X_1 = M_1$, where X – export, M – import. In other words, spatial market equilibrium is reached when excessive export supply in country A (XS_A) equals excessive import demand in country B (MD_B) corrected by the impact of trade cost τ_{AB} (Barrett and Li, 2002; Baulch 1997).

Demand and supply shocks, in one or both countries, lead to the new market equilibrium. Moreover, any disruptions of trade due to increase of tariff or non-tariff barriers in the short run cause an increase in price differences as well as a reduction in trade volume. COVID-19 could lead to supply and demand shocks as well as to trade constrains. The logistic limitations arising from COVID-19 leading to trade reduction are in essence similar to those of non-tariff barriers such as import or export quotas. They do not totally prohibit the trade as would be the case with trade bans but instead limit it, which may also have price implications.

Referring to Figure 1, let us assume that as a result of COVID-19 trade between these countries has decreased to the Q_2 level. This manifests in a decrease in exports from country A to the X_2 level and a decrease in imports from country B to the M_2 level. The aforementioned changes should result in lower prices in the country with surpluses and higher prices in the country with shortages. Therefore, it can be concluded that the restrictions related to COVID-19 should lead to the weakening of spatial integration of agri-food commodity markets. Of course, this degree will depend e.g. on the type of goods and their storability, or on the elasticity of domestic demand and supply.

In order to verify this mechanism in the context of COVID-19, monthly data on trade in agri-food commodities

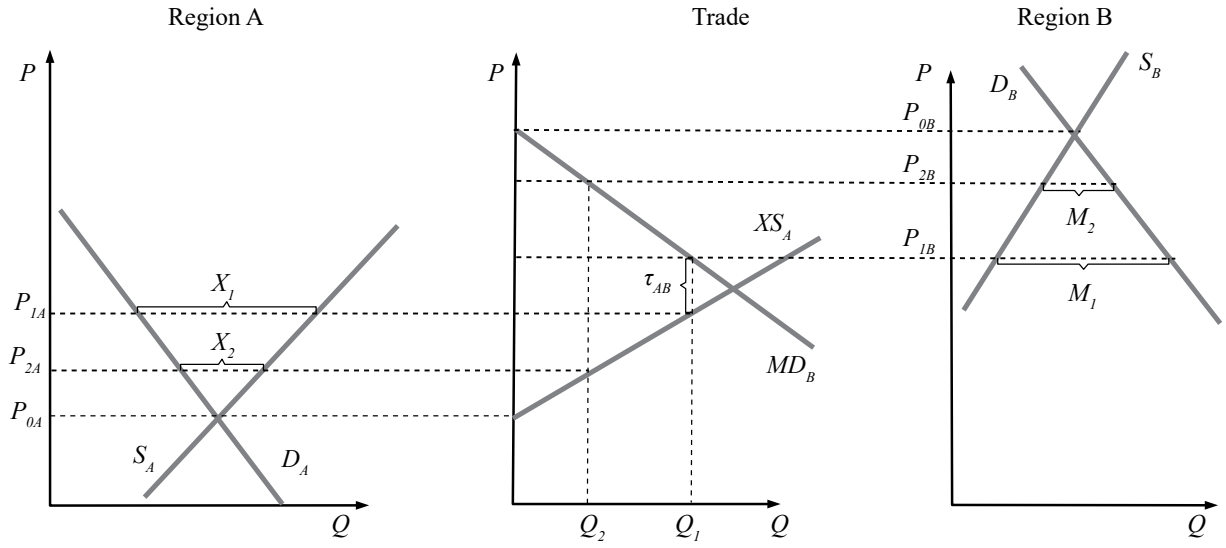

Figure 1: Partial spatial equilibrium model.
Source: own composition based on Samuelson (1952)

(total, intra and extra, export and import values expressed in euro) according to the SITC classification in 2015-2020 were used. Changes in the international trade itself are an indication of strengthening or weakening of the spatial market integration. The export position of a country and its competitiveness is demonstrated by its trade balance known as net export (Latruffe, 2010). In an open economy, net export takes into account both domestic and foreign factors affecting supply and demand, and consequently prices. A variable that reflects changes in the trade balance, and it is at the same time commonly used in econometric calculations, is the ratio of the export X_{ij} to the import M_{ij}:

$$NEX_{ij} = X_{ij} / M_{ij}, \tag{1}$$

where X – export, M – import, i – analysed country, j – analysed commodity. At the same time, the above-mentioned ratio roughly illustrates a countries' level of self-sufficiency.

The second variable used was the monthly producer prices index of food (2015 = 100) in the EU countries. This variable seems to be more reliable in international comparisons than agricultural prices as it reflects the situation on the broader commodity market. Retail prices, on the other hand, were found to be more susceptible to local short-term demand shocks, i.e., panic buying (Imai *et al.,* (2020) point to the growth of the gap between retail and wholesale prices) and on the pricing policy of the retailer (Hillen, 2020). Thus, producer prices appear to better reflect the potential changes in spatial integration of agri-food commodity markets.

The source of this information was Eurostat's food price monitoring tool (2021) which uses data collected by Eurostat and National Statistical Offices and comprises agricultural and food price indices and annual rates of price change for EU countries. In total, price time series in 21 EU countries were used. Due to the lack of statistical data for such countries as Malta, Luxemburg, Estonia, Latvia, Slovakia and Cyprus they were not included in the study. A certain limitation of the study stems from the fact that these indices express prices in national currencies.

During the research design, we also considered taking into account smaller aggregates (e.g. markets of meat, vegetables, milk). However, we faced another limitation in view of the insufficient availability of price information in the Eurostat database. In such cases, the number of units (countries) would be much smaller than in the case of food aggregates. Smaller geographical regions (e.g. NUTS 2) also do not fit the proposed methodology related to the spatial market integration due to a complete lack of trade data that reflects the self-sufficiency of regions.

Another difficulty when analysing small aggregates is to separate the impact of COVID-19 from specific factors shaping the situation on a given market (e.g. weather conditions, inventory levels, changes in yields, etc.). So the remaining factors are assumed as *ceteris paribus*.

Due to the potential impact of seasonality on trade and prices, these variables were deseasonalised using the X-12 ARIMA procedure (X-12-ARIMA, 2011). If the seasonality was non-significant, then the original data was used.

In the study, simple descriptive indicators and linear regression models based on cross-sectional data were used. In regression models, price changes ΔP in countries ($i = 1, \ldots, N$) between period t_0 and $t_0 + T$ were explained using export to import ratio NEX in initial period t_0. Two forms of equations were employed[1]:

$$\Delta \log(P_{i,t_0,t_0+T}) = \beta_0 + \beta_1 \log(NEX_{i,t_0}) + \varepsilon_{i,t_0,t_0+T}, \tag{2}$$

$$\Delta \log(P_{i,t_0,t_0+T}) = \beta_0 + \beta_1 NEX_{i,t_0} + \varepsilon_{i,t_0,t_0+T}, \tag{3}$$

[1] We also estimated regression models based on the following equation: $\Delta \log(P_{i,t_0,t_0+T}) = \beta_0 + \beta_1 \log(NEX_{i,t_0}) + \varepsilon_{i,t_0,t_0+T}$. In that case, in line with spatial equilibrium, the expected sign of β_1 was positive. However, obtained results indicated a non-significant relationship between changes in trade balance and price changes in the COVID-19 pandemic period.

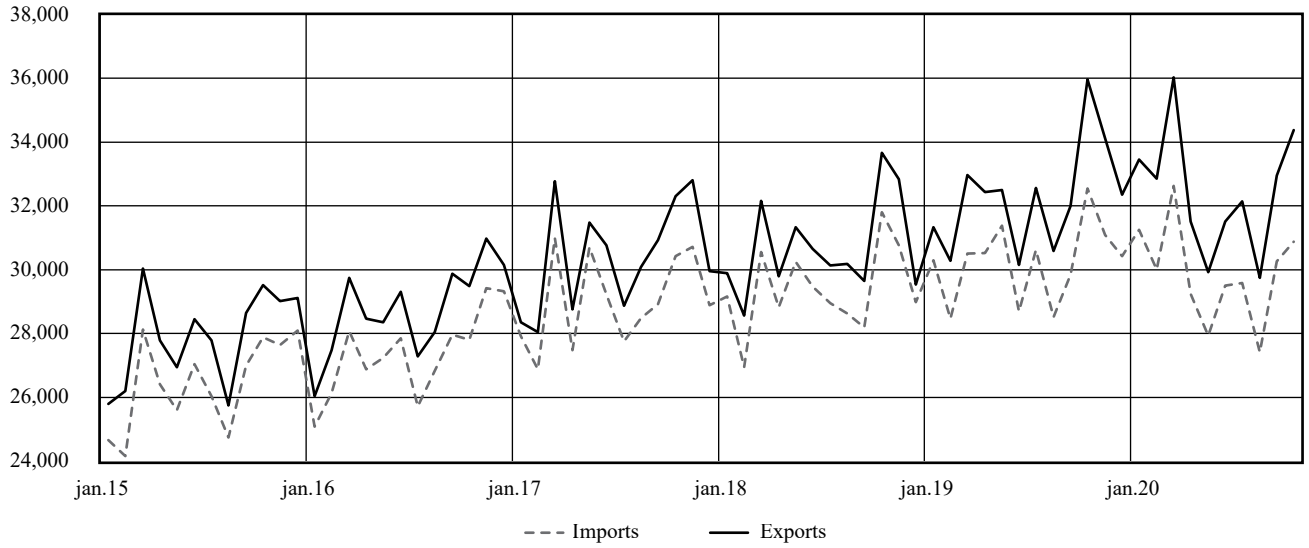

Figure 2: Value of exports and imports of agri-food commodities from January 2015 to October 2020 in analysed EU countries (billion euro).
Source: own composition based on the Eurostat database

Here, (initial) period t_0 representing the pre-COVID-19 era was the first quarter of 2020 or the year 2019, whereas $t_0 + T$ reflected period covered by COVID-19 (2nd and 3rd quarter of 2020 or particular month IV-IX of 2020). Models 2 and 3 were estimated using OLS method. Standard errors of estimation were calculated by using OLS estimator as well as White estimator, often referred to as heteroscedasticity-consistent estimator. The second case standard errors are robust in the presence of possible heteroscedasticity.

It was expected that the occurrence of substantial trade constraints due to COVID-19 would result in the estimated regression coefficient β_1 being negative and statistically significant. Therefore, the anticipated reaction of surplus countries is a fall in prices, while that of countries with shortages is an increase in prices of agri-food products. To sum up, under the conditions of supply-demand shocks accompanied by significant trade constraints stemming from COVID-19, the countries and regions with surpluses or shortages are more exposed to price changes than countries with balanced trade.

Results

From the theoretical point of view and the literature review, international trade is one of the main channels through which COVID-19 may affect prices of agri-food products. It is commonly believed that COVID-19 has led to disturbances in global supply chains (e.g. Aday and Aday, 2020; Baldwin, 2020; OECD 2020), which is reflected in the decline in trade of agri-food products. Figure 2 shows the value of exports and imports of agri-food products in the analysed 21 EU countries. There are relatively deep declines in both cases in Q2 and Q3 of 2020, which can be mainly attributed to COVID-19 restrictions.

It is worth noting that on the year-to-year basis, the shrinkages in the value of exports and imports of agri-food products in the 2nd and 3rd quarter of 2020 were small due to the upward tendencies of these variables. For example, the decline in exports and imports in the second quarter of 2020 compared to the second quarter of 2019 was 4.3 and 2.2%, respectively.

A much stronger deterioration of international trade can be observed when comparing its value in the 2nd and 3rd quarter of 2020 to trade value in the 1st quarter of 2020. The export of agri-food products in Q2 of 2020 decreased by 9.1%, and in Q3 of 2020 – by 7.3%. In turn, imports in the 2nd and 3rd quarters of 2020 were lower by 7.7% and 7.0%, respectively. These results may be disturbed by the seasonality in exports and imports. Calculations performed on seasonally adjusted data show that exports in Q2 and Q3 of 2020, compared to their values in Q1 of 2020, were lower by 9.3% and 6.2%, while imports fell by 2.8% and 2.5%, respectively. Interestingly, the volume of industrial production of agri-food products in the EU-27 in the 2nd and 3rd quarter of 2020 decreased by 6.9% and 2.1%, respectively (seasonally adjusted data). Presented results are the evidence of a deterioration in spatial integration of agri-food markets in the EU countries in the first phase of the COVID-19 pandemic.

Despite the deterioration of the trade balance in agri-food products in the EU countries in the second and third quarters of 2020, the export-import ratio was still high. It can be noticed that producer prices in the EU-27 also decreased during this period (Figure 3). The agri-food producer prices in Q2 of 2020 fell by 0.6% and in Q3 of 2020 by 1.3%, compared to the Q1 2020 price level. It seems that this can be largely attributed to the COVID-19 effect, as the decrease in the X/M ratio illustrates the possible appearance of surpluses in the EU market, while the price mechanism enables the demand to be balanced with supply.

However, the estimates made for aggregated data do not reflect potential changes in individual countries or sectors. As a result of COVID-19 constraints, agri-food prices could both rise and fall depending on the initial net export position of the country. Thereby, it can be expected that prices in countries (or markets) with export surpluses should decline, whereas prices in countries with shortages should raise. The graphs in Figure 4 essentially confirm this thesis (see

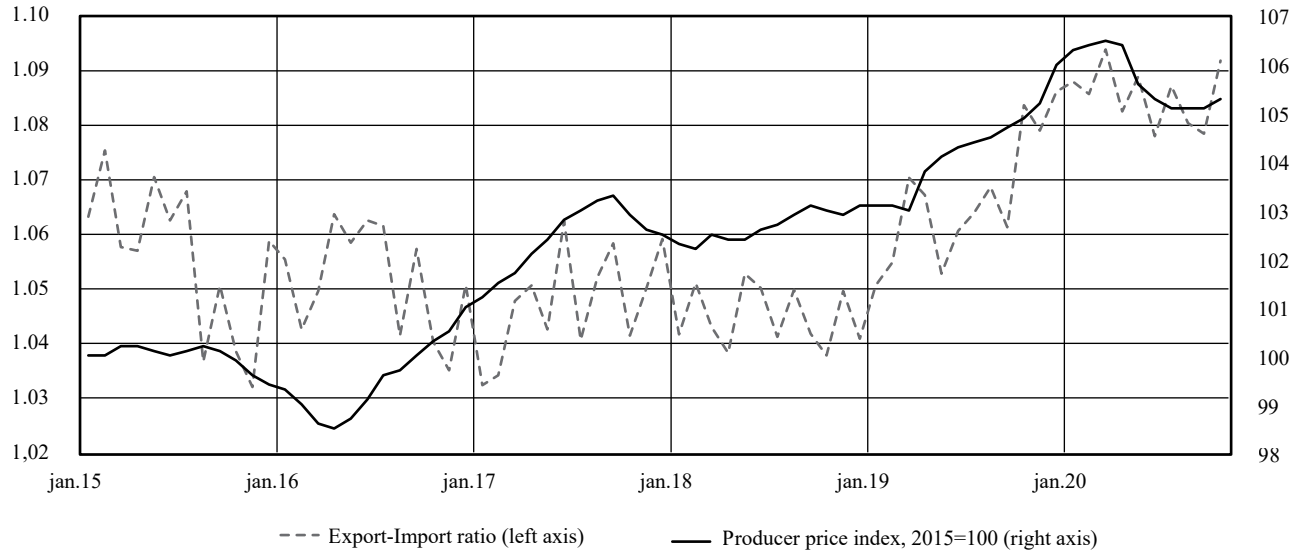

Figure 3: The export-import ratio for agri-food commodities in analysed 21 EU countries and the index of producer prices in the EU-27 (seasonally adjusted data).

Source: own composition based on the Eurostat database

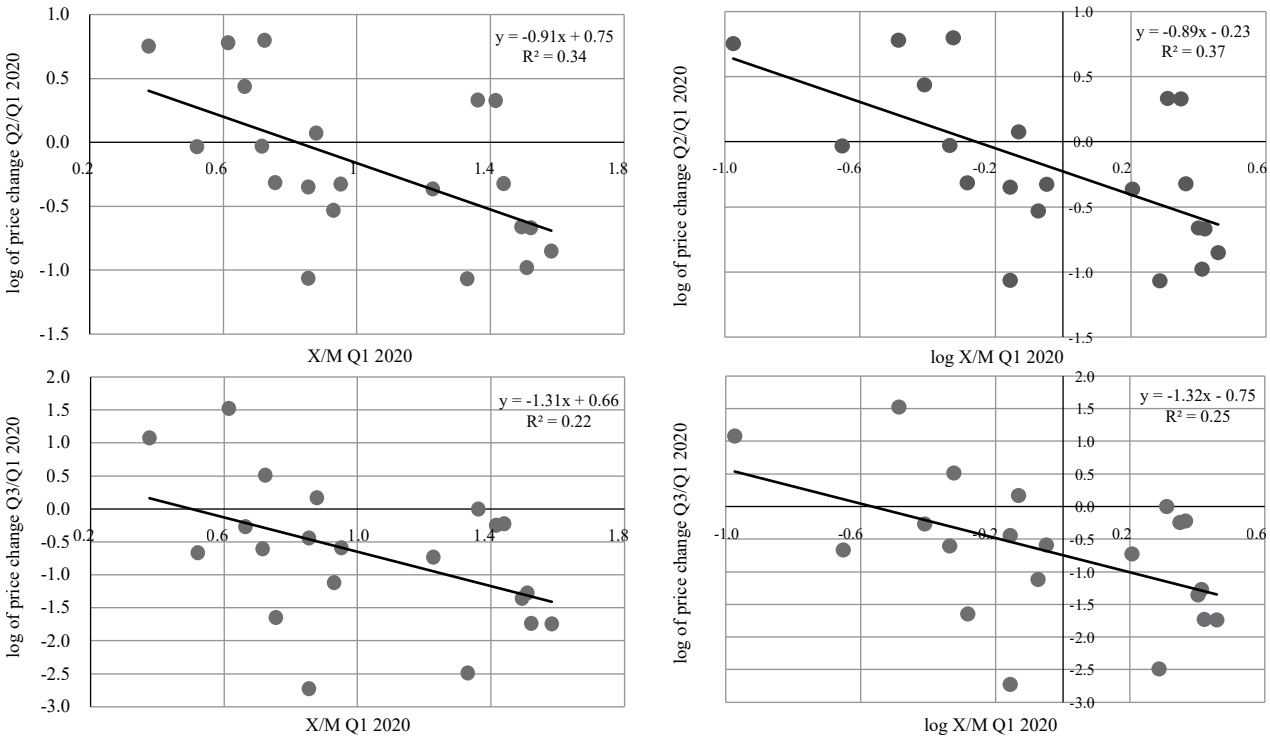

Figure 4: The relationship between changes in producer prices of agri-food commodities and the export-import ratio in 21 EU countries (based on seasonally adjusted data).

Source: own composition based on the Eurostat database

eq. 2 and 3). There is a negative and statistically significant ($p = 0.05$) relationship between the level of the export-import ratio or its log in the 1st quarter of 2020 and price changes in the 2nd and 3rd quarter of 2020. It is worth adding that similar conclusions were obtained when the export-import ratio for the year 2019 was assumed as the independent variable (Table 1).

Table 1 provides more detailed estimates of these relationships (only the slope β_1 of the regression coefficient and its statistics are presented). The results are statistically significant for both OLS estimator as well as a heteroscedasticity-consistent estimator (for HC estimator even lower standard errors were obtained than for OLS estimator). It can be seen that the absolute magnitudes of β_1 coefficients in regression models estimated for Q3/Q1 2020 price changes are higher than for Q2/Q1 2020 price changes. This implies a stronger impact of the country's initial self-sufficiency level on prices in the 3rd rather than the 2nd quarter of 2020. Although the magnitudes β_1 were greater for regressions models where the dependent

Table 1: Slope estimates for regression models for 21 countries.

Y variable (price change, 2020)	X variable (X/M ratio)	Slope (β_1)	OLS estimator			White estimator (HC)		
			Se	t-Stat	p-value	Se	t-Stat	p-value
Δ log P: 2Q/1Q	log NEX (2019)	-0.866	0.264	-3.280	0.004	0.206	-4.200	0.001
Δ log P: 2Q/1Q	log NEX (1Q 2020)	-0.891	0.268	-3.325	0.004	0.213	-4.175	0.001
Δ log P: 2Q/1Q	NEX (2019)	-0.892	0.298	-2.990	0.008	0.262	-3.402	0.003
Δ log P: 2Q/1Q	NEX (1q 2020)	-0.908	0.293	-3.099	0.006	0.247	-3.679	0.002
Δ log P: 3Q/1Q	log NEX (2019)	-1.293	0.511	-2.530	0.020	0.420	-3.080	0.006
Δ log P: 3Q/1Q	log NEX (1Q 2020)	-1.319	0.522	-2.526	0.021	0.427	-3.087	0.006
Δ log P: 3Q/1Q	NEX (2019)	-1.287	0.576	-2.234	0.038	0.504	-2.555	0.019
Δ log P: 3Q/1Q	NEX (1q 2020)	-1.305	0.569	-2.292	0.034	0.491	-2.661	0.015
Δ log P: 4M/1Q	log NEX (1Q 2020)	-0.253	0.304	-0.832	0.416	0.316	-0.800	0.434
Δ log P: 5M/1Q	log NEX (1Q 2020)	-1.035	0.341	-3.034	0.007	0.314	-3.299	0.004
Δ log P: 6M/1Q	log NEX (1Q 2020)	-1.390	0.442	-3.142	0.005	0.358	-3.883	0.001
Δ log P: 7M/1Q	log NEX (1Q 2020)	-1.509	0.507	-2.976	0.008	0.426	-3.537	0.002
Δ log P: 8M/1Q	log NEX (1Q 2020)	-1.558	0.546	-2.851	0.010	0.449	-3.466	0.003
Δ log P: 9M/1Q	log NEX (1Q 2020)	-0.890	0.549	-1.619	0.122	0.449	-1.983	0.062

Source: own calculations based on the Eurostat database

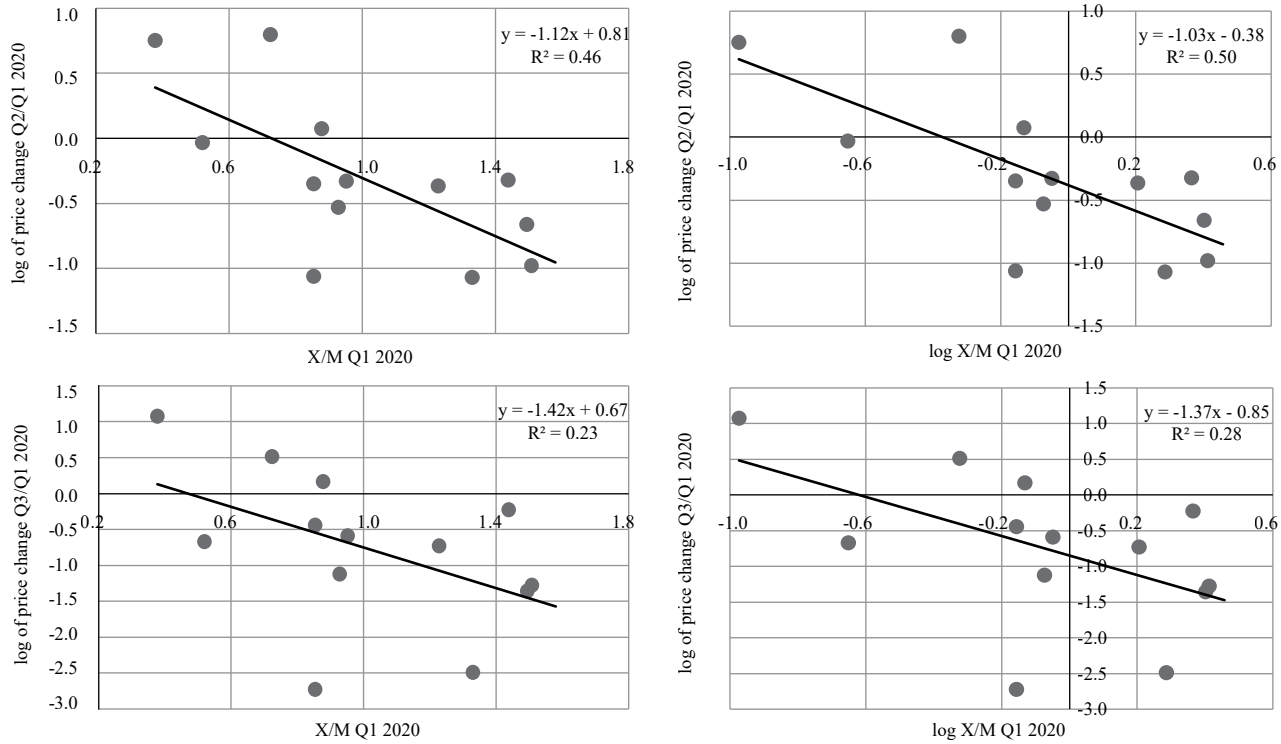

Figure 5: The relationship between changes in producer prices of agri-food commodities and the export-import ratio in 13 EU euro area countries (based on seasonally adjusted data).

Source: own composition based on the Eurostat database

variable was the price change between Q3 and Q1 of 2020 than for models where it was the price change between Q2 and Q1 of 2020, the first relationship was slightly less statistically significant (see: t-Stat, p-value, R^2). This may indicate that in the long-run other factors (e.g. exchange rates, domestic demand, etc.) play an increasingly greater role in determining domestic prices.

Table 1 also presents β_1 estimates for models, where the dependent variables were price changes between specific months (M4-M9) and the first quarter of 2020, whereas the independent variable was a log[2] of the export-import ratio in Q1 of 2020. The estimated β_1 coefficients and Student's t-statistics indicate that in April 2020 there were no statistically significant price effects of the COVID-19 pandemic. This can be justified by a speculative increase in demand for food products in the first months of the pandemic (Akter, 2020). It was only from May 2020 until August 2020 that the relationship between price changes and the export position was negative and significant. It can also be noticed that the impact of the initial export-import ratio on the price change between September 2020 and the 1st quarter of 2020 weakened again.

Bearing in mind that the used price information is in the form of indices based on prices expressed in national

[2] Conclusions drawn from regression models, where the independent variable was the level of the export-import ratio were essentially the same.

currencies, fluctuations both in exchange rates and in the general level of countries' inflation may play a significant role. Hence, analyses for the euro area countries as a relatively homogeneous group might be more reliable. The estimated regression equations for 13 euro area countries are included in Figure 5. Comparing Figures 5 and 4 it can be seen that the correlations between price changes in Q2/Q1 of 2020 and the level of the trade balance in Q1 of 2020 for the euro area countries are stronger than in the group of 21 EU countries (see slope and R^2). However, we cannot see any differences for the regression models (21 countries vs 13 countries) explaining the price movements between Q3 and Q1 of 2020. Although in this case there are only 13 countries, the results also show a statistically significant impact of the level of food self-sufficiency of the euro area countries on changes in food prices in the first two quarters of the pandemic ($p = 0.05$ for HC and $p=0.10$ for OLS estimator).

It is worth emphasizing that we have also studied the relationships between price changes and trade balance changes in the 2nd and 3rd quarters of 2020. Obtained results for the 21 and 13 countries indicated on positive, but not statistically significant (p-values over 0.1), relationship in 2nd quarter of 2020 between analysed variables (as it had been expected). For the third quarter correlations were close to zero. This may be due to the fact that changes in the trade balance are much more volatile than the level of the trade balance itself. Such results also mean that it was the threat of surplus stocks in countries with surpluses and the threat of food shortages in countries with low self-sufficiency that was significant driving force behind price changes in the first months of the COVID-19 pandemic.

Conclusions

The aim of the research was to determine the importance of the trade balance for changes in agri-food producer prices in the EU countries in the first two quarters covered by the COVID-19 pandemic. Overall, in the whole EU in the 2nd and 3rd quarters of 2020 agri-food exports as well as imports significantly decreased. This implies a deterioration of spatial integration of the UE agri-food markets (both intra- and extra-EU). Therefore, the economic consequence of the COVID-19 pandemic, in line with the spatial integration concept, is the reduction of economic welfare. Due to the fact that in this period exports in the EU decreased more than imports, the trade balance also deteriorated. This resulted in a decline in agri-food producer prices in the EU.

Research conducted on a group of 21 countries belonging to the EU and on a group of 13 countries belonging to the euro area confirmed the significant impact of the countries' level of self-sufficiency on changes in agri-food prices in the second and third quarter of 2020. The negative relationships between the countries' export-import ratio and price trends during the COVID-19 pandemic indicate that agri-food prices in the surplus countries fell and in the countries with food shortages increased due to the COVID-19 pandemic, ceteris paribus. Therefore, one of the key driving forces determining agri-food prices in the EU in the 2nd and 3rd quarter of 2020 was related to the exposure to food shortages and surpluses. We are not of the opinion that the level of self-sufficiency is the only factor determining the behaviour of food prices during the COVID-19 pandemic; nevertheless, it is one of the most important, next to the severity of the imposed restriction as indicated in the literature. Taking it into account allows for a better understanding of the impacts of the pandemic on the agri-food sector and explaining different directions in price movements across countries referred to in literature and statistics.

Our study has also some limitations related to the data and methodology used. One of them is the fact that agri-food prices have been expressed in national currencies, so their changes may also be caused by other factors (e.g. exchange rate changes). Moreover, small sample and the lack of control variables slightly limit the power of inference. In order to increase the power of inference, one can consider applying panel models using high-frequency data (for example monthly, weekly, or even daily). However, in this case probably we should look for structural changes due to COVID-19 and/or include other variables explaining pandemic severity and other characteristics of the investigated countries or commodity markets. In future research, it seems advisable to carry out analyses involving smaller aggregates or specific markets, however, there might be a problem of collection of comparable data for a large number of the EU countries.

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Factors influencing consumers' behaviour towards organic food purchase in Denmark and Tanzania

This paper adds to the debate about factors influencing consumer behaviours that lead to the actual purchase of organic food in both developed and developing countries. Accordingly, authors seek to understand how consumers' knowledge about organic food and consumers' overall health consciousness play out as mechanisms for consumers' behaviours leading to actual purchase. Samples from Tanzania as a developing country and Denmark as a developed country are used. A total of 1393 consumers filled the questionnaire. The study found that consumer knowledge and health consciousness function as underlying mechanisms in the relationship of attitude and subjective norms for actual purchase of organic food behaviour in Tanzania. In addition, consumer knowledge and health consciousness function as an underlying mechanism in the relationship of attitude and perceived behaviour control for actual purchase of organic food in Denmark. The study argues for enhancing consumers' knowledge of organic food as the latter has been championed for its perceived health benefits in both developed and less developed countries.

Keywords: organic foods, consumer behaviour, theory of planned behaviour, consumer knowledge, health consciousness
JEL classification: Q13

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Introduction

The global market for organic food and drinks reached $81.6 billion in 2015 with North America and Europe accounting for as high as ninety percent of sales (Willer & Lernoud, 2017). Organic food sales are also reported to have recently increased in Asia, Africa, and Latin America (Willer & Lernoud, 2017). The same report shows an increased growth rate in the organic food market in developing countries. Organic foods are produced without chemical pesticides, fertilisers, antibiotics, and growth hormones, which consumers perceive to be healthier (Lim *et al.*, 2014) than the conventionally produced, packed or canned food that usually are assumed to be harmful to human health (Sazvar *et al.*, 2018). Consumers have become cautious, and consumption of organic food is considered as a new lifestyle trend (Al-Taie *et al.*, 2015) that promotes well-being and health (Molinillo *et al.*, 2020). Consumers are now more knowledgeable about what they consume, and insist on knowing the benefits of a particular food before they decide to purchase it (Onyango *et al.*, 2006). Suppliers also require a better understanding of what drives consumers to purchase organic food so they may develop effective marketing strategies to increase sales. Thus, the present study explores the consumer's knowledge about organic food and consumer's overall health consciousness as underlying mechanisms of consumer behaviour which lead to actual purchase of organic food.

Prior research about organic food has focused on a range of consumer behaviours that lead to the consumer's organic food purchase intention. Specifically, the theory of planned behaviour with the inclusion of three important constructs; consumer attitude, subjective norms and perceived control behaviour, has been used to explain the consumers' intention to purchase organic food (Shahriari *et al.*, 2019). However, despite the understanding offered by the previous studies about how consumers develop their behaviours to purchase organic food, at least three research gaps still exist that need to be addressed. First, consumer's knowledge about organic food and consumer's health consciousness as underlying mechanisms that link consumer behaviours (as indicated by consumer's attitude, subjective norms, and perceived behaviour control) with the actual purchase of organic food is underexplored. Second, the comparison and reinforcement of the validity of consumers' planned behaviour models across developed and developing countries is less researched. Third, the prior studies have focused on consumers' planned behaviours which lead to the intention to purchase rather than an actual purchase.

The present study fills these knowledge gaps as explained below. First, the consumer knowledge about organic food revolves around the organic food's environmental impact, and animal welfare and fair trade, which collectively influence the consumer's decision to purchase organic food (Basha & Lal, 2019). However, the consumer knowledge regarding organic food has the power of itself to play as a mechanism that links consumer behaviour (namely, consumer attitude, subjective norms, and perceived behaviour control) with actual purchase of organic food. But not all consumers are consciously interested in finding out the information regarding environmental impact (Tait *et al.*, 2016), animal welfare (Grunert *et al.*, 2018) and fair trade (Clonan *et al.*, 2010) that helps them in making the organic food purchase decision. For example, Pham *et al.* (2019) concluded that environmental impact is not a final motivation for organic food purchase, and consumers tend to re-interpret the meaning of "organic" to suit their individual purchasing behaviour. Therefore, when it comes to organic food purchase, consumers extract the information/knowledge which they consider essential and beneficial in terms of taste, health benefits, premium price, availability, and food safety (Rana & Paul, 2017). The present study tests consumer knowledge as a mechanism that connects consumers' behaviour (in terms of attitude, subjective norms, and perceived behaviour control) with actual purchase of organic food.

Second, prior studies have shown that the market for organic food has started to grow partly due to speculated concerns for food safety and health issues that are linked with non-organic food (Wekeza & Sibanda, 2019). The non-organic food has also been associated with rising incidences of non-communicable diseases (Wagner & Brath, 2012). Accordingly, Hansen *et al.* (2018) has considered health consciousness as an antecedent factor that leads to the purchase intention of organic food. Instead, the present study regards the health consciousness factor as an underlying mechanism that connects attitude, subjective norms, and perceived control behaviours with the actual purchase of organic food.

Third, some prior studies focus on intention to purchase rather than the actual purchase itself. For example, Molinillo *et al.* (2020) considered health consciousness as a mediating factor between product characteristics and willingness to purchase organic food. However, the intention and willingness to purchase is a prerequisite for the actual purchase. As a matter of fact, the willingness and intention to purchase proved unrealistic as many consumers claimed the positive attitude toward organic food but fewer engaged in actual purchasing (Voon *et al.*, 2011). The actual purchase is the result of intention and willingness as described by Ajzen (1991); therefore, the present study used actual purchase as a dependent variable which includes an individual's readiness to purchase organic food.

Lastly, prior studies focused on developed countries to identify factors that influence the purchase of organic food. Although there is some homogeneity in consumer motives (Thøgersen *et al.*, 2015) for purchasing organic food across countries, Asif *et al.* (2018) have argued that some macro and structural factors (such as governments subsidies and regulations) may boost the production and consumption of organic food, which in turn, may influence the awareness and purchase of organic food. This observation has fuelled our comparative study with data from a developed country and a developing country. The present study selected, on the one hand, the well-industrialised producer and matured supplier of organic food, Denmark, and, on the other hand, the emerging producer and novice supplier of organic food, Tanzania. In the present study, we expect differences in the strength of the mechanisms chosen to explain differences in consumer behaviours to purchase food between the two countries as Molinillo *et al.* (2020) suggest that a research should look at samples from different countries to ensure that theories have cross-national validity.

Theoretical Model: Planned Behaviour

The theory of planned behaviour as suggested by Ajzen (1991) is used as a basis in this study. The theory suggests that an individual's intention usually controls the individual's actions that are crucial in predicting and elucidating the individual's behaviour. Ajzen (2002) further indicates that three constructs, namely, attitude, subjective norms, and perceived behaviour control affect the intention to perform the behaviour. The present study attempts to improve this theory by including two new constructs (health consciousness and knowledge) as mechanisms (mediators) that link attitude, subjective norms, perceived behaviour control with actual purchase of organic foods in Tanzania in comparison to Denmark. As mentioned earlier, the present study focuses on the actual purchase of organic food rather than the intention to purchase as the actual purchase is the result of the purchase intention and willingness. The motivation here is to find out how consumers' health consciousness and knowledge influence the relationships of attitude, perceived behaviour control and subjective norms with actual purchase of organic food in Tanzania and Denmark.

The construct "attitude" in the theory of planned behaviour is described as the degree to which a person holds a favourable or unfavourable assessment of a certain product (Ajzen, 2002). Thus, if a consumer holds a favourable assessment of a certain product, the attitude towards it becomes positive. A person's attitude towards a behaviour represents an evaluation of the behaviour and its outcomes, for example, the positive attitude towards organic foods purchase represents its favourable assessment. Alphonce and Alfnes (2012) have shown Tanzanians' positive attitude towards purchase of organically produced tomatoes. In Denmark, school pupils have positive attitudes toward organic food and health, which influences their organic food consumption positively (He *et al.*, 2012).

"Subjective norm" in theory of planned behaviour is "the perceived social pressure to engage or not engage in a behaviour" (Ajzen, 2015). This notion can greatly influence purchase intention toward organic food (Bartels & Reinders, 2010). For example, Tanzanian consumers are more likely to be influenced by their peers who have similar consumption behaviours (Chacha, 2009) whereas family members and TV programs are social influencers for healthy eating among Danish consumers (Grønhøj, 2013). Previous studies such as of that of Çabuk *et al.* (2014) have shown that an individual may possess a favourable attitude towards certain behaviour. However, the individual may lower the intention to achieve the behaviour if the individual perceives difficulties in doing so.

Ajzen (2002) defined "perceived behaviour control" as the perception of ease or difficulty in performing a particular behaviour. However, perceived behaviour control relies on consumer's perceived limitations and ability that may affect the consumers' purchase intention (Yeon Kim & Chung, 2011). Thus, the perceived behaviour control considers the evaluation of resources desirable for performing a behaviour and the degree to which people have these resources (Ajzen, 1988). Access to organic food in Denmark is assured because organic food is produced and processed by large-scale industrialised units and distributed by mainstream sales channels (Wier *et al*., 2008). The effort to make certified organic food visible and accessible to consumers in Tanzania (Sogn & Mella, 2007) is not very effective. In Tanzania, the primary incentive of producing organic food is its export potential. However, the fact that it is exported significantly hinders its local access and availability. Consistent with the above discussion, this study extends the theory of planned behaviour as shown in Figure 1.

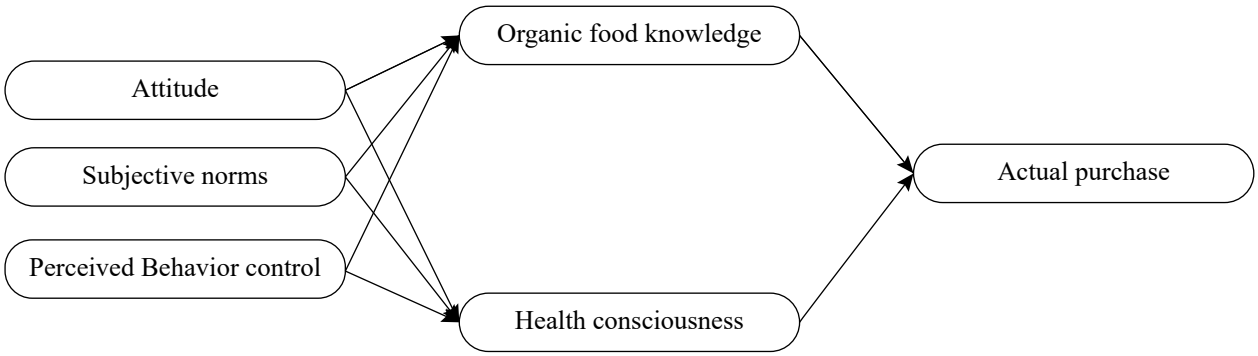

Figure 1: The Theoretical Model.
Source: Own composition

Hypotheses

Influence of Knowledge

Knowledge refers to what the consumers think they know about a product (Brucks, 1985). It has been used as a key influencer in consumers' behaviour regarding the actual purchase of organic food (Van Loo *et al.*, 2013). Both subjective and objective knowledge play their part in influencing consumers' decision to purchase organic food (Pieniak *et al.*, 2010). Consumer's objective knowledge refers to accurate factual information stored in the consumer's mind, and consumer's subjective knowledge is a belief about the stored knowledge about a product (Moorman *et al.*, 2004). Subjective knowledge of organic food refers to consumers' knowledge and understanding of organic food quality (Hsu *et al.*, 2016). From scientific point of view, organic foods are defined as foods that are grown without synthetic pesticides and synthetic fertilisers, and with extra attention to the preservation of environment, biodiversity, and animals (Ahmad & Juhdi, 2010); and, they contain high nutrition (Grzybowska-Brzezinska *et al.*, 2017). A study by Petrescu and Petrescu-Mag (2015) states that a high percentage of consumers believe that organic food contributes to environmental protection. However, there are critics say that organic-food farming uses more land that leads to deforestation which in turn causes high carbon dioxide emissions and biodiversity-loss making it less efficient than conventional farming. However, this negativity about the organic-food farming process does insignificant impact on consumer-thinking as they typically rely on a simple definition of organic foods to understand their meaning. Also, consumers may find it difficult to verify regulation about the organic food production process and its compliance (Lee & Jiyoung, 2016). The knowledge about organic food safety and healthiness has remained subjective along with diverse beliefs about them (Fernqvist & Ekelund, 2014). For all these reasons, and for the purposes of this study, we contend that simple knowledge that consumers possess about organic food leads to enhanced willingness to its purchase, and this may result into positive impact on actual purchase behaviour (Mesías Díaz Francisco *et al.*, 2012). However, consumers' insufficient knowledge may lead to confusion (such as, whether or not to even purchase organic food) as the consumers may fail to realise the benefit of the uniqueness of organic food compared to conventional food (Yiridoe *et al.*, 2005). Thus, it is argued in this study that simple and sufficient consumer knowledge about organic food is an underlying factor that influences actual purchase of organic food.

The knowledge about 'organic' food is expanding in Africa. Dixon (2002) points out that an individual can voluntarily identify, gather, and possess knowledge, and share it with others. This way, knowledge is transferred from one person to another. Multiple factors such as the rise of non-communicable disease (Wiggins & Keats, 2017), food safety risks associated with foodborne diseases, food fraud, and an absence of effective enforcement of regulations have contributed to numerous food-related concerns and controversies from consumers (Boatemaa *et al.*, 2019). Consumers have been developing self-knowledge, which leads them to inquire about the origin of the products they want to buy (Engel, 2009). In addition, consumers are highly sensitive to information gathered about organic food (Muhammad *et al.*, 2016), when the awareness of what to eat has come from their "significant others" (Wang *et al.*, 2019). The perceived social pressure (subjective norms) influences the actual purchase of organic food as people are affected by what others think (Ruiz de Maya *et al.*, 2011). Due to the rising positive influence of social peers as well as openness to change in developing countries (Mainardes *et al.*, 2017), consumers may feel confident regarding the sufficiency of their own knowledge and abilities to perform a given purchase behaviour (perceived behaviour control). Despite few studies on how consumers gain knowledge about organic food in Africa, the available studies such as Wang *et al.* (2019) have found that the consumer search about knowledge of organic food is positively linked with the consumer's positive attitude about organic food purchase in developing countries.

Consumers in developed countries have developed a habit of purchasing organic food because of the well-structured food-related environmental dimensions such as visibility, accessibility, and availability at the point of purchase (Henryks *et al.*, 2014). An increase in the knowledge of where to access the products influences the perceived behaviour control positively. Moreover, an introduction of European Union organic food logo in 2010, which aimed to harmonise and boost its organic food sector, added awareness and

recognition of organic food among consumers in Europe (Van Loo *et al.*, 2013). This increase in knowledge from the information in the organic food labels in developed countries makes it easier for consumers to purchase organic food. Prior studies such as Janssen and Hamm (2012) found out that the consumers' perception of organic labelling schemes is based on their overall knowledge about the organic products in Denmark. Higher organic food knowledge possessed by consumers influences the positive attitude towards its purchase in developed countries (de Magistris & Gracia, 2008). Furthermore, the experimental studies by Hidalgo-Baz *et al.* (2017) have indicated that the consumers' knowledge causes the willingness to purchase organic food. Therefore, these arguments suggest three hypotheses as stated below.

Hypothesis 1 (H1): Knowledge mediates the relationship between attitude and actual purchase of organic food.

Hypothesis 2 (H2): Knowledge mediates the relationship between subjective norms and actual purchase of organic food.

Hypothesis 3 (H3): Knowledge mediates the relationship between perceived behaviour control and actual purchase of organic food.

Influence of Health Consciousness

Health consciousness as a construct is positioned as a determinant of food purchase by consumers in organic food studies (Akhondan *et al.*, 2015; Yadav & Pathak, 2016). Basha and Lal (2019) and Çabuk *et al.* (2014) found that consumers' attitude, subjective norms and perceived behaviour control regarding purchase of organic food were caused by their awareness of the chemical effects present in foods. This impact may be caused by the lower content of unhealthy substances such as dietary cadmium and synthetic fertilisers and pesticides in organic foods although only a few clinical and epidemiological studies have been carried out so far to affirm this (Brantsæter *et al.*, 2017). Though a few clinical studies have been carried out to prove if organic foods contribute to human health (Dangour *et al.*, 2010), numerous health-benefit studies associated with organic food also exist in the literature, and this creates a room for the current study which assesses health consciousness as an underlying mechanism between consumers' behaviour (attitude, perceived behaviour control and subjective norms) and purchase of organic food.

In our present study's context, it may be noted that numerous earlier studies have shown that consumers are ready to purchase nutritious vegetables in Africa (Armesto *et al.*, 2020; Popa *et al.*, 2019). The knowledge of consumers about food explains their willingness to purchase high quality (i.e. nutritious) vegetables in Kenya (Ngigi *et al.*, 2011). Food safety risks associated with foodborne diseases, food fraud, as well as the absence of effective enforcement of regulations are the challenges that are noted in South Africa (Boatemaa *et al.*, 2019). The behaviour to purchase organic products has translated into a health movement in developed and developing countries (Hansen *et al.*, 2018; Wekeza & Sibanda, 2019). The existence and awareness of health consciousness is explained by the consumers' behaviour to purchase organic food in Tanzania (Wang *et al.*, 2019) as well as in Denmark (Hansen *et al.*, 2018). Speculation about non-communicable diseases has contributed to consumers' awareness in Tanzania regarding their health maintenance, thereby strengthening their commitment for organic food purchase (Wang *et al.*, 2019). Denmark has a robust healthcare system (Mainz *et al.*, 2015) which serves as a source of early information on imminent diseases; such a system makes consumers selective in their food choices. Also, the social influencers for healthy eating are mainly attributed to family members, television programmes and school teachers (for adolescents) in Denmark (Grønhøj, 2013). Consistently, considering the role of health consciousness in healthy eating as well as its application to the theory of planned behaviour, this study suggests three more hypotheses as stated below.

Hypothesis 4 (H4): Health consciousness mediates the relationship between attitude and actual purchase of organic food.

Hypothesis 5 (H5): Health consciousness mediates the relationship between subjective norms and actual purchase of organic food.

Hypothesis 6 (H6): Health consciousness mediates the relationship between perceived behaviour control and actual purchase of organic food.

Research Methods

Sample Size, Respondents and Sampling Techniques

The above research model hypotheses were tested with data gathered from two countries (Tanzania and Denmark) using the same survey instrument. Tanzania is one of the two countries with the largest number of organic producers accounting for 21% of all producers in Africa, who produce from 0.7% (268,726 hectares) of its agricultural land (Willer & Lernoud, 2017). The present market share for organic food in Tanzania is not known, although the certified organic export from Tanzania was estimated to be $2 million in 2005 (Rundgren & Lustig, 2007). The study selected Denmark as a second country due to its highest organic food market share (9.7%) as well as the highest per-capita organic food consumption in Europe (Willer *et al.*, 2018). Denmark has a well-developed organic food market with pro-organic consumers and about 51% of them purchase organic food every week (Hansen, 2019). Consumers in Denmark enjoy organic food. The government of Denmark is actively engaged in enhancing the national supply of organic food (Mellino, 2013). Although these two countries (Tanzania and Denmark) are culturally and economically different, they are included in the current study because of the countries' significant efforts made toward the availability of organic food. The tests were replicated to generate two independent data sets aimed at establishing the robustness of the results. The findings about the two models based on two data sets (Denmark = 663, Tanzania = 730) were compared statistically to identify any significant differences. The questionnaire was

initially drafted in English, and then, translated into Danish and Swahili, respectively. After that, the Danish and Swahili versions of the questionnaire were translated back into English by an independent scholar to assess whether the two versions of the questionnaire were conceptually and linguistically equivalent.

Our ideal sample size required as per structural equation model (SEM) follows N:q rule (Chelang'a *et al.*, 2013), where N in the ratio represents the number of cases and q refers to the number of model parameters that require statistical estimates. The hypothesised model in this study had 24 parameters that needed statistical estimates. Therefore, the minimum ideal sample size was 23 (items) × 20 (cases) = 460 for each data set. In Tanzania, the data were collected from 16 supermarkets (8 in Kilimanjaro and 8 in Arusha region). The supermarkets selected were those that sold organic food. The respondents included in the study were based on the following criteria: (1) the respondent should be responsible for the family's grocery shopping; (2) the respondent should consume organic foods at least three times a week, and (3) the respondent should have a minimum monthly income of $650. The researchers approached 802 customers, 730 agreed to participate in the study resulting in 91 percent of respondents qualified to participate. Likewise, the same instrument was used as an online survey in Denmark. All cities in Denmark were selected to participate. The online survey format was opted to avoid high costs that are associated with a traditional face-to-face survey. The study used paid advertisement on Facebook for seven days inviting all organic food consumers to participate. The Facebook advertisement option enabled us to identify the prospective respondents for the survey. For those who clicked on the advertisement were able to access the questionnaire directly. We controlled the response by ensuring that the respondents met the three conditions (as stated earlier in the case of Tanzania questionnaire) of an organic consumer. If any one condition were not met, the subsequent questions could not be answered. To implement this, we used the following statement in the questionnaire: "If you meet all three criteria above you may continue to the organic food related-questions below." To minimise response error, at the end of the questionnaire, we asked the following qualifying error control question "I honestly responded to the questions in this questionnaire" with a Likert scale ranging from 1=strongly disagree to 7=strongly agree (Wu Gavin, 2019). Only respondents who checked "strongly agree" were chosen for further tests. The study also met the other criteria needed for sample robustness, namely, sample size and representation of the population being studied. As many as 940 respondents answered the questionnaire. Only 663 respondents replied "strongly agree" on the error control statement resulting in 70.5 percent of respondents qualified for the further analysis.

Measures

Our questionnaire was developed using items adapted from Ajzen (2002) to measure the attitude, subjective norms and perceived behaviour control. The actual purchase of organic food items were adapted from Ham *et al.* (2018a). The knowledge items were adapted from Flynn and Goldsmith (1999) with a slight change in connectives (De Leeuw *et al.*, 2012). The items on health consciousness were adapted from Tarkiainen and Sundqvist (2005). All items are shown in Appendix 1. However, the questionnaire started with a brief description of organic food and included a statement that was intended to give respondents confidence to answer the questions. The statement stated, "Be assured that all answers you provide will be kept in the strict confidentiality". The questionnaire had two sections. The first section had 24 statements that measured the six constructs (Figure 1). All constructs were measured on a seven-point Likert scale ranging from 1= "strongly disagree" to 7= "strongly agree". The second section contained demographic questions. Both data collection instruments were piloted on 30 respondents to assess their appropriateness and relevance before they were administered to all respondents. We followed a recommendation by Browne (1995) that 30 independent respondents or more are adequate for estimating a parameter. These respondents are not included in the overall data analysis sample. However, our study controlled for education, marital status, income and access to organic food (Dimitri, 2012), age and gender (Tung, 2012), organic food label recognition (Teisl *et al.*, 2001), and family size to minimise the possibility of contaminating our intended results.

Data Analysis

We used Statistical Package for the Social Sciences (SPSS) and Analysis of Moment Structures (AMOS) to analyse the data. To test the proposed hypotheses, we used the structural equation model (SEM) technique with the maximum likelihood estimation as suggested by Honkanen *et al.* (2006); Wang *et al.* (2019) and Irianto (2015). We adopted the most commonly used measures of fit including the chi-squared test (χ^2), root mean square error of approximation (RMSEA), standardised root mean residual (SRMR) and comparative fit index (CFI). A low χ^2 with an insignificant *p*-value was considered the acceptable threshold level. Other threshold levels for goodness of fit were RMSEA (cut-off < 0.08), SRMR (Cut-off < 0.08) and CFI (Cut-off > 0.9) (Hair *et al.*, 2013). The mediation results were confirmed by using the bootstrapping method (Andrew Hayes Process macro) applied as a *post hoc* analysis for evaluating the significance of the indirect paths (Hayes, 2017).

Results

Demographic Characteristics of the Respondents

The demographic results showed that in Tanzania more than 70 percent of the participants were female, while in Denmark 67 percent were male. The majority of the participants from Tanzania were between 25 and 55 years old, and 94.4% of the participants in Tanzania had an income above $650. In contrast, the majority of participants in Denmark

were between 25 and 66+ years old, with a monthly income above $1000. For Tanzania, the above-mentioned group represented the middle-class people who were able to purchase organic food products and had a high demand for a variety of products (Wang *et al.*, 2019). This case was different for the participants in Denmark, who had monthly income between $1000-1500; they represented a lower socio-economic class (Madsen *et al.*, 2010). Most of the participants, 63.3 and 73 percent in Tanzania and Denmark, respectively, had education levels above a bachelor's degree. Access to organic food was 89 percent in Denmark, which was higher than that of Tanzania (69 percent). Organic food label recognition level was very high in Denmark (92 percent), unlike Tanzania (23 percent). The demographic distribution of organic food respondents is shown in Table 1.

Reliability and Validity Measures

First, common method variance was examined by using Harman's one-factor test. The results showed that no single factor was dominant, whereby the first factor explained only 22.5 and 29.7 percent of the total variance for the Tanzania and Denmark samples, respectively. Thus, common method variance was not a significant problem in the data and results. Second, the study examined all variables using the correlation matrix to find out if there is a multicollinearity concern. The variables chosen for the studies were related to one another only modestly as the correlation coefficients that varied from 0.01 to 0.61 for both studies indicated no multicollinearity concern (Tabachnick and Fidell, 1996). Third, construct validity was assessed by using discriminant validity and convergent validity. Average variance extracted (AVE) met the threshold recommended by Hair *et al.* (2013) and is shown in Table 2, and construct reliability (CR) was higher than 0.7. Discriminant validity was measured using the method proposed by Fornell and Larcker (1981). This method needs the extracted variance for each construct to be greater than the squared correlation (i.e., shared variance) between the constructs. In our study, square roots of AVE are shown in Table 3 in the diagonal.

The smartPLS suggested by Hair Jr *et al.* (2017) was employed on this study to conduct a multigroup analysis (MGA) to assess if the path coefficients are equal across two samples employed. Table 4 depicts the differences of path coefficient estimates between the two groups. There were differences between two groups on four paths only. For example, we observed that the subjective norms to organic food knowledge as well as subjective norms to health consciousness were not significant in Denmark. Also, the perceived behaviour control to organic food knowledge as well

Table 1: Demographic distribution of organic food respondents.

Variable	Group	Tanzania (%)	Denmark (%)
Gender	Male	22.0	67.0
	Female	78.0	33.0
Age	25-35	16.4	19.2
	36-45	32.9	40.8
	46-55	39.6	24.2
	56-65	11.1	9.7
	66 and above	0.0	6.0
Marital status	Married	64.0	47.7
	Single	25.9	38.7
	Other	10.1	13.6
Education	Primary school	7.1	5.0
	High school	10.8	19.2
	Associate degree	18.6	2.8
	Bachelor	21.6	46.9
	Master	34.9	21.2
	PhD	6.8	5.0
	Other	0.0	0.0
Family monthly Income	650-1000	67.1	0.0
	1001-1500	30.0	89.0
	1501 and above	2.9	11.0
Occupation	Business	43.8	26.6
	Full-time-employees	21.9	46.9
	Part-time job	14.0	5.6
	Unemployed	6.4	2.6
	Housewives	13.8	18.4
Household size (persons)	<4	17.3	61.9
	>4	82.7	38.1
Access to organic food	Yes	69.0	89.0
	No	31.0	11.0
Organic food label recognition during the purchase	Yes	23.0	92.0
	No	77.0	8.0

n (Tanzania consumers) = 730; *n* (Denmark consumers) = 663
Source: Own composition

Table 2: The Reliability and Validity Measures.

Tanzania						Denmark				
Measured Variables	**Pool sample factor loading**	**Factor loadings**	**α**	**CR**	**AVE**	**Measured Variables**	**Factor loadings**	**α**	**CR**	**AVE**
Attitude										
Att1	0.83	0.72				Att1	0.87			
Att2	0.91	0.87				Att2	0.64			
Att3	0.84	0.91				Att3	0.66			
Att4	0.93	0.77				Att4	0.70			
Att5	0.85	0.82				Att5	0.98			
Att6	0.73	0.78	0.90	0.91	0.62	Att6	0.85	0.82	0.85	0.65
Subjective Norms										
SN1	0.84	0.86				SN1	0.73			
SN2	0.89	0.89				SN2	0.68			
SN3	0.79	0.77				SN3	0.81			
SN4	0.85	0.82	0.92	0.93	0.74	SN4	0.73	0.82	0.83	0.55
Perceived Behaviour Control										
PBC1	0.87	0.84				PBC1	0.85			
PBC2	0.96	0.81				PBC2	0.93			
PBC3	0.83	0.83	0.86	0.86	0.68	PBC3	0.87	0.91	0.91	0.78
Health Consciousness										
HC1	0.91	0.83				HC1	0.81			
HC2	0.71	0.95				HC2	0.88			
HC3	0.98	0.89	0.91	0.93	0.79	HC3	0.87	0.88	0.89	0.73
Actual Purchase										
AP1	0.86	0.77				AP1	0.75			
AP2	0.93	0.89				AP2	0.88			
AP3	0.82	0.82				AP3	0.87			
AP4	0.87	0.85				AP4	0.91			
AP5	0.80	0.83	0.94	0.91	0.74	AP4	0.89	0.91	0.91	0.73
Knowledge										
KN1	0.97	0.69				KN1	0.76			
KN2	0.89	0.78				KN2	0.77			
KN3	0.78	0.88				KN3	0.81			
KN4	0.81	0.85	0.87	0.86	0.63	KN4	0.84	0.84	0.87	0.68

Note: Att = Attitude, SN = Subjective norms, PBC = Perceive Behaviour control, HC = Health consciousness, AP = Actual purchase, KN = Knowledge, CR = Construct reliability, α = Cronbach alpha AVE = average variance extracted.
Source: Own composition

Table 3: The Discriminant Validity.

Tanzania						
	IP	**KN**	**Att**	**PBC**	**HC**	**SN**
AP	0.852					
KN	0.098	0.772				
Att	0.428	0.058	0.784			
PBC	0.084	0.013	0.022	0.824		
HC	0.47	0.001	0.564	0.037	0.883	
SN	0.227	0.091	0.225	0.02	0.244	0.857
Denmark						
	SN	**IP**	**KN**	**PBC**	**HC**	**Att**
SN	0.738					
AP	0.442	0.789				
KN	0.063	0.098	0.882			
PBC	0.561	0.47	0.001	0.88		
HC	0.22	0.232	-0.073	0.244	0.857	
Att	-0.052	-0.079	-0.149	-0.081	-0.074	0.628

Note: Att = Attitude, SN = Subjective norms, PBC = Perceive Behaviour control, HC = Health consciousness, AP = Actual purchase, KN = Knowledge.
Source: Own composition

Table 4: Multigroup Analysis.

	Tanzania		Denmark		MGA
Paths	**PC**	**t-value**	**PC**	**t-value**	**PC**
Att → KN	0.24	2.66**	0.26	4.10***	0.04 ns
SN → KN	0.30	6.05*	0.20	2.21 ns	0.17*
PBC → KN	0.12	0.29 ns	0.25	0.15*	0.21 ns
KN→ AP	0.21	2.37**	0.27	0.17**	0.03 ns
Att → HC	0.23	2.71***	0.23	3.08*	0.04 ns
SN → HC	0.17	2.23*	0.10	1.74 ns	0.08 ns
PBC → HC	0.19	2.37ns	0.11	2.23**	0.15 ns
HC → AP	0.22	5.52*	0.11	2.71**	0.07 ns
Variance explained R^2					
KN	0.28		0.27		
HC	0.18		0.19		
AP	0.21		0.23		

Note: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$, ns = non-significant, PC = Path coefficient, MGA = Multigroup analysis, Att = Attitude, SN = Subjective norms, PBC = Perceive Behaviour control, HC = Health consciousness, AP = Actual purchase, KN = Knowledge.
Source: Own composition

as the perceived behaviour control to health consciousness were not significant in Tanzania.

Multigroup analysis

The SmartPLS software suggested by Hair Jr *et al.* (2017) was used in this study to conduct a multigroup analysis (MGA) to assess if the path coefficients are equal across two samples (Tanzania and Denmark) employed. The data from both samples was combined and the multi-group analysis (MGA) was run using multi-group permutation tests through SmartPLS (Hair Jr *et al.*, 2017). The results depict a significant difference between the two groups in the path from subjective norms to organic food knowledge (Table 4). Further, this study observed differences on groups as follows: the path for the subjective norms → organic food knowledge and the path for subjective norms → health consciousness was not significant for Denmark, but they were significant for Tanzania. Also, the path for perceived behaviour control → organic food knowledge and path for the perceived behaviour control → health consciousness was not significant for Tanzania but were significant for Denmark.

Structural Equation Model Results

Tanzanian consumers

The bootstrapping procedure was conducted by creating a 95 percent confidence interval (percentile and bias-corrected) around the indirect effect estimates. The results with $p \leq 0.05$ were considered significant. To achieve the full first condition, the paths from attitude, subjective norms, and perceived behaviour control to actual purchase were assessed. The results showed the significant and positive path from attitude ($\beta = 0.40$, $p < 0.001$) and subjective norms ($\beta = 0.15$, $p < 0.001$) to actual purchase (Model 1). With the involvement of knowledge (Model 2), the effect of attitude ($\beta = 0.27$, $p < 0.01$) and subjective norms ($\beta = 0.12$, $p = 0.05$) on actual purchase remained significant but smaller than in Model 1. Furthermore, with the involvement of health consciousness as a mediator (Model 2), the effect of attitude ($\beta = 0.25$, $p < 0.001$) and subjective norms ($\beta = 0.11$, $p < 0.05$) on actual purchase remained significant but smaller than those in Model 1. By these results, Hypothesis 1, 2, 4, and 5 were supported.[1]

Denmark consumers

We applied the same conditions using the sample from Denmark, in which the paths between the attitude and perceived behaviour control to knowledge and health consciousness were significant except for the subjective norms. For Model 1, the results indicated the significant and positive effect of attitude ($\beta = 0.71$, $p < 0.001$) and perceived behaviour control ($\beta = 0.52$, $P < 0.001$) on actual purchase. With the involvement of knowledge in Model 2, the effect of attitude ($\beta = 0.39$, $p < 0.05$) and perceived behaviour control ($\beta = 0.28$, $p = 0.05$) on actual purchase remained significant but smaller than those in Model 1. Moreover, the involvement of health consciousness as a mediator (Model 2), and the effect of attitude ($\beta = 0.31$, $p < 0.01$) and perceived behaviour control ($\beta = 0.22$, $p < 0.01$) remained significant and positive but smaller than those of Model 1. By these results, H1, H3, H4, and H6 were supported. The mediation results are summarised in Table 5.

The smartPLS suggested by Hair Jr *et al.* (2017) was employed on this study to conduct a multigroup analysis (MGA) to assess if the path coefficients are equal across two samples employed. Table 4 depicts the differences of path coefficient estimates between the two groups. There were differences between two groups on four paths only. For example, we observed that the subjective norms to organic food knowledge as well as subjective norms to health consciousness were not significant in Denmark. Also, the perceived behaviour control to organic food knowledge as well as the perceived behaviour control to health consciousness were not significant in Tanzania.

[1] β is a standardized beta coefficient that compares the strength of the effect of each individual independent variable with the dependent variable. The higher the absolute value of the beta coefficient, the stronger the effect. The p-value for each term tests the null hypothesis that the coefficient is equal to zero (no effect).

Table 5: The Mediation Results.

		Tanzania		Denmark	
Hypotheses	**Mediation path**	**Model 1**	**Model 2**	**Model 1**	**Model 2**
H1	Att -KN-AP (Model 2)	0.40***	0.27**	0.71***	0.39*
H2	SN -KN-AP (Model2)	0.15***	0.12*	0.11ns	0.09ns
H3	PBC-KN-AP (Model 2)	-0.09ns	-0.06ns	0.52***	0.28*
H4	Att-HC-AP (Model 2)	0.40***	0.25**	0.71***	0.31**
H5	SN-HC-AP (Model 2)	0.15***	0.11*	0.11ns	0.10ns
H6	PBC-HC-AP (Model 2)	-0.09ns	-0.06ns	0.52***	0.22**
	Fit statistics				
	X^2	473.03	363	272	261.31
	X^2/df	2.28	2.03	1.54	1.50
	RMR	0.03	0.07	0.05	0.04
	CFI	0.95	0.91	0.98	0.98
	RMSEA	0.05	0.03	0.03	0.03

Note: ns= Not significant; Model 1 constrained; Model 2 free; n (Tanzania consumers) = 730; n (Denmark consumers) = 663; * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$; $\chi 2$ = Chi-squared, df = degrees of freedom, RMR = Root mean square residual, CFI = Comparative fit index, RMSEA = Root mean square error of approximation; Att = Attitude, SN = Subjective norms, PBC = Perceive Behaviour control, HC = Health consciousness, AP = Actual purchase, KN = Knowledge.
Source: Own composition

Discussion and Implications

As per the published available data (Willer & Lernoud, 2017), the organic food consumption has been increasing worldwide. This means a necessity for the organic food companies to understand customers' motives behind the actual purchase of organic food. The findings in earlier studies have focused on numerous dimensions of consumer behaviour and consumers' willingness or attention to purchase organic food. The underlying mechanisms which connect consumer behaviours with actual purchase of organic food have largely been ignored. This study processes a theoretical model that links the theory of planned behaviour constructs with consumer knowledge about organic food, health consciousness, and the actual purchase of organic food. To do the mediation analysis, the direct paths were first assessed as recommended by Hair *et al.* (2013). The results did not find the direct relationship between subjective norms and actual purchase of organic food in Denmark, and perceived behaviour control and actual purchase of organic food in Tanzania. This was a significant difference between Denmark and Tanzania. Later, to test the hypotheses, the knowledge and health consciousness were introduced into the significant paths. The present study makes several contributions to the existing literature on consumer behaviour and actual purchase of organic food.

First, the proposed model focuses on the knowledge and health consciousness variables as underlying mechanisms that link consumer behaviour dimensions (consumer attitude, subjective norms, and perceived behaviour control) with the actual purchase of organic food. Most of the previous studies have linked these behaviours with intentions or willingness to purchase organic food (Chelang'a *et al.*, 2013; Shahriari *et al.*, 2019). However, it is known that the willingness and intention to purchase does not always lead to the actual purchase because of the barriers such as lack of availability and high price of the organic food (Ham *et al.*, 2018b). Therefore, an understanding of the actual purchase of organic food is essential. This study's results indicate that knowledge and health consciousness are underlying mechanisms in the relationship of attitude and subjective norms with the actual purchase of organic food in Tanzania. The knowledge and health consciousness have received attention as predictor variables (and not as underlying mechanisms) in prior studies (Ngigi *et al.*, 2011). The results of this study imply that the immediate information that consumers seek on health benefits changes their behaviour regarding food choices in Tanzania.

Second, knowledge and health consciousness are underlying mechanisms in the relationship of consumer attitude and perceived behaviour control with actual purchase of organic food in Denmark. In Denmark, the results indicate partial mediation of health consciousness and knowledge in the relationship of attitude and perceived behaviour control with actual purchase of organic food.

Third, the study encountered a significant difference in antecedent variables in the case of two countries. Attitude, subjective norms, and actual purchase were significant paths in Tanzania, and attitude, perceived behaviour control, and actual purchase were significant paths in Denmark. There was no significant path between subjective norms and actual purchase of organic food in Denmark, implying that Danes are not affected by what "important" people think or by social influence, which is in contrast with Ruiz de Maya *et al.* (2011). There was no significant path between perceived behaviour control and the actual organic food purchase in the Tanzania sample which is in contrast with Wang *et al.* (2019). A possible explanation is the inadequate availability of organic food in Tanzania, which is caused by its significant exports to other countries (Bakewell-Stone *et al.*, 2008; Valerian *et al.*, 2011). As per this study, both consumer knowledge and health consciousness were the underlying mechanisms that linked consumer attitude and subjective norms with actual purchase of organic food in Tanzania. Whereas consumer knowledge and health consciousness were the underlying mechanisms linking consumer attitude and perceived behaviour control with actual purchase of organic food in Denmark. The results concerning consumer knowledge are aligned with those of Choi and Kim (2011) which states that consumer knowledge explains the consumer

purchase behaviour of organic food. The results concerning health consciousness are in agreement with Alphonce and Alfnes (2012) which asserts that consumers rely on food safety being beneficial for their health. However, our study uniquely identifies both consumer knowledge and health consciousness as underlying mechanisms of actual purchase behaviour, unlike Choi and Kim (2011).

Conclusions

The prior studies have suggested that the differences in economy and culture of different countries cause dynamism in consumer behaviour from country to country (Al-Hyari *et al.*, 2012; De Mooij, 2019). The present study invites future research to examine the role of cultural and economic aspects of organic food purchases empirically. Moreover, the present study considered regular and middle-class consumers of organic food, which provides room for a future study to focus on occasional and rich class consumers for a more complete understanding of consumer behaviour of organic food. The present study used a mix of online and field surveys to obtain data from two countries. Only few studies (Moon & Balasubramanian, 2003) have collected data in this blended way, but have also shown that the two techniques (online and field survey) produce similar results. Future comparative studies may use consistent methods (either online or field survey) in two countries to ensure further generalisation of findings. Lastly, the present study focused on consumer's simple knowledge about organic food in general and did not incorporate the consumer's knowledge and understanding about the organic farming processes and techniques; therefore, future studies may use our conceptual work to explore consumer behaviour based upon consumer knowledge about specific organic products that are produced by using different organic food processes and techniques.

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Appendix

Appendix 1: Constructs and their Measures.

Codes	Items (All were in seven-point (1=strongly disagree to 7=strongly agree)	Author
	Subjective norms	
SN1	Most people I value would buy organic food rather than non-organic food.	Ajzen (2002)
SN2	My family thinks that I should buy organic food rather than non-organic food.	
SN3	People I value, such as my teachers, think I should buy organic food.	
SN4	Most friends whose opinions regarding diet are important to me think that I should buy organic food.	
	Attitude	
Att1	I think that purchasing organic food is a good idea.	Ajzen (2002)
Att2	I think that purchasing organic food is interesting.	
Att3	I think that purchasing organic food is important.	
Att4	I think that purchasing organic food is beneficial.	
Att5	I think that purchasing organic food is wise.	
Att6	I think that purchasing organic food is favourable.	
	Perceived behaviour control	
PBC1	If I wanted to, I could buy organic food instead of non-organic food.	Ajzen (2002)
PBC2	I think it's easy for me to buy organic food.	
PBC3	It's mostly up to me whether or not to buy organic	
	Actual purchase	
AP1	When I buy organic food, I buy meat and meat products from organic farms.	
AP2	When I buy organic food, I buy fresh fruits and vegetables from organic farms.	
AP3	When I buy organic food, I buy organic eggs.	
AP4	When I buy organic food, I buy organic bakery products.	
AP5	When I buy organic food products, I buy organically grown grains and beans.	Ham *et al. (*2018)
	Health consciousness	
HC1	I choose food carefully to ensure good health.	Tarkiainen and Sundqvist (2005)
HC2	I consider myself as a health-conscious consumer.	
HC3	I often think about health-related issues.	
	Organic food Knowledge	
KN1	I know different types of organic foods	Flynn and Goldsmith (1999)
KN2	I think I know enough about the term organic food	
KN3	I know about organic food well enough to be able to purchase them	
KN4	I have been interested to learn about organic foods	

Appendix 2: The Questionnaire.

This questionnaire is about organic food. Organic food is fresh or processed food farmed without the use of synthetic chemicals, such as human-made pesticides and fertilisers. The aim of this survey is to know the awareness of organic food products in the country. I would like to have a few minutes of your time to answer this survey. There are no right or wrong answers, only your personal opinions matter.

1. Are you able to access organic food easily in your area (Please tick an appropriate answer)?
□ Yes
□ No

2. Can you recognise organic food label during the purchase?
□ Yes
□ No

3. Please select the most appropriate response from 1 = strongly disagree to 7= strongly agree level

S/N	Statement	1	2	3	4	5	6	7
1	I know different types of organic foods							
2	I think I know enough about the term organic food							
3	I know about organic food well enough to be able to purchase them							
4	I have been interested to learn about organic foods							
5	I choose food carefully to ensure good health.							
6	I consider myself as a health-conscious consumer.							
7	I often think about health-related issues.							
8	When I buy organic food, I buy meat and meat products from organic farms.							
9	When I buy organic food, I buy fresh fruits and vegetables from organic farms.							
10	When I buy organic food, I buy organic eggs.							
11	When I buy organic food, I buy organic bakery products.							
12	When I buy organic food products, I buy organically grown grains and beans.							
13	If I wanted to, I could buy organic food instead of non-organic food.							
14	I think that it is easy for me to buy organic food.							
15	It is mostly up to me whether to buy organic							
16	I think that purchasing organic food is a good idea.							
17	I think that purchasing organic food is interesting.							
18	I think that purchasing organic food is important							
19	I think that purchasing organic food is beneficial							
20	I think that purchasing organic food is wise.							
21	I think that purchasing organic food is favorable.							
22	Most people I value would buy organic food rather than non-organic food.							
23	My family thinks that I should buy organic food rather than non-organic food.							
24	People I value, such as my teachers, think I should buy organic food.							
25	Most friends whose opinions regarding diet are important to me think that I should buy organic food.							

Demographic (Please tick an appropriate answer)

4. Gender
□ Male
□ Female

5. Marital Status
□ Married
□ Single
□ Other

6. Age
□ 25-35
□ 36-45
□ 46-55
□ 56-65
□ 66 and above

7. Education level
□ Primary school
□ High school
□ Diploma
□ Bachelor
□ Masters
□ PhD
□ Other (explain)……

8. Occupation
□ Business
□ Full-time employee
□ Part-time job
□ Unemployed
□ Housewife

9. How many people in your house are living permanently?
□ Less than 4
□ Over than 4

10. Monthly income (in USD)
□ 650-1000
□ 1001-1500
□ 1501 and above

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Tea export competitiveness and the nexus between tea export and economic growth: The cases of Bangladesh, India and Sri Lanka

Long since the end of the British India regime, Bangladesh, India, and Sri Lanka have produced a significant volume of tea which continues to bring them invaluable foreign currency earnings through exports. Our paper explores the tea export competitiveness of these countries by employing the Revealed Symmetric Comparative Advantage (RSCA) index, and analyses the nexus between tea export and economic growth over the period from 1980 to 2018 using several dynamic econometric approaches. Results suggest that Bangladesh has lost its tea export competitiveness over the last decade. India posted moderate performance, while Sri Lanka consistently kept its dominant position. Further, the Johansen Cointegration test outcomes report no long-run relationship between tea export and economic growth across all the countries. The Granger Causality outcomes illustrate that only in Sri Lanka is it the case that tea export causes short-run economic growth. Lastly, the impulse response function projects tea export and economic growth, taking into consideration the response of each to a shock from the other. Extrapolation from the results indicate that, in contrast to the cases of Bangladesh and India (where no direct relationship was found), tea export and economic growth are intimately interconnected in Sri Lanka. This article further recommends effective policies so that economic growth in these countries can remain steady and that their tea industries can thrive.

Keywords: tea export, competitiveness, economic growth, Asia

JEL classifications: F14, O11, Q17

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Introduction

Over the years, tea has become one of the golden egg spawning cash-crops throughout the world due to its taste and widespread acceptance by the global public. More exactly, exporting tea from major tea-producing countries has become important to the economy and provides a crucial export earning source (Gunathilaka and Tularam, 2016). In the modern era, economic activities encompassing the tea sector have tremendously extended. Notably, the tea industries not only bring foreign currencies, but they also create jobs for vulnerable populations (Jannat, 2017). In addition to economic benefits, tea plantations also provide other essential ecosystem services such as carbon sequestration (Kamau *et al.*, 2008). The export competitiveness of tea has burgeoned in recent years, affecting the degree of participation of the industry in internal trade (Fetscherin *et al*., 2010). Tea export competitiveness can be achieved if a country produces and exports a vast amount of tea and produces the best quality tea with a comparative advantage. Otherwise, the global customer will lose its appetite for the tea, and tea export competitiveness will diminish for that particular country.

The tea industry alone contributes 1% of the GDP of Bangladesh (BTB, 2017), while it accounts for 3% of total world tea production, meaning that the country ranks as the 10th largest tea producer in the globe (Asiatic Society of Bangladesh, 2014). Bangladesh's most adjacent neighbours, India and Sri Lanka are some of the largest tea producers. However, India contributed 21% of world tea production in 2017 (FAOSTAT, 2017). Besides, the tea industry is also the second-largest source of employment in India, providing livelihoods for more than 3.5 million individuals (Tea Board of India, 2014). For Sri Lanka, the tea industry plays a significant role in the Sri Lankan economy and it contributes 0.7 percent to the national GDP (CBSL, 2019). The tea industry accounted for 15% of total exports in 2018 and provides one million workplaces in Sri Lanka (Hilal, 2020). However, the tea export volume of Sri Lanka has cumulatively decreased by 3.63 % for the period of 2014-2018 and the country's percentage share of world exports has dwindled to 14.7 % in 2018 from 17.3% in 2009 (CBSL, 2019). In contrast, other major exporting countries, namely India, China and Kenya have increased their tea export value due to globalisation and their respective tea industries' competitiveness.

It should also be mentioned that very few countries are blessed with a suitable climate and apposite landscapes for tea cultivation – Bangladesh, India and Sri Lanka are among these countries. Due to their unique climate, favourable soil quality and the accessibility of different vastly demanding varieties of tea, the majority of tea producing countries are located in Asia, especially India, Sri Lanka and Bangladesh (Basu Majumder *et al*., 2010). Moreover, Bangladesh, India and Sri Lanka, jointly the former British India, are of same geographical region, occupying more or less comparable socio-economic positions. Henceforth, this study focuses on these counties to address the research objectives, taking into account that all of these nations possess a historic reputation for tea production and that the tea industry constitutes an indispensable part of their economy. Undoubtedly, tea adds significant appreciation in the value chain and grants employment opportunities to millions of

people in this Indian sub-continent region which, in turn, boosts the income of the economy.

The export of agricultural products attracts policymakers' attention because it is a significant source of foreign exchange earnings, plus a catalyst for crop diversification and a rise in farm income (Suresh and Mathur, 2016). Given the significance of tea in the economy of Bangladesh, India and Sri Lanka, the extent to which these countries have a comparative advantage in the international market deserves to be explored. Also, the consequences of tea export for the overall economy need to be empirically addressed. Recognising the importance of tea and tea export in the economies of Bangladesh, India and Sri Lanka, we therefore aimed to explore the export competitiveness of tea and analyse the nexus between tea export and economic growth. This study contributes to the literature in the following ways: (a) it is the first endeavour, to the best of the authors' knowledge, to assess the tea export competitiveness of the aforementioned countries while at the same time analysing the nexus between tea export and economic growth using secondary data; (b) it assesses the comparative advantage of the tea exports of these counties, helping them to recognise their competency and position in world trade and (c) the novelty of this paper lies in the adoption of newly introduced RSCA index and application of dynamic econometric approaches to determine relationship between tea export and economic growth.

The paper is organised as follows: Section 2 represents the relevant literature review; Section 3 describes the data and the methodology used in this study, Section 4 presents the empirical results to address the objectives of this study and finally, Section 5 concludes.

Literature Review

From a theoretical perspective, it is generally assumed that exports support the economy. Being competitive in export brings in more foreign currency. Export competitiveness and export-led economic growth hypotheses are frequently discussed in the literature. Thus, the literature review is divided into two sections.

Export competitiveness of tea and other agricultural products

The theory of competitiveness is vastly adopted in neoteric economic literature to assess the shapes of trade and specialisation of nations in products that enjoy a competitive advantage (Saboniene, 2009). The export competitiveness of various agricultural products has been widely explored in recent years (e.g. Juhász, 2013; Török and Jámbor, 2013; Shalbuzov, 2020). Rahardjo *et al.* (2020) tried to investigate the competitiveness of Indonesian coffee in the international market by using Revealed Comparative Advantage (RCA) index and Export Product Dynamics (EPD). Results indicated that low value of RCA implying the comparative advantage of Indonesia still needs to be improved because of losing opportunities to be able to trade with other countries. Török *et al*. (2020) revealed that the level of comparative advantage of beer has substantially changed over three decades due to per capita beer production and consumption, the number of beers with geographical indications, and European Union (EU) membership. Likewise, Török and Jámbor (2016) reported that quality of production area and EU accession affect the competitiveness for ham trade of Europe.

In this same manner, tea, being one of the most significant agricultural export items, has attracted the attention of researchers who have begun to shed light on its international competitiveness in the context of different regions. The study of Nugrahaningrum *et al*. (2020), adopting Trade Specialization Index (ISP), RCA, CMS and Diamond Porter Theory confirmed that Indonesian tea has strong competitiveness in the international market. Jin (2019) attempted to measure the competitiveness of Chinese tea export in comparison to other major tea exporting countries. The outcome of RCA showed that although China enjoys a comparative advantage in tea export, it ranks lower compared to other countries. Hong and Song (2015), employing Revealed Comparative Advantage index exhibited that Fujian is well dominant in the international tea market. A similar kind of study attempted by Sachitra (2016), based on the partial least squares structural equation model, showed that government support, brand loyalty, and the state of demand have also positively influenced the export competitiveness of Sri Lanka's tea industry. Where the stability rate of tea export from India are concerned, Adhikary and Maity (2010) found instability indices are the highest for Iran and the lowest for the USA.

Agricultural export and economic growth nexus

Export-led growth hypothesis is historically of great concern in the field of economics. The hypothesis claims that with the expansion of exports, the economy of a nation grows. In developing economies, agricultural exports, alongside non-agricultural exports, drive long-term economic growth (Sanjuán-López and Dawson, 2010). Barros Jr. *et al.* (2019) in their investigation extrapolated that coffee which is believed to be a substitute of tea stimulates the economy of Brazil through fostering industrialisation, a position which validates the export led-growth hypothesis. Gilbert *et al.* (2013), who adopted an Engle Granger cointegration test, confirmed that coffee and bananas have played a significant role in accelerating economic growth in Cameroon. Similarly, Faridi (2012), by employing the Johansen Cointegration technique, revealed that agricultural exports have propelled the economic growth of Bangladesh.

Although numerous studies have accentuated the linkage between agricultural export and economic growth (e.g. Canchari *et al*., 2018; Shah *et al*., 2015; Dawson, 2005), rarely has any study set out to investigate the connection between tea export and economic growth. However, Chantal *et al.* (2018) studied the impact of the tea, coffee, and flowers export in Rwanda using multiple regression analysis. The study found that tea export positively affects economic growth. Muthamia and Muturi (2015), by adopting the Cointegration model and the Vector autoregressive (VAR) model, revealed that a direct relationship exists between tea export earnings and agricultural value-added. However, in recent years no research has been conducted to evaluate the

competitiveness of tea exported from Bangladesh, India and Sri Lanka. Furthermore, no study has attempted to assess the interrelationship between tea export and the economic growth of Bangladesh, India, and Sri Lanka. Hence, this paper aims to fill these research gaps.

Methodology

Secondary data covering the period from 1980-2018, retrieved from FAOSTAT and World Bank, were employed for this research. Table 1 depicts an overview of data. In line with previous studies (Canchari *et al.*, 2018; Olayungbo and Quadri, 2019), Real Gross Domestic Product proxied economic growth.

The Revealed Symmetric Comparative Advantage (RSCA) (Laursen, 2015) index was adopted to derive the competitiveness of tea export. This index is an updated and symmetric form of Balassa's Revealed Comparative Advantage (RCA) index (Balassa, 1965). RSCA index is the best tool for analysing comparative advantage (Laursen, 2015). It is widely applied in recent studies (e.g. Rossato *et al*., 2018; Naseer *et al.*, 2019).

The equational representation of RCA is as follows:

$$RCA_{ij} = (x_{ij}/x_{it}) / (x_{wj}/x_{wt}), \quad (1)$$

where RCA_{ij} stands for revealed comparative advantage of country *i* for a product *j* and x_{ij} denotes total export of country *i* in product *j*. Subscript *wj* represents the world export of product *j*, and subscript wt refers to the total export of all products across the world.

The equational representation of RSCA is as follows:

$$RSCA = (RCA - 1) / (RCA + 1), \quad (2)$$

The value of the RSCA index ranges from -1 to 1. RSCA > 0 implies that a country enjoys a comparative advantage in the product that it exports, whereas RSCA < 0 indicates otherwise.

This study also tests the survival and stability rate of the RSCA index using STATA software. Following Török and Jámbor (2016), the value of standard deviation of RSCA index over the period was used to check the stability of RSCA index. Higher value of standard deviation means unstable variation from year to year and vice versa. Moreover, following Bojnec and Fertő (2016), a survival function *S* (*t*) can also be calculated through employing the thenonparametric Kaplan-Meier product limit estimator. Following Bojnec and Fertő (2016), a sample having n independent observations stand for (*ti*; *ci*), where *i* = 1, 2, ..., *n*, and *ti* indicates the survival time. And *ci* denotes the censoring indicator variable *C* (considering the value of 1 if a failure appeared, and 0 otherwise) of observation *i*. Let, *nj* denotes the number of subjects at failing risk at *t* (*j*) and *dj* indicates the number of failures observed. The Kaplan-Meier estimator of the survival function is then (with the convention that $\hat{S}(t) = 1$, if $t < t(1)$):

$$\hat{S}(t) = \prod_{t(i) < t} \frac{n_j - d_j}{n_j}, \quad (3)$$

After exploring tea export competitiveness, we moved on to investigating the nexus between tea export and economic growth. Prior to operating the Johansen Cointegration approach, we ran the Augmented Dickey-Fuller (ADF) test to check the stationarity of the series employed. The equational representation goes as:

$$\Delta Y_t = \mu + \delta Y_{t-1} + \beta_1 \Delta Y_{t-1} + \\ + \beta_2 \Delta Y_{t-2} + ... + \beta_p \Delta Y_{t-p} + \varepsilon_t, \quad (4)$$

where H_0:δ=0, up against H_1:δ. Rejection of H_0 means the series is stationary, whereas accepting H_0 denotes series is non-stationary.

The Johansen cointegration test (Johansen, 1991) can only be applied if all the variables are stationary at 1st difference. It takes its starting point in the vector autoregression (VAR) of order *P* given by the following equation:

$$Y_t = \mu + A_1 Y_{t-1} + ... + A_p Y_{t-p} + \varepsilon_t, \quad (5)$$

where y_t is an $n \times 1$ vector of variables that are integrated of order one-commonly denoted I (1), and ε_t is an $n \times 1$ vector of innovations. Results depicted in the trace test and Max-eigenvalue test guide to decide whether long-run relationship exists or not between tea export and economic growth across Bangladesh, India and Sri Lanka.

Granger Causality scrutinizes the short-run causal association between existing series. It includes estimating two equations with VAR for LNGDP and LNTEX as presented in the equation.

$$\Delta LNGDP_t = \sum_{i=1}^{n} \alpha_{1i} \Delta LNTEX_{t-1} + \\ + \sum_{i=1}^{n} \beta_{1i} \Delta LNGDP_{t-1} + \epsilon_t, \quad (6)$$

Table 1: Description and source of data.

Data	Unit	Source
Total export of all products across the world	Current USD	WDI
Total export of all products in Bangladesh/ India/ Sri Lanka	Current USD	WDI
Total tea export across the world	Current USD	FAOSTAT
Total tea export in Bangladesh/ India / Sri Lanka	Current USD	FAOSTAT
Gross Domestic Product	Constant 2010 USD	WDI

Notes: WDI indicates World Development Indicator (https://data.worldbank.org/), while FAOSTAT denotes Food and Agriculture Organization Corporate Statistical Database(http://www.fao.org/faostat/en/#data)
Source: Own composition

$$\Delta LNTEX_t = \sum_{i=1}^{n} \alpha_{1i} \Delta LNGDP_{t-1} + \\ + \sum_{i=1}^{n} \beta_{1i} \Delta LNTEX_{t-1} + \epsilon_t \quad , \quad (7)$$

where LNGDP = natural logarithm of GDP, LNTEX = natural logarithm of tea export, Δ is the differenced operator and ϵ_t denotes the error term.

Lastly, we drove the impulse response function from the VAR system. Impulse response function illuminates the mechanisms via which shock spreads over time. The impulse response function of an infinite moving average in a VAR framework looks as:

$$x_t = \sum_{i=1}^{n} A_j u_{t-j}, \quad (8)$$

where X_t refers to (m × 1) vector of the variables examined, A_j is represented as $\beta_n A_{j-n}$. β_n denotes the coefficient of the exogenous variable(s) A_j at nth time (j = 1, 2, 3,…,n) and u_t denotes the shock. Now, to demonstrate the responses of conditional forecast of economic growth to tea export shock in the VAR system, the equation is expressed as:

$$\Delta LNGDP_t = \beta_1 \Delta LNTEX_{j-1} + \beta_2 \Delta LNTEX_{j-2} + \\ + \beta_3 \Delta LNTEX_{j-3} + ... + \beta_n \Delta LNTEX_{j-n} + u_{t-j} \quad , \quad (9)$$

To determine the responses of conditional forecasts of tea export to the economic growth shock in the VAR system, this expression follows:

$$\Delta LNTEX_t = \beta_1 \Delta LNGDP_{j-1} + \beta_2 \Delta LNGDP_{j-2} + \\ + \beta_3 \Delta LNGDP_{j-3} + ... + \beta_n \Delta LNGDP_{j-n} + u_{t-j} \quad , \quad (10)$$

where Δ is the differenced operator, LNGDP denotes natural logarithm of GDP, LNTEX indicates the natural logarithm of tea export. Moreover, an impulse response function predicts the response of a variable to shock in another variable over the period in future. Microsoft Excel and Eviews software advocated the data analysis process.

Results and Discussion

Comparative advantage of tea export

Table 2 shows the tea export competitiveness of Bangladesh, India and Sri Lanka over the year 1980-2018 from the findings of the Revealed Symmetric Comparative Advantage index. It is evident from results that, over the last 40 years, Bangladesh is gradually losing its comparative advantage in tea export. In 1980, Bangladesh (0.951), India (0.993), and Sri Lanka (0.966) experienced roughly equal degrees of comparative advantage in tea export. However, since then, Bangladesh has lost its tea export potential in the international market. However, India and Sri Lanka have noticeably managed to keep their export performance high. Bangladesh lost its comparative advantage in tea export since the year 2010 when its RSCA value went below 0. It follows from this that tea export from Bangladesh failed to keep pace with other competitors in the global market. Moreover, while con-

Table 2: RSCA index and Kaplan-Meier survival rates for Bangladesh, India and Sri Lanka.

Year	Survivor function	RSCA Bangladesh	RSCA India	RSCA Sri Lanka	Year	Survivor function	RSCA Bangladesh	RSCA India	RSCA Sri Lanka
1980	0.974	0.951	0.966	0.993	2000	0.462	0.732	0.900	0.993
1981	0.949	0.960	0.964	0.993	2001	0.436	0.419	0.884	0.993
1982	0.923	0.965	0.952	0.993	2002	0.410	0.316	0.851	0.993
1983	0.897	0.961	0.952	0.992	2003	0.385	0.583	0.842	0.993
1984	0.872	0.976	0.948	0.992	2004	0.359	0.705	0.823	0.994
1985	0.846	0.959	0.955	0.992	2005	0.333	0.692	0.786	0.994
1986	0.821	0.946	0.955	0.992	2006	0.308	0.554	0.779	0.991
1987	0.795	0.945	0.953	0.993	2007	0.282	0.367	0.772	0.991
1988	0.769	0.957	0.947	0.994	2008	0.256	0.407	0.759	0.995
1989	0.744	0.946	0.951	0.993	2009	0.231	0.209	0.724	0.994
1990	0.718	0.935	0.952	0.993	2010	0.205	-0.183	0.692	0.994
1991	0.692	0.948	0.949	0.993	2011	0.179	-0.487	0.736	0.994
1992	0.667	0.938	0.938	0.991	2012	0.154	-0.504	0.694	0.994
1993	0.641	0.932	0.924	0.987	2013	0.128	-0.709	0.686	0.993
1994	0.615	0.946	0.923	0.985	2014	0.103	-0.410	0.659	0.994
1995	0.589	0.914	0.925	0.991	2015	0.077	-0.733	0.691	0.992
1996	0.564	0.896	0.899	0.993	2016	0.051	-0.693	0.658	0.991
1997	0.538	0.872	0.926	0.993	2017	0.026	-0.486	0.630	0.991
1998	0.513	0.880	0.916	0.992	2018	0.000	-0.658	0.627	0.990
1999	0.487	0.887	0.903	0.992					

Source: Own composition

centrating on the overwhelming domestic demand, Bangladesh tea firms failed to adopt updated knowledge, information and strategies, a failure that reduced the country's tea export opportunities abroad (Blomstermo *et al*., 2004). This finding for Bangladesh is in line with the previous study of Suprihatini (2005) which focuses on Indonesia.

India, on the contrary, is enjoying a comparative advantage in tea export over the same period. Admittedly, the RSCA value has contracted gradually, implying that India has diversified its export sectors (The Economic Times, 2016). Yet, India is sustaining its position in the worldwide tea market. This is because of its active involvement of Indian tea board with the country's tea industries. The tea board is carrying out different promotional activities aimed at improving the production, consumption and boosting the international trade demand of tea (Navitha and Sethurajan, 2018). The promotional activities include a Darjeeling charity auction, attendance at major trade events, tea seminar and contests, publicity through social media, print media and websites, and a patronage programme (Navitha and Sethurajan, 2018). This result is in line with the findings of Nugrahaningrum *et al.* (2020), who have explored the strong position of Indonesian tea in the world market.

Meanwhile, Sri Lanka's RSCA value has always been above 0.98 over the last 40 years, which indicates Sri Lanka's specialisation in tea production and export was consistent. It also symbolises that Sri Lanka has been able to capture its global tea demand with technological progression. The RSCA values in the recent scenario of 2018 for Bangladesh, Sri Lanka, and India are -0.65, 0.99, and 0.62, respectively. These values are notifying that, at present, except for Bangladesh, Sri Lanka and India enjoy a comparative advantage in tea export**.** It is a matter of concern that since 2010, Bangladesh has drastically lost its competitiveness in tea export. This may be due to the overwhelming domestic demand. Low-quality tea may be another contributing factor.

Meanwhile, India and Sri Lanka, after meeting their local demand, still managed to keep their export performance high, ensuring decent quality. A finding parallel to this outcome, extrapolated by Pascucci (2018), in the case of coffee export of Switzerland, was found to be highly competitive. Table 2 also provides insights on the survival rate of tea export for these countries. Bangladesh enjoyed comparative advantage in tea export from 1980 to 2009. Since then, its RSCA value went below 0 and tea export competitiveness failed to survive. On the other hand, both India and Sri Lanka experienced an RSCA value above 0 over the entire period. This indicates that India and Sri Lanka consistently survived in their tea exporting endeavours. It also worth noting that the survival times of the analysed RSCA index in the tea trade are not persistent over the study period (Table 2). Survival chances of 97% at the start of the period fell to 0% by 2018, implying stiff competition in the tea trade of the selected countries. Similar results also found regarding the European ham trade (Török and Jámbor, 2016) and global beer trade (Török *et al.*, 2020).

However, standard deviations of the RSCA indices over the whole study period are quite high (0.609) for Bangladesh, suggesting variation from year to year, and they seem to remain relatively unstable over the entire period. Besides, the declining tea export trend of Bangladesh is indicating that Bangladesh's tea export is unstable over the period. Comparing to Bangladesh, the RSCA indices are relatively stable in the case of India. Although, earlier in 1980, India scored an extraordinary RSCA value, it gradually diminished over the years. This signifies that despite being competitive, India experienced instability in tea export. The results on instability in tea export for Bangladesh and India point towards a lack of innovation and a lack of technological adoption (Pascucci, 2018). However, Sri Lanka's tea export competitiveness was stable over the years as its RSCA value has always kept the same trend and the value of standard deviation is very low (0.001).

Nexus between tea export and economic growth

This paper hypothesises that tea export affects the economic growth of the selected countries. We proceed to step-by-step econometric analysis in an effort to identify whether the tea export has significant effect on the economic growth of the selected three countries. In the first step, like every time series analysis, we conducted the unit root test where the null hypothesis is that time series has a unit root. Table 3 illustrates the outcome of the ADF test for checking stationarity. Results revealed that all variables of Bangladesh, India and Sri Lanka were non-stationary, implying that p-value was greater than 0.05. Consequently, we cannot reject the null hypothesis. Since, the variables are non-stationary, we transformed those in the first difference to make stationary. However, the results in Table 3 show that first difference p-value of economic growth and tea export is smaller than 0.05. Hence, we reject the null hypothesis and therefore, these variables do not have a unit root, meaning that the time series is stationary. Given the findings, we ran Johansen Cointegration, Granger causality, and Impulse Response Function.

Table 3: ADF test results.

Augmented Dickey-Fuller test with t-statistic						
	Bangladesh		**India**		**Sri Lanka**	
Variable	**Level**	**1st Diff.**	**Level**	**1st Diff.**	**Level**	**1st Diff.**
LNGDP	0.795	-9.509***	-2.220	-10.586***	-1.483	-4.673***
	(0.999)	(0.000)	(0.465)	(0.000)	(0.817)	(0.003)
LNTEX	-3.024	-5.179***	-2.453	-6.691***	-3.488	-5.577***
	(0.139)	(0.001)	(0.348)	(0.000)	(0.060)	(0.000)

*** Denotes rejection of null hypothesis at 1 percent level of significance and p-values in the parenthesis.
Source: Authors' calculations using Eviews

Firstly, we conduct Johansen Cointegration test to explore the cointegration between tea export and economic growth. The outcomes of Johansen Cointegration test are presented in Table 4 to make decision regarding long-run relationship. The Trace statistic and Max-Eigen statistic for Bangladesh, India, and Sri Lanka remain well inside the 0.05 critical values. Also, p-values obtained from trace statistic and Max-Eigen statistic results ascertain that all the null hypotheses of no cointegrating equation defined for Bangladesh, India, and Sri Lanka are accepted. In other words, economic growth and tea export do not move together in the long-run and they do not affect each other in the long-run. Therefore, we infer that no long-run relationship exists between economic growth and tea export in any of the cases of Bangladesh, India, and Sri Lanka. This outcome is apparent for Bangladesh since Bangladesh lost its export competitiveness in recent years as visible from the above. However, having a strong position in the international tea market with the bulk of tea export, the case of India and Sri Lanka seems unusual. The reason behind there being no long-run relationship between tea export and economic growth may be an inability to use resources efficiently, not getting a fairer price, a higher cost of production (Krishna, 2019; Hilal *et al*., 2020), or maybe the unstructured tea industry.

Next, we illuminate the short-run causality inter-linkages between economic growth and tea export (Table 5). As evident from the findings, in the short-run, no directional causality runs between economic growth and tea export across Bangladesh and India, connoting that economic growth and tea export do not substantiate any short-run effect on each other. However, in Sri Lanka, evidence of unidirectional causality signifies that tea export causes short-run economic growth. A similar type of finding was revealed from the study of Chantal *et al*. (2018), where they found that tea export affects the GDP of Rwanda. Hence, although no causal relationship exists in the long-run, tea export is vital for the Sri Lankan economy since it contributes to the short-run growth of Sri Lanka. The finding revealed for Sri Lanka supports the export-led growth hypothesis in the short-run. Similar short-run findings for the case of citrus export were revealed by Bakari (2018) in Tunisia. The outcome suggests that a structured frame of action and long-term policy implications can drive Sri Lanka's tea export to the long-run economic growth. Besides, Fair Trade International Certification should be in action, which gives international recognition in global market and higher prices of their tea products, as well as professional international and local advice to uphold best practices and boost the economic growth in the long run.

The reason behind Bangladesh and India failing in promoting economy through tea export may be due to several factors. Firstly, low degree of institutional quality. Institutional quality as a proxy for a good economic institutional quality helps achieve the export-led growth hypothesis (Sathyamoorthy and Cheong, 2019). Secondly, adopting

Table 4: Johansen Cointegration test.

Unrestricted Cointegration Rank Test (Trace)				
Country	**Hypothesized no. of CE(s)**	**Trace statistic**	**0.05 critical value**	**Prob.**
Bangladesh	None	12.848	15.494	0.123
	At most 1	1.247	3.841	0.153
India	None	13.836	15.494	0.087
	At most 1	1.2469	3.841	0.264
Sri Lanka	None	11.038	15.494	0.209
	At most 1	0.955	3.841	0.328
Unrestricted Cointegration Rank Test (Max Eigenvalue)				
	Hypothesized no. of CE(s)	**Max-Eigen statistic**	**0.05 critical value**	**Prob.**
Bangladesh	None	13.801	14.264	0.119
	At most 1	1.047	3.841	0.173
India	None	12.589	14.264	0.090
	At most 1	1.246	3.841	0.264
Sri Lanka	None	10.082	14.264	0.206
	At most 1	0.955	3.841	0.328

Source: Authors' calculation using Eviews.

Table 5: Granger causality test for Bangladesh, India and Sri Lanka

Country	Null hypothesis	F-statistic	Prob.	Decision
Bangladesh	ΔLNTEX does not cause ΔLNGDP	1.194	0.316	No short-run directional causality
	ΔLNGDP does not cause ΔLNTEX	0.261	0.771	
India	ΔLNTEX does not cause ΔLNGDP	0.119	0.731	No short-run directional causality
	ΔLNGDP does not cause ΔLNTEX	0.264	0.610	
Sri Lanka	ΔLNTEX does not cause ΔLNGDP	2.507	0.047**	Unidirectional causality from tea export to economic growth
	ΔLNGDP does not cause ΔLNTEX	0.530	0.593	

** Denotes rejection of null hypothesis at 5 percent level of significance.
Source: Authors' calculation using Eviews

inward-looking policies causes resources to shift in the industries that only produce for domestic markets (Dawson, 2005). The result for Bangladesh and India having no long-run and short-run impact of tea export on the economic growth is in line with the study of Levin and Raut (1997), where they found that export of primary commodities or agricultural commodities do not significantly affect economic growth. Similar result was unveiled by Gilbert (2013) for cocoa export of Cameron as no impact on economic growth was found. Moreover, the interpretation of Faridi (2012) also claimed that agricultural export does not have any positive impact on the economic growth.

Finally, using the impulse response function, the study shows the effect of any shock generated in the tea export and economic growth on each other. As of Bangladesh, according to Figure 1, with one standard deviation shock to LNTEX, LNGDP faces a slight decay till the second period in the future. However, after the second period, the shock generated from LNTEX leads to a surge in LNGDP, as it reaches its peak in the third period. Further, LNGDP's response starts to deteriorate until it passes the fourth period. Later in the fourth period, a shock given by LNTEX becomes mild, and LNGDP stays positive and dormant throughout the future periods. It demonstrates that uncertainty in tea export leads to a slight fallout in economic growth till the second period onwards, and then economic growth reaches its peak in the third period and then goes downward again. It follows that a shock to tea export becomes lenient and economic growth stays static on the positive side. Moreover, a shock in LNGDP induces LTEX to drop till the second period. Following the second period, LNTEX moves upward but remains negative and for the rest of the periods in the future, this trend continues. This means a shock to economic growth tempts tea export to decrease and continues to deter tea export in Bangladesh. Therefore, we can infer that despite any uncertainty in tea export, economic growth slightly flatters in the initial stage, while uncertainty in economic growth induces tea export to shrink in the future.

In the case of India, a shock originating in tea export causes a slight spike in economic growth in the second period (Figure 2). Since the third period, its effect dissipates and adheres to the trend. Similarly, in the figure, a shock to economic growth yields the same response in tea export, and it does not fluctuate to a noticeable extent in the future. In India, therefore, the shock given separately in LNTEX and LNGDP has no significant impact on each other. Henceforth,

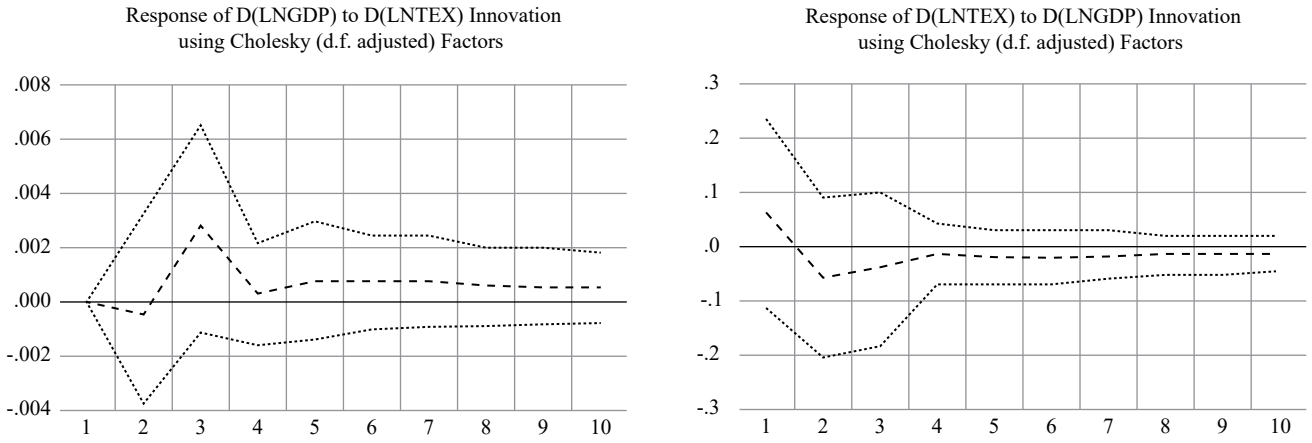

Figure 1: Impulse response function for Bangladesh.
Source: Authors' composition using Eviews.

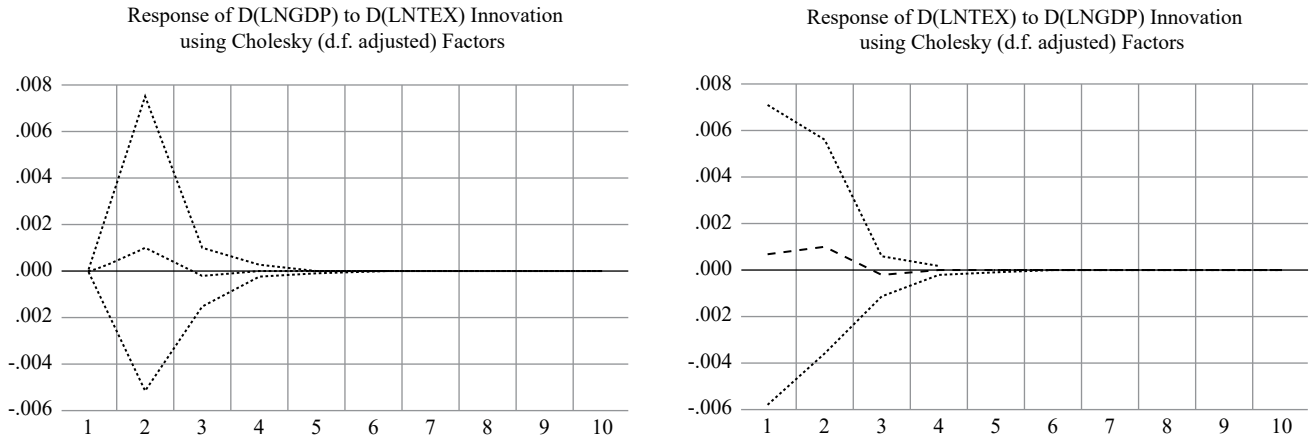

Figure 2: Impulse response function for India.
Source: Authors' composition using Eviews

uncertainty occurred in tea export and, in the economic growth, invariably do not hurt each other in the future.

As for Sri Lanka, Figure 3 illustrates that one standard deviation shock to LNTEX leads to fluctuation in LNGDP over the period. It is discernible that any shock in tea export pushes economic growth downward till the second period onwards. Then, the economic growth bounces back in response to any shock given in tea export and reaches its peak in the third period. Economic growth again experiences drastic fallout and becomes negative in the fifth period. However, economic growth goes upward since that juncture and persists in positive direction throughout the future periods until it gets affected again in the ninth period. Moreover, Figure 3 states that tea export faces a steep descent from the first to second period, ending up touching its peak in the third period. After then tea export once again rides in the downturn and becomes stable after the seventh period. So, tea export suffers in the first two periods from shock in economic growth and becomes the highest in the third period. Since that period, tea export digests slight fallout to the seventh period in the future, after which the effect of shock in economic growth disappears. These findings reveal that tea export matter hugely to steady economic growth in Sri Lanka. This is because uncertainty in tea export causes heavy fluctuations in the country's economic growth, whereas uncertain economic growth at home also affects tea export. However, in Bangladesh and in India, uncertainty with regard to tea export does not significantly hamper future economic growth.

Consequently, we can conclude that tea export and economic growth are interlinked in Sri Lanka despite having no long-run relationship with each other. It can also be inferred that if the Sri Lankan government cannot manage to keep tea export stable and high, Sri Lanka might endure an economic depression, as can be seen in Figure 3. Nevertheless, Bangladesh and India should always try to expand tea export to earn more foreign currency, especially Bangladesh, which is losing its export competitiveness.

Conclusions

This article attempted to reveal the comparative advantage of tea export and dynamics between tea export and economic growth across Bangladesh, India, and Sri Lanka. Results indicated that over the last 40 years, Bangladesh lost its comparative advantage in tea export, whereas India managed to sustain its competitiveness, and Sri Lanka remained at the top with an RSCA value of 0.99 in the last couple of years. RSCA value of Bangladesh in the year 2018 was -0.65, while India scored 0.88 and Sri Lanka mastering at 0.99. These findings validate that Sri Lanka enjoys the highest comparative advantage in tea export, whereas India remained on a positive track and Bangladesh lost its tea export potential.

Moreover, the outcomes revealed from the Johansen Cointegration test indicate that tea export and economic growth do not affect each other in the long run for Bangladesh, India and Sri Lanka. However, in the short-run, results revealed by Granger causality argue that it is solely in the case of Sri Lanka that tea export cause economic growth, in contrast to Bangladesh and India, where there is no evidence of causality between the tea export and economic growth found. Lastly, the Impulse Response Function outcomes forecast that in Bangladesh, economic growth experiences an initial spike in response to uncertainty in tea export. However, the shock dissipates quickly and does not massively affect economic growth. Interestingly, in India, neither is economic growth affected significantly by uncertainty over tea export, nor *vice versa*. Meanwhile, in Sri Lanka, economic growth heavily fluctuates if there is a shock to tea export, and inverse is also true. Hence, this article recommends that the Bangladesh government should eye on entering a new world tea market and expand the country's foreign earnings, whereas India should formulate a plan to improve its tea industry to lift its economy. Most importantly, Sri Lanka should redesign its policy towards tea industries because despite leading the world, as shown in the findings, the

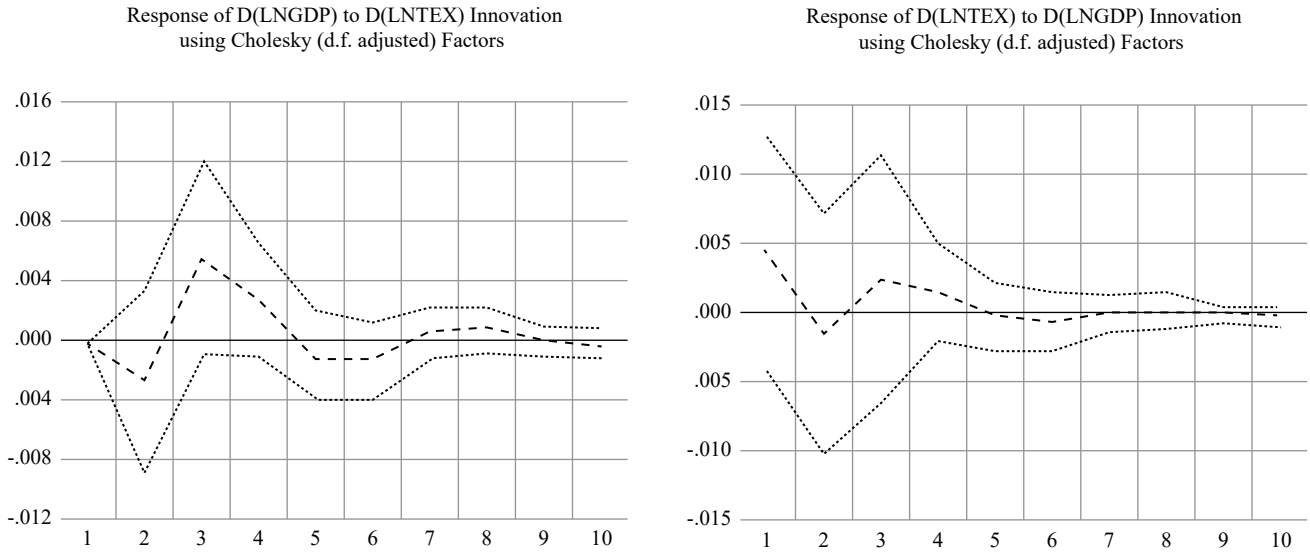

Figure 3: Impulse response function for Sri Lanka.
Source: Authors' composition using Eviews

country's tea export have failed to promote economic growth in the long-run. Therefore, immediate actions are required to investigate the hindrances, not only in Sri Lanka but also for Bangladesh and India. Alongside, governments of these countries should look forward to expanding tea export since growth in agricultural exports leads to economic growth.

Nevertheless, our paper is constrained by some limitations, that may guide direction to further research avenues. First, we only incorporated Bangladesh, India and Sri Lanka in our study representing a specific region. Further research can be conducted on other major tea-producing and tea-exporting countries. Second, due to data unavailability, we were not able to analyse the factors that affect tea export potential. Hence, if more data becomes available, this limitation can be addressed. Third, we only considered the relationship between tea export and economic growth. In the future, scholars may attempt to disclose the linkages between other major agricultural exporting products and economic growth from a macroeconomic perspective. Fourth, with the advent of modern econometrics and machine learning, further study can adopt updated econometric models in determining the association between agricultural export, non-agricultural export, and economic growth.

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Is there a pass-through from the international coffee price to the Mexican coffee market?

We estimate the transmission of coffee prices from the international market to the Mexican market for the period 2004-2019. Our estimates are obtained from a single equation conditional Error Correction Model (ECM). We estimate our proposed model for two overlapping periods: before a hypothesised break (2004-2013), and full sample (2004-2019). The results of the first estimation suggest that given a 1% increase in the international price of coffee, the Mexican price increases by 0.9%, which is larger than previous estimates in the literature, but a finding which is consistent with the idea of more market integration due to free trade agreements. Furthermore, we find that Mexican coffee production has no effect in the determination of local coffee prices. Our model also implies a previously undocumented break in the long-run relationship between international and national prices, which started in 2015 but was statistically significant until 2017. This latter finding suggests that the international coffee price pass-through to the Mexican economy has come to an end.

Keywords: agricultural market, agricultural supply chain, agricultural exports

JEL classifications: Q11, Q13, Q17

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Introduction

In a globalised world, the transmission of international prices to local markets is of key importance in the determination of equilibrium prices. Trade agreements have especially significant effects on the vertical integration of internationally traded crops and, by extension, on their local prices. Smallholders' well-being therefore depends on the transmission of international prices (Wohlgenant, 2001; and Krivonos, 2004). In this paper, we explain the behaviour of coffee price pass-through from the international market to the Mexican market. In addition, we provide evidence of a break in this pass-through.

Previous research has analysed the transmission of prices between the international and the Mexican coffee markets, comparing the periods before and after the liberalisation of the coffee market in Mexico (Krivonos, 2004; Jaramillo and Benítez, 2016). However, none of these studies have previously documented the break in the long-term relationship between both price series that is suggested by our results. This break has significant implications for the individuals who participate in the production chain, in particular the smallholders.

Indeed, Mexican coffee growing is considered a fundamental agricultural activity because it allows the integration of production chains, the generation of foreign exchange and jobs, and the well-being improvement of thousands of smallholders, most of them of indigenous origin. However, the population dedicated to the production of this crop receives a small proportion of the final exportation price. This phenomenon differs in each country and depends on specific conditions such as policies that affect production, exports, or the market structure (Krivonos, 2004).

The understanding of the processes related to price changes is crucial. Price transmission factors throughout the supply chain play an important role in determining the size and distribution price shock effects or trade policy reforms on the well-being of the population that intervenes in these markets (Vavra and Goodwin, 2005).

In this paper, we use a single equation conditional Error Correction Model (ECM) to determine the dynamics and duration of the adjustment between the coffee price in Mexico and the international coffee price for the period 2004-2019. Furthermore, in applying this model we discern a possible break in the relationship of both variables, which suggests that the transmission of coffee prices between the international and Mexican markets has come to an end, with important consequences for Mexican smallholders.

As the microeconomic theory suggests, coffee producers' revenue depends directly on the yields obtained in each production cycle and on the local market price. Nonetheless, the local market price depends indirectly on the international price. In fact, we have noticed from the data that in Mexico's case both prices follow a close relationship, at least until the year 2013. But this marked pass-through has faded away since the year 2014 (see Figure 1). This could be due, in part, to the decline in Mexican production because of the coffee rust plague (also known as roya). Indeed, according to the data reported by the Agricultural and Livestock Information Service (SIAP), the lowest production of coffee was registered in the 2015-2016 agriculture cycle, with just 824 thousand tons (about 59 percent of average production in the period 2004-2015).[1]

On the international market, the prices of the Arabica and Robusta varieties of green coffee are carried out through the agricultural Commodity Exchange of New York and London. To determine the prices received by producers in Mexico, the National Coordination of Coffee Organizations, C.A. (NCCO) takes as a reference the price of Arabica coffee that is quoted on the Commodity Exchange of New York (because most of the national production belongs to this coffee variety). According to Elms and Otero (2020),

[1] Although this latter is just a guess, and it is not part of our research question, we wanted to call the attention of the reader to this potential research topic.

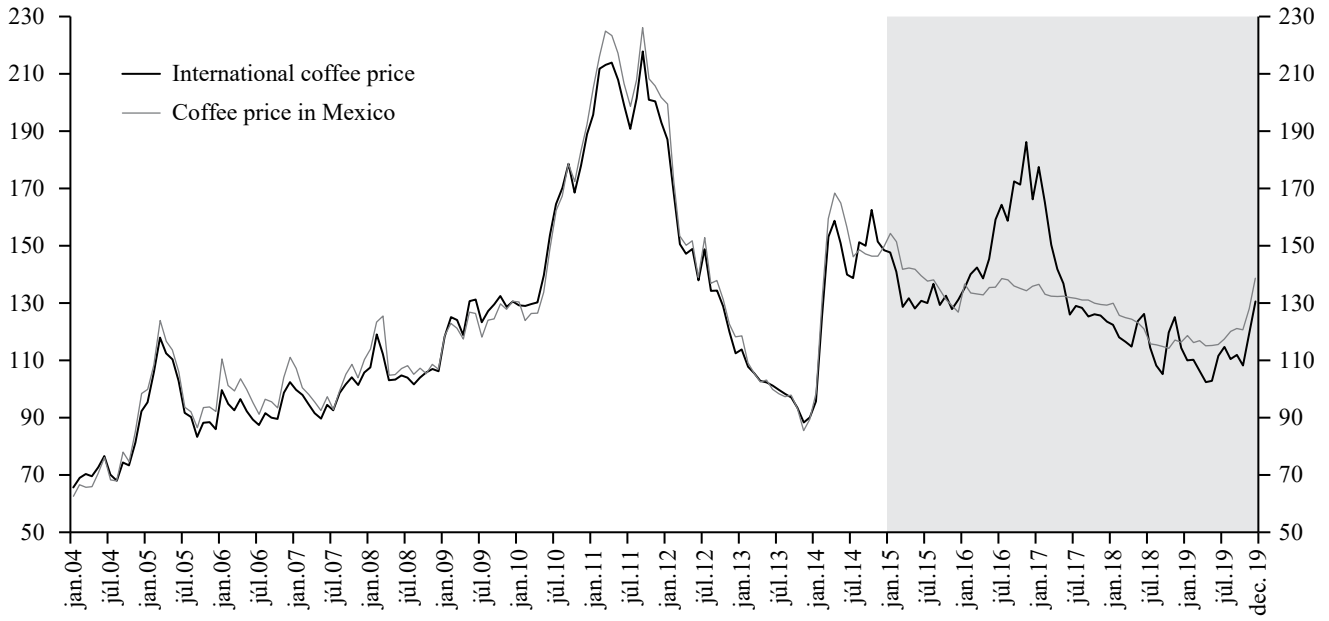

Figure 1: Mexican and international coffee prices (Jan-04 / Dec-19).

Note: Standardised prices are plotted, converted from a constant Mexican pesos series to a base year 2013=100. The light grey area represents the period where the price relationship break begins.

Source: Own elaboration with data from International Coffee Organization (ICO), Banco de México (Banxico), Agricultural and Livestock Information Service (SIAP) and Mexican Institute of Statistics (INEGI)

around 85 percent of the coffee produced in Mexico is of Arabica variety and 15 percent is Robusta. The International Coffee Organization (ICO) classifies four categories of coffee according to the type of bean: Colombian Milds, Other Milds, Brazilian Naturals and Robust. The production of Mexico is considered within the group Other Milds.

Until 1989, the international coffee trade was regulated through a series of International Coffee Agreements of the ICO, maintaining stable prices and controlling the supply of coffee beans. After the breaking of these agreements, at the beginning of the 90s the Mexican market transitioned to a scheme of free supply and demand. This period was characterised by a behaviour of constant increases and decreases of prices in the world market, which have continued until recent years. According to data released by SIAP, the Mexican coffee price was between 3,834 and 13,879 constant pesos per ton, between 2004 and 2019.[2] On the other hand, the average international coffee price (Other Milds group), was quoted between 25,719 and 95,454 constant pesos per ton for the same period.

Despite the historically strong relationship between the Mexican and the international coffee price, in this document we show that, in recent years, the price received by Mexican coffee producers has not maintained a close relationship with the world market price, suggesting a break in price transmission that affects more than 500 thousand Mexican smallholders. According to SAGARPA (2017), the coffee crop represents 0.66 percent of the national agricultural GDP and 1.34 percent of the production of agro-industrial goods. Despite its small contribution to agricultural GDP, the importance of coffee lies in the size of the population dedicated to this economic activity and in the conservation of the biodiversity involved in the production of this crop. Indeed, Mexican coffee farming involves around three million people throughout the value chain, of whom almost half live in areas classified as highly marginalised (de la Vega *et al*., 2012).

Most producers in Mexico work on small plots, use traditional technology for coffee production and, in general, rely only on family labour. According to information from the United States Department of Agriculture, in recent years, production costs have increased due to the lack of workers in the field, whose labour represents more than 80 percent of total production costs (Elms, 2019). Therefore, the income of many families dedicated to coffee production, who rank among the poorest producers of Mexico, depends on exogenous factors such as international prices, the exchange rate, climatic conditions, migration, etc.

The rest of this research work is organised as follows. The first section presents a review of the literature on the price transmission of agricultural goods that chiefly focuses on the coffee market. The next section (methodology) describes the data and variables included in the econometric model. We then present the main results. Finally, we summarise and discuss our findings.

Literature Review

The first studies on the transmission of prices of agricultural goods were motivated by an interest in knowing the impact of trade reforms on the agricultural sector markets among different countries. For example, Baffes and Gardner (2003) evaluated the degree to which international prices have been transmitted to local commodity markets, following the implementation of agricultural reforms during the 1980s and early 1990s, in eight developing countries. These authors found that only the price and trade policies implemented in

[2] Using the Mexican Consumer Price Index (CPI) as deflator.

Mexico, Chile and Argentina allowed a significant pass-through of world price movements to domestic prices.

Likewise, Krivonos (2004) assessed whether the reforms implemented in the late 1980s and early 1990s in 13 producer and exporter countries, affected the relationship between prices quoted in the international market and the prices paid to producers in the respective local markets. Following the approach of Baffes and Gardner (2003), Krivonos (2004) used a Vector Error Correction (VEC) model with which he estimates the transmission of short-term prices, the speed of adjustment and the equilibrium price of coffee producers. His results indicate that the participation of producer prices in the international price has increased substantially in all the countries analysed, except Tanzania. The author also concluded that there was a close cointegration between the national and world markets, after the reforms, and that the international price transmission signals improved in most cases.

The transmission of coffee prices, after the presence of reforms, has been also analysed for some specific countries. Worako, van Schalkwyk, Alemu and Ayele (2008) studied the case of Ethiopia. Worako *et al.* (2008) concluded that, after the reforms, there is greater integration between Ethiopia's coffee markets and the world market, and between some auction markets and the world market. On the other hand, Jaramillo and Benítez (2016) studied the case of the Mexican market. The hypothesis of these authors is that the 1989 reforms on coffee export quotas and the process of trade liberalisation led to greater commercial integration between Mexico and the international coffee market. The results of Jaramillo and Benítez (2016) show that, in the period of state intervention, Mexican prices required between 11 and 32 periods to complete their adjustment, but it was reduced to only five periods in the liberalisation period. Furthermore, the authors found that the price transmission elasticities were 0.35 before liberalisation and 0.61 after liberalisation of the coffee market.

Price transmission has been also analysed between the international market and the coffee consumer market. Alonso and Estrada (2016) used a VEC model to compare the series of consumer prices of ground coffee in five cities in Colombia with the international price of coffee. These authors found that coffee prices to retailers respond differently to unexpected shocks in the international price; in Barranquilla, Bogotá, Cali and Medellín the effects disappear after 36 months or more, while for Cartagena they disappear in a shorter period. Additionally, the authors found that local prices tend to adjust upward if they are below long-term equilibrium. This adjustment is around three years for all cities, except for Cali, which has a much slower adjustment speed.

The movement of prices of basic goods between markets can be related in different ways, especially for products found in different sectors, as shown by Jena (2016). This author examined the nature and extent of the impact of international prices on domestic prices in India from 2001 to 2012. To do so, he developed price indices for different products, classified into three groups. Jena (2016) used a VEC model with which he showed that domestic prices of raw materials (metals and energy) move together with world prices. But the integration of markets for agricultural products, between the Indian domestic market and the international market, is far from complete.

In general, the results found by Krivonos (2004), Worako *et al*. (2008), Jaramillo and Benítez (2016), and Alonso and Estrada (2016) point out that there is a relationship between what happens in the international market and the national coffee markets. In other words, there is an integration of the coffee supply chain, mainly reflected in the period after the liberalisation of the coffee market in each country analysed.

This paper is related to the previous literature that made use of VEC models but differs in terms of the context in which such a model is applied. In other words, the previously cited research has used VEC models to analyse the effects of agricultural policies on the coffee price relationship, whereas the focus of this paper is the transmission of coffee prices from the international market to the Mexican market. Furthermore, in this paper we use an ECM model to determine if the price relationship has been broken in the most recent years.

Methodology

Data

In this document, we model the price of coffee in the Mexican market (dependent variable) in relation to the Mexican production of coffee and the international price of coffee (independent variables). Our time series tracks the variables of interest over a period of 16 years, with measurements being made monthly (192 observations in total). The data altogether covers the period from January 2004 (Jan-2004) to December 2019 (Dec-2019).

International prices have a monthly frequency and correspond to the category Other Milds. We obtain this international price variable from ICO. These prices are published in US cents per pound. To make the international price comparable to the local price in Mexico we express the former in pesos per ton using the monthly FIX exchange rate published by Banco de Mexico. Finally, we express this variable in real terms using the Mexican National Consumer Price Index (CPI).

We construct the Mexican coffee price using the annual figures reported by SIAP. Then, we express these annual data into monthly figures imputing the coffee producer price index (PPI) growth rate to the annual frequency variable. We implicitly assume that the baseline coffee price in 2004 corresponds to the mean rural price reported by SIAP and that its monthly growth rate is the same as the one observed in the coffee PPI from 2004 to 2019.

Mexican coffee production is obtained from SIAP, with monthly frequency. Given that the production data is reported as accumulated production throughout the coffee agricultural year (October-May), we use the following formula, proposed by Gálvez-Soriano (2018), to "disaggregate" the data:

$$q_t = c_t - c_{(t-1)}, \tag{1}$$

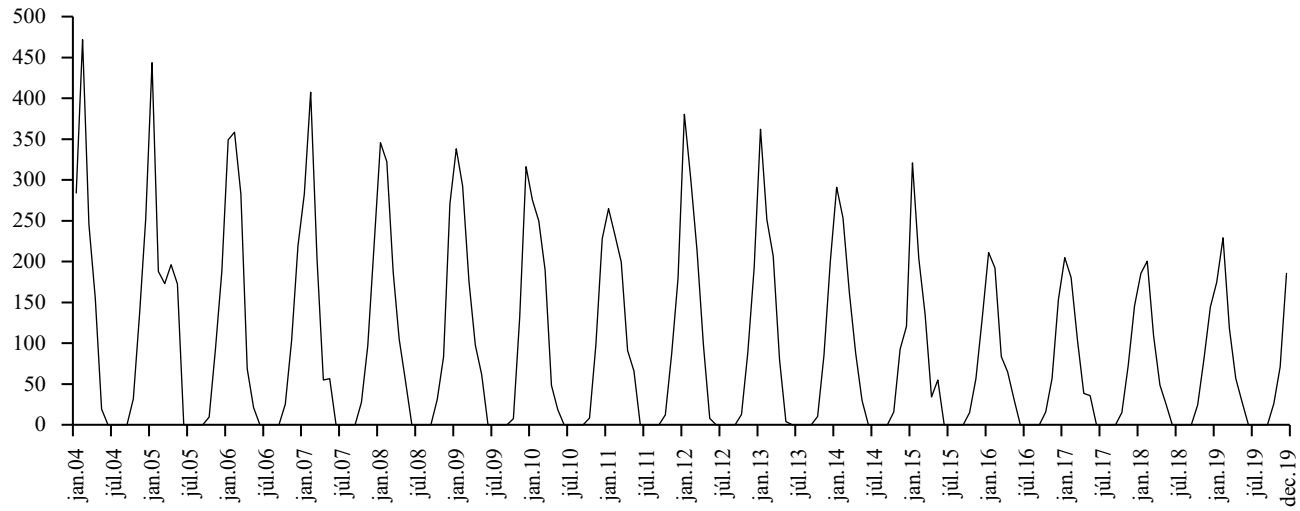

Figure 2: Coffee production in Mexico.
Note: Standardised quantities to base 2013=100.
Source: Own elaboration with data from Agricultural and Livestock Information Service (SIAP) and INEGI

where, q_t is the disaggregated monthly production, while c_t is the accumulated production in period *t*. That is, the production of the previous month is subtracted from the production of the current month.

The production of coffee in Mexico has a strong seasonal aspect. The highest level of production is consistently present in January, while the lowest production is obtained in the period June-September of each year. This is important to notice because we need to remove the seasonal factor from all three variables to be included in the model. Otherwise, the remaining seasonality will be captured by the error term, violating our assumptions of white noise and normality.

Indeed, we give three treatments (transformations) to the variables in our dataset: standardisation, Box-Cox transformation, and seasonal adjustment. First, we standardise all variables to express them in terms of a common base year 2013=100. Second, we use a Box-Cox (1964) transformation by means of a natural logarithm (i.e., $\lambda = 0$) to reduce the variance of the series. Finally, we seasonally adjust all variables in our database using the X-13ARIMA-SEATS program as in Gálvez-Soriano (2020).[3]

Econometric Model

We use a single equation conditional Error Correction Model (ECM) to analyse the relationship between both Mexican and international coffee markets. The model we propose considers Mexican coffee prices as the dependent variable, P_t^M, while the explanatory variables are international coffee prices P_t^M and Mexican coffee production (P_t^I). Our intention by including production as a control variable in the model is to capture the effect of the supply side forces in the determination of the equilibrium local price.

In our model specification we follow Engle and Granger (1987), but instead of performing a two-step estimation, we propose a single VEC equation, which is known in the literature as ECM and it is preferred for having a higher power than traditional VEC models (Kremers, Ericsson, and Dolado, 1992; Banerjee *et al*., 1993; and Zivot, 2000). Hence, our proposed ECM can be expressed as follows:

$$\Delta P_t^M = \alpha_1 P_{t-1}^M + \alpha_2 P_{t-1}^I + \alpha_3 Q_{t-1}^M \sum_{i=2}^{p} \beta_{i-1}(\Delta P_{t-i}^M) + \\ + \sum_{j=2}^{q} \gamma_{j-1}(\Delta P_{t-j}^I) + \sum_{k=2}^{r} \delta_{k-1}(\Delta Q_{t-k}^M) + \varepsilon_t \quad (2)$$

where ΔP_t^M is the difference operator and all variables are expressed in natural logarithms. Finally, ε_t is the error term, which is assumed to be white noise with normal distribution.

The first three terms of the ECM correspond to the cointegration vector, which defines the long-term relationship among the model variables. The second part of the equation (sums of differenced terms) defines the short-term relationship.

We are interested in the coefficient associated to the international price of coffee, in the cointegration vector, α_2. This coefficient will tell us about the long run relationship between Mexican and international price, in terms of elasticities. Similarly, the coefficient associated to the Mexican production of coffee, α_3, will express the long-term relationship between Mexican price and quantity (in terms of elasticities).

Finally, α_1 can be interpreted as the speed of adjustment, which should be negative and smaller than one in absolute value ($-1 < \alpha_1 < 0$). We consider three cases to explain the interpretation of this coefficient.

- If $\alpha_1 \approx -1$, deviations from the long-run equilibrium will take approximately one period to adjust (in our case, one month).
- If $\alpha_1 \approx -0.5$, deviations from the long-run equilibrium will take approximately two periods to adjust (in our case, two months).
- If $\alpha_1 \approx 0$, deviations from the long-run equilibrium will take several periods to adjust.

Additionally, we follow the two-step estimation proposed by Engle and Granger (1987) to obtain the speed of adjustment parameter from an unconditional VEC model.

[3] Seasonal adjustment models we developed were based on the document "Procedure for obtaining seasonal adjustment models with the X12-ARIMA program" by the Specialized Group on Seasonal Adjustment (GED) at the Specialized Committee of Macroeconomic Statistics and National Accounts of Mexico.

We decided to do this to permit greater comparability with previous research.

Thus, our plan is to estimate the proposed ECM in the period 2004-2013, which corresponds to the hypothesised break in the international price passthrough. Then we will offer a sensibility analysis of our estimation using a "rolling window" with 10 years of data. Additionally, we perform the estimation of the ECM with the complete sample to avoid any concern of ad-hoc analysis in our results. And, finally, we provide an estimation of the speed of adjustment parameter using a traditional unconditional VEC model.

Results and discussion

We first verify that our variables of interest have the same integration order. To do that, we evaluate the existence of a unit root using the following tests: Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Our analysis suggests that all series are non-stationary. Furthermore, we find that all three variables are integrated of order one, *I*(1). The latter was confirmed by unit root tests to the series in first differences. Indeed, these tests suggest that the stationarity of the series is induced with the first difference (see Table 1).

On the other hand, even if all series of interest are integrated of the same order, we would like to know if there could be an equation that expresses the long run equilibrium relationship of these variables. This can be tested by performing a Johansen cointegration test. To do it, we specify an autoregressive vector of order three, considering that the series have intercept but not trend (as suggested by the unit root tests). In both, the trace test and the maximum eigenvalue test, the null hypothesis of zero cointegration vectors is rejected against the alternative of one or two cointegration vectors, with a significance level of 5%. In other words, these tests suggest that there is a long-term relationship between the price series and the Mexican production of coffee (see Table 2).

The cointegration of the variables implies that Mexican and international coffee prices have a close long-term relationship. This can be observed in the cointegration vector of ECM we propose. Indeed, the results of the model estimation suggest that, in the long term, when the international price of coffee increases 1%, the Mexican price increases 0.9% (see column (1) of Table 3). Notice, however, that this effect corresponds to the period 2004-2013, which does not include the hypothesised break in the international coffee price passthrough and which, furthermore, covers a period post NAFTA. Thus, this estimation is larger than previous findings in the literature, which is consistent with the idea that trade agreements and globalisation contribute to the integration of the markets.

We also find that there is no long run relationship between Mexican price and production (see column (1) of Table 3). This result is strikingly interesting because it suggests that the determination of the local coffee equilibrium price does not depend on the demand and supply forces in the Mexican market. Furthermore, the local equilibrium price is determined based on the international price alone. On the other hand, if we follow the ECM estimation using the full sample, we no longer find a long run relationship between these three variables (see column (2) of Table 3).

Our ECM is robust to changes in the estimation period within the sample analysed. We show this performing a coefficients stability analysis using a CUSUM test. Figure 3 shows the accumulated sums of recursive residuals behaviour (CUSUM) and the accumulated sum of squared recur-

Table 1: Unit root test.

Variable	Ho: The series has a unit root					Ho: The series is stationary	
	Augmented Dickey-Fuller Test		Phillips-Perron Test			Kwiatkowski-Phillips-Schmidt-Shin Test	
	None	Intercept	None	Intercept	Trend and Intercept	Intercept	Trend and Intercept
International price	**0.649** [0.001]	**0.607** [0.001]	**0.601** [0.001]	**0.501** [0.001]		**0.01<p<0.05** [p>0.10]	
Mexican price	**0.630** [0.001]	**0.550** [0.001]	**0.583** [0.001]	**0.438** [0.001]		**0.01<p<0.05** [p>0.10]	
Mexican production	**0.159** [0.001]	**0.064** [0.001]	**0.075** [0.001]	0.035 [0.001]	**0.169** [0.001]	**p<0.01** [p>0.10]	p>0.10 [p>0.10]

Note: Unit Root Test performed for the monthly period 2004m01-2013m12. We show the p-values to reject the Ho. Numbers in **bold** suggest that the series has a unit root, with 95% confidence. In brackets, we show the p-value for the test with the differenced series.
Source: Own calculations

Table 2: Results of Cointegration Johansen test.

Ho: number of cointegrating vectors	Intercept without Trend			
	Maximum Eigenvalue Test		Trace Test	
	Statistics	Critical values	Statistics	Critical values
r=0	48.375*	21.132	56.217*	29.797
r<=1	6.128	14.265	7.842	15.495
r<=2	1.714	3.841	1.714	3.841

Note: Cointegration Johansen test performed for the monthly period 2004m01-2013m12. A star (*) denotes that Ho is rejected at 5% of statistical significance.
Source: Own calculations

sive residuals (CUSUM squared). In both tests, the CUSUM values are situated between the 95 percent confident interval. This suggests that the fitted ECM is parsimonious and stable.

Following Engle and Granger (1987), we also estimate the speed of adjustment of the Mexican price to exogenous changes in the variables of interest, which affect the cointegration relation. We find that the coefficient of adjustment obtained from a traditional VEC model estimated before the break is -0.41. This suggests that deviations from the long-run relation will be adjusted in 41% next period. Furthermore, the full sample estimation suggests a much smaller speed of adjustment (-0.13). These results are comparable with previous finding in the literature. On the other hand, the speed of adjustment derived from our ECM is close to one (-0.91) in the period before the break. This implies an almost instant adjustment of Mexican prices to deviations from the equilibrium. Similarly, ECM estimations in the full sample period suggest a speed of adjustment close to zero (-0.09), which implies an unstable equilibrium. This latter finding supports the idea that there is a break in the long run relationship between international and Mexican coffee prices, after the year 2013. Indeed, the additional observations included in the full sample model change dramatically the estimated coefficients in the cointegration vector because, in recent years, both variables are no longer in long term equilibrium.

Table 3: ECM estimation.

Dependent Variable: DLOG(mx_price)		
Method: Least Squares		
Sample:	2004-2013	2004-2019
Variable	(1)	(2)
LOG(mx_price(-1))	-0.91*** (0.185)	-0.09* (0.050)
LOG(int_price(-1))	0.93*** (0.188)	0.04 (0.46)
LOG(mx_prod(-1))	-0.01 (0.012)	0.00 (0.009)
Adjustment coefficient	-0.41	-0.13
R-squared	0.453	0.501
Sum of squared residuals	0.183	0.249
Durbin-Watson statistic	2.091	1.819

Note: This table shows only the vector of cointegration of our ECM. Column (1) shows the results of the model estimated with the sample before the break. Column (2) shows the results of the estimation using the full sample. Both models were estimated using EViews 9. Standard errors in parenthesis. ***p<0.01, **p<0.05, *p<0.10.
Source: Own calculations

Taken altogether, the results of our ECM suggest a strong transmission of the international coffee price into the Mexican market before the hypothesised break (in 2014). Furthermore, we show that Mexican coffee production does not play any role in the determination of the local price. However, if we include the period of the break in our analysis, we find that the long-term relationship between international and Mexican coffee price disappears. However, at this point we have yet to prove whether there was effectively a break in the passthrough of the international price of coffee.

To determine whether the long-term relationship between the price series was broken, we analyse the regressions of the ECM by adding observations at the end of the series, under the rolling window approach as suggested by Gálvez-Soriano (2020). In Figure 4 we summarise the rolling window analysis to estimate the coefficient associated with the international price (in the cointegration vector). The dashed grey lines are the confidence intervals at the 95% level and the continuous grey line corresponds to the coefficient associated to the international price in the vector of cointegration (estimated with different rolling windows of time, starting with 2004-2013 and finishing with 2008-2018).

Note that the estimate of the coefficient associated with the international price is stable and consistent until the year 2014. Afterwards, the estimation of the coefficient decreases constantly. This reduction in the coefficient suggests that the long-term relationship between the national and international prices began losing strength from 2015 onwards. However, the period with the clearest reduction in the magnitude of the estimated coefficient is observed until 2017. In fact, although it is clear graphically that both prices behaved differently since 2014 (see Figure 1), we can argue that the

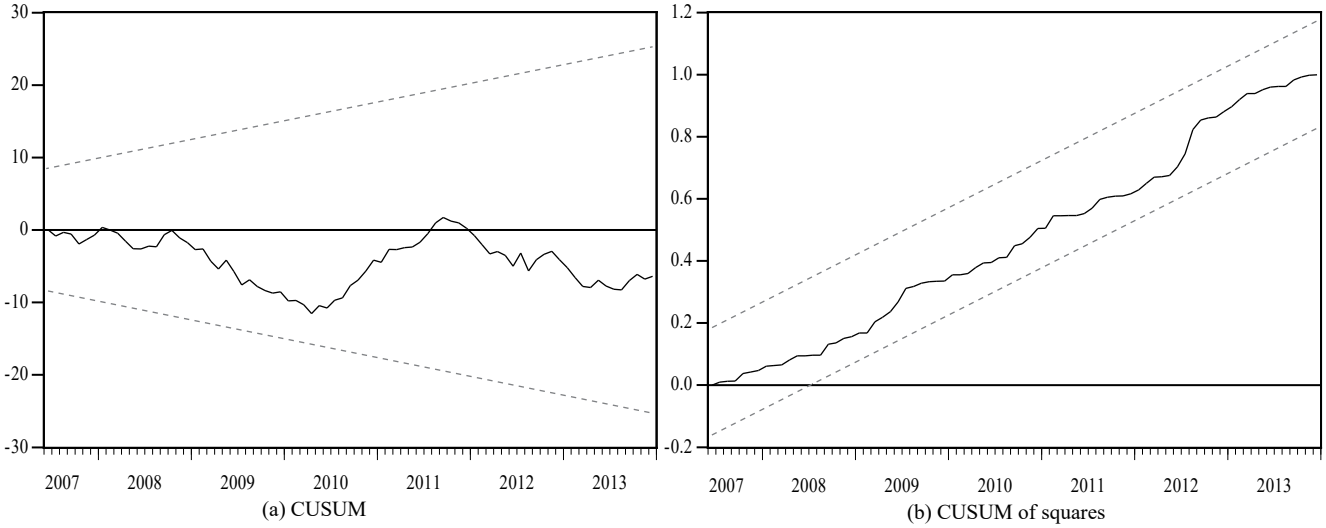

Figure 3: CUSUM test results.
Note: This Figure shows the CUSUM tests for our VEC model using the sample before the break. This suggests that the ECM coefficients are stable to changes in time data.
Source: Own calculations

passthrough of the international price of coffee disappears since the year 2017 in terms of the loss in the statistical significance (see Figure 4). On the other hand, interestingly the loss in the relationship between international and Mexican coffee prices was accompanied with an improvement in the long-run relationship between Mexican coffee price and Mexican coffee production (see Figure 5).

The breakdown in the price relationship could be related to the presence of the coffee rust plague that affects Mexican production. This mechanism is plausible if domestic coffee supply shocks affect the relationship between international and domestic coffee prices. We find suggestive evidence of this latter claim when we perform the rolling window analysis, where we observe that the weaker the prices relationship, the stronger the production-price relationship. Indeed, coffee production registered for the 2015-2016 agricultural cycle was the lowest during the last thirty years. Consequently, Mexican coffee exports decreased and reached its minimum in this same period (see online appendix). Following this logic, domestic supply shocks affect the relationship between international and domestic prices through a reduction in the participation of international coffee trade and, hence, a diminishing importance of international prices.

On the other hand, this break could also be associated with structural changes in the economy (such as changes in agricultural productivity that cause changes in the local price regardless of the international price) and/or policy changes (such as government programmes, guaranteed prices, etc.). These possible explanations, although interesting to our findings, are left as open questions to future research.

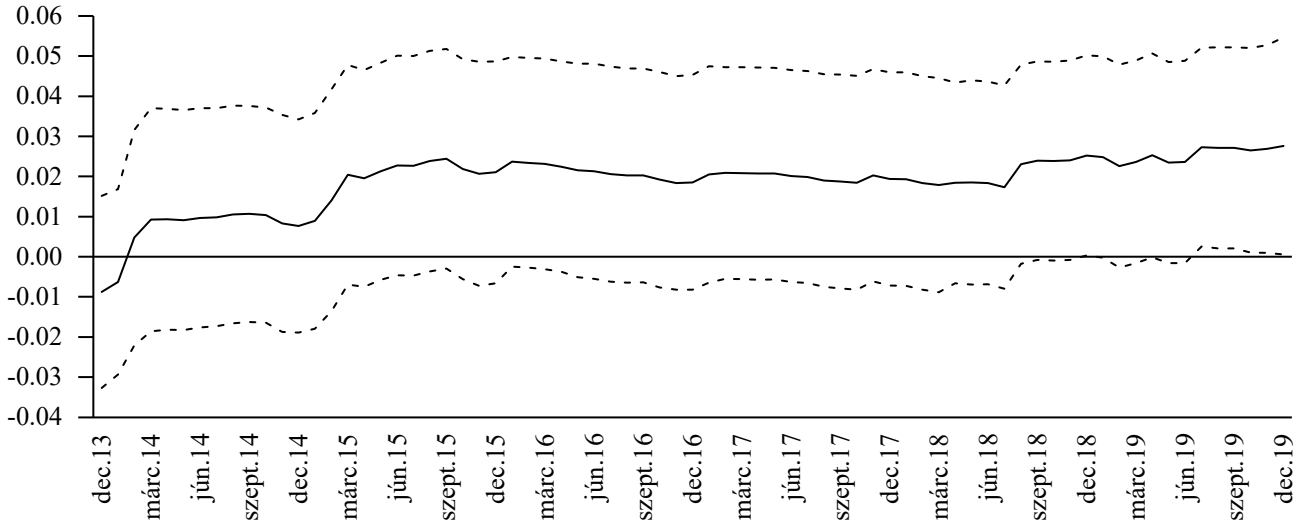

Figure 4: Price and quantity long-term relationship.

Note: Continuous grey line represents the estimate of the coefficient associated with the international price, for different windows of time (all finished at the date indicated). Dotted grey line indicate the 95% confidence interval.
Source: Own calculations.

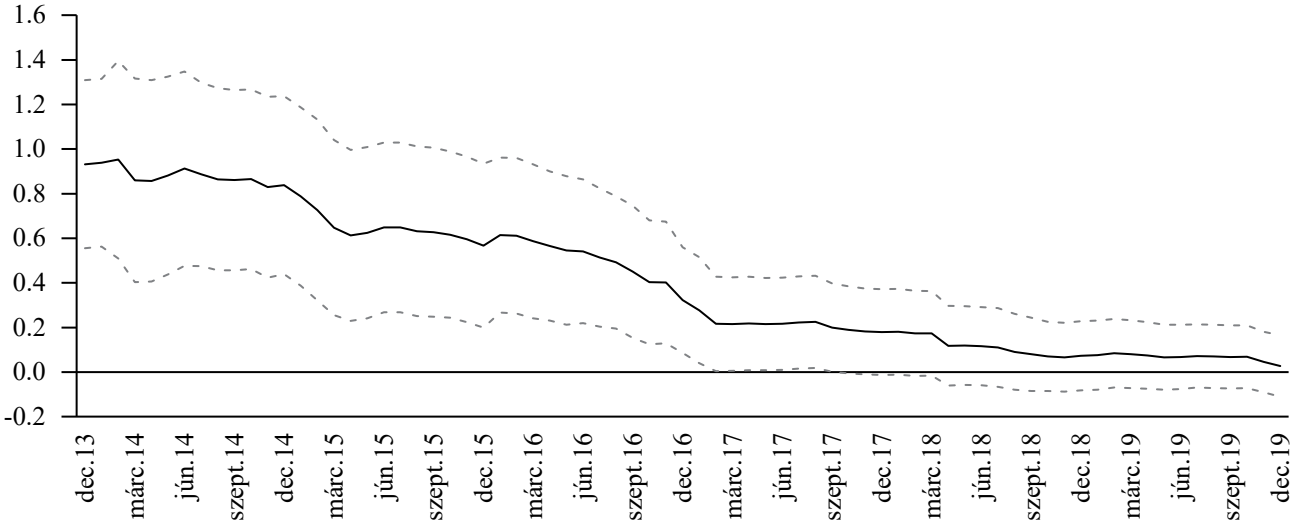

Figure 5: Long-term prices relationship breakdown.

Note: Continuous grey line represents the estimate of the coefficient associated with the Mexican quantity of coffee produced, for different windows of time (all estimated periods finish at the date shown). Dotted grey line indicate the 95% confidence interval.
Source: Own calculations

Conclusions

Our motivation for writing this paper was to discuss a graphically evident break in the transmission of international coffee prices to the Mexican coffee market. This hypothesised break starts in 2014, but later we showed that the statistical relationship between local and international price weakens over time. To evaluate our hypothesis, we proposed to measure the long-run relationship of both variables (plus Mexican coffee production as control) using a single equation conditional ECM. With this model, we were able to estimate the influence of the variables that affect the price received by Mexican producers as well as to evaluate the sensitivity of the long-run relationship to exogenous changes (in our case, to the hypothesised break).

We began our estimations using the period prior to the hypothesised break (2004-2013). Our results suggest that an increase of 1% in the international price of coffee increases in 0.9% the Mexican price. This estimation is larger than previous findings in the literature, which is consistent with the idea that trade agreements and globalisation contribute to the integration of the markets (Baffes and Gardner, 2003; Krivonos, 2004 and Jaramillo and Benítez, 2016). Nevertheless, we want to highlight here that this strong relationship corresponds to a period that does not include the hypothesised break in the international coffee price passthrough and which, furthermore, only examines the situation post-NAFTA.

Interestingly, we found no effect of Mexican production on its local price. This result has not been noticed previously in the literature and it is a striking finding because it suggests that the determination of the local coffee equilibrium price does not depend on the demand and supply forces in the Mexican market. On the other hand, we estimated the speed of adjustment of the Mexican price to exogenous changes in the variables of interest, which affect the cointegration relation. We found that deviations from the long-run relation will be adjusted by 40% in the next period (in the pre-break sample, 2004-2013). This estimation is 8 percentage points larger than the estimations of Jaramillo and Benítez (2016) in relation to a similar sample period (2000-2010).

We have offered evidence of a breakdown in the relationship of Mexican and international prices. Indeed, we applied our ECM to the full-sample period (2004-2019), and we found that the international price no longer has any statistically significant effect on the Mexican price. Furthermore, we gave further support to that finding by performing a rolling window analysis. Our results suggest that the breakdown started in 2015 but caused a loss in the statistical significance of the long-run relationship between prices until 2017. This event is relevant to further research on the effect of crop prices on the smallholders' well-being in developing economies.

Finally, we claim that the findings in this paper are relevant for policy decisions. Indeed, the break in the coffee transmission prices suggests that coffee smallholders are now less integrated with the supply chain. Hence, they are becoming more exposed to an increasing number of intermediaries, which reduces the price paid to producers and increases the final price paid by consumers. Given this market imperfection, the government may intervene to reduce the inefficiencies either by buying the product directly from coffee smallholders or by improving the commuting roads, so that the industrial companies can reach the small producers more easily instead of buying from intermediaries. Moreover, the government could provide financing options for producers to purchase the capital equipment needed (hulling and roasting machinery) to transform coffee beans into commercial coffee because this process will reduce the number of intermediaries. We consider these two latter points as other potential avenues for further research.

Acknowledgements

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Annex

In this annex we make two points regarding the main results of our paperr. First, exports reflect the drastic reduction in Mexican production but also support our conclusion about the international coffee price fading pass-though. Second, quantity of coffee produced in Mexico is gradually recovering importance in the determination of the local price.

A1. Coffee exports

In this paper, we suggest that the breakdown in the price relationship could be related to the presence of the coffee rust plague that affects Mexican production. We also point out that coffee production reached a minimum in the 2015-2016 agricultural cycle, among the last thirty years. At the same time, Mexican coffee exports have decreased since 2000 and have reached its minimum in 2015 (see Figure A1). Therefore, a lower coffee production undermines the relationship with the international trade (in terms of exports) and, hence, with the international prices.

Additionally, it is worth to notice that exports have maintained a low level since 2003. In particular, Mexican coffee exports have remained at a historically low level since the breakdown in the price relationship.

A2. Long run relationship between price and quantity (Mexican market)

In this paper, we document a break in the price relationship (between 2014 and 2015, which became statistically significant until 2017). Thus, we suggest that because of the break the Mexican coffee price does no longer follow the changes of the international coffee price. Furthermore, we find that, before 2014, Mexican coffee production did not play any role in the Mexican price determination. However, we also find that more recently Mexican coffee production is gaining importance in the determination of Mexican price (see Figure 4). This latter result suggests that, in the medium run, coffee production will be a relevant factor in the determination of the coffee price (in the Mexican market). All these results have important policy implications, which are discussed in our paper.

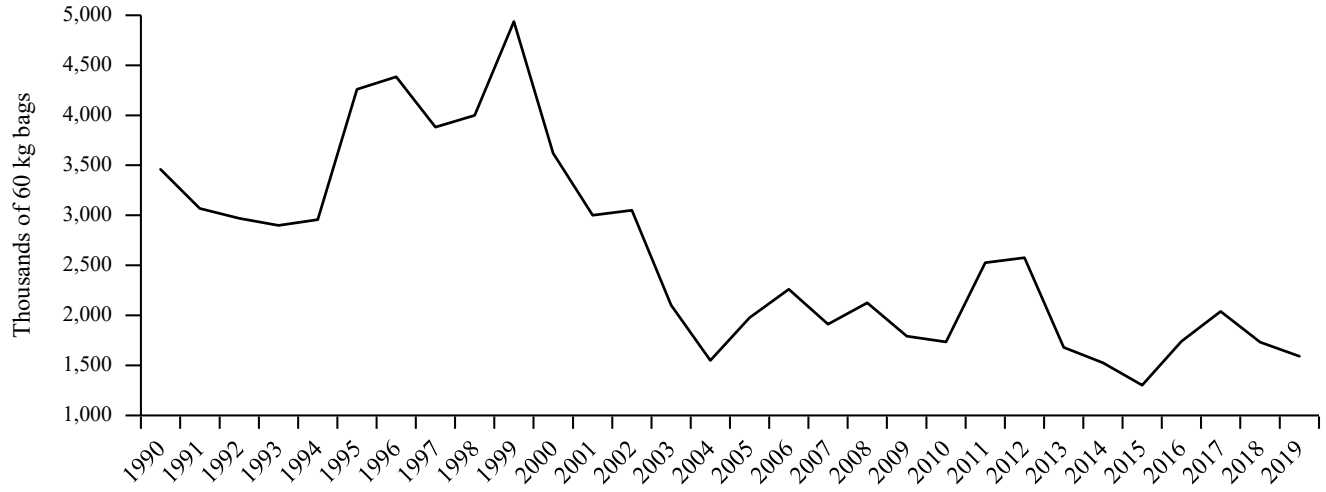

Figure A1: Green coffee bean Mexican exports.

Note: Green coffee exports show a declining behaviour even before our hypothesised break, but also show its minimum level in 2015.
Source: United States Department of Agriculture, Foreign Agricultural Service

Short communication

Ioannis MITSOPOULOS*, Maria TSIOUNI*, Aleksandra PAVLOUDI*, Dimitrios GOURDOUVELIS and Stamatios AGGELOPOULOS***

Improving the technical efficiency and productivity of dairy farms in Greece

This paper aims to examine the current state of dairy cattle farming in Greece, to identify factors that affect its profitability, and to analyse the efficiency of farms, using the non-parametric Data Envelopment Analysis (DEA) method. It also assesses the economic viability of dairy cattle farms by quantifying the technical efficiency of their processes, with a view to suggesting measures that may serve to improve competitiveness. Results have shown that the mean technical efficiencies estimated for the CRS and VRS DEA approaches are 0.693 and 0.754 respectively, indicating that 30.7% and 21.6% equiproportional decreases in inputs are feasible, given the level of outputs and the production technology.

Keywords: data envelopment analysis, efficiency, dairy cattle farms, financial management
JEL classification: Q12

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Introduction

The livestock farming sector in Greece represents 30% of total agricultural production. One of the most important livestock activities is dairy cow farming, the main output of which is milk intended entirely for human consumption. The number of dairy cows kept in Greece is about 106,000, representing about 20% of the total bovine population (Eurostat, 2019). Their annual production of milk stands at about 650,000 tons, representing only 1% of the EU-28 cows' milk production and covering about 40% of the total consumption of Greece (Eurostat, 2019). The Greek dairy cow sector is mainly characterised by relatively small farms, in terms of the number of the cows that they breed, and low milk yields (Theodoridis and Ragkos, 2014).

The dairy cow sector has low competitiveness due to the high production costs compared with other EU countries (Vlontzos and Theodoridis, 2013; Aggelopoulos *et al.,* 2009). Greece has the highest feeding costs among the EU countries, which in the case of dairy account about 70% of the total production costs (Arsenos, 2018). However, in Greece, due to existing semi-arid climatic conditions that characterised by low height of rainfall throughout the year and dry summers, the annual pasture production is relatively low. Therefore, the dairy cows' nutrition relies exclusively on harvested feedstuffs, with all that this entails for feed costs (Siafakas *et al.,* 2019). Other components of production cost that plays an important role in dairy farming are the annual costs of purchased imported animals (replacement heifers), the annual costs of fixed assets and the compensation of labour (Kitsopanidis, 2006). Most farms in the country operate under increasing returns to scale, so in order to achieve lower production costs and improved profitability, an increase in size is required (Theocharopoulos *et al.,* 2007).

The high production cost of Greek dairy cow farms is one of the major problems of the sector, resulting in reduced efficiency and low competitiveness in relation to other EU countries. As a result, every business development initiative in the industry ought to be coupled with reducing production costs. Moreover, with the abolition of quotas (March 2015), a new framework came into being for milk producers all over the EU. Under this new regime, it has been estimated that an 11% increase in cows' milk production would be achieved by 2020, an increase expected to come mainly from the Northern European countries (Kempen *et al.,* 2011; Jansik *et al.,* 2014).

Nowadays, dairy markets worldwide are facing increasing competition, a fact which highlights the need to improve the competitiveness of milk production in the European Union. In this environment of growing liberalisation and competition, it is essential for the Greek dairy sector to improve its performance and to increase its productivity by identifying and adopting the best farm practices (Theodoridis and Ragkos, 2014).

Over the last ten years, milk yields have shown an increase, a fact which demonstrates that the animals have become far more productive than in previous years. This was achieved because, in order to take advantage of the favourable aspects of the new policy framework, farmers have made large investments in infrastructure. This change in the structure of the sector and the concomitant need for investments were readily appreciated by dairy farmers, who chose to shift from small-scale family farming to a form of entrepreneurial livestock farming activity, in the process bringing about a considerable improvement in the general conditions under which dairy cow farms operate. Dairy farmers replaced their traditional sheds, which were usually situated next to the family house, with modern buildings outside the villages, whose capacity was capable of sustaining larger herds. The

adoption of such modern practices resulted in improved animal welfare, better hygiene conditions and higher milk yields (Abas *et al.,* 2013).

Nonetheless, the low competitiveness of the dairy sector in Greece clearly shows that the modernisation of building facilities and machinery were not designed rationally but were based on limited data and misleading projections of the future, which finally led to an overestimation of their efficiency (Tsiouni *et al.,* 2017).

Technical efficiency measurement is a very useful tool for evaluating agricultural sectors and economies under development status. Specifically, Data Envelopment Analysis (DEA) models that first established by Farell (1957) and then improved by Charnes *et al.* (1978) and Banker (1984) are extremely effective non-parametric approaches of technical efficiency, which do not require any specification of a functional form for the formation of the production frontier. However, due to its non-parametric nature, DEA attributes all measurement errors to inefficiency and requires the application of bootstrapping techniques to overcome this disadvantage (Simar and Wilson 2007).

So far, a small number of research papers have determined the competitiveness of the dairy cattle sector in Greece. Vlontzos and Theodoridis (2013) measured the efficiency and the productivity change of Greek dairy firms, using a non-parametric approach (DEA). This implementation provided helpful information regarding the efficiency ranking of the firms that operate in the Greek dairy industry. Their results showed that inefficient firms were over-invested and over-exposed to high-risk operation practices, findings which implied that remedial actions were possible with a view to improving efficiency in the future.

By contrast, Psychoudakis and Dimitriadou (1999) applied Data Envelopment Analysis in the data of 86 dairy farms and found that the majority of those farms were relatively efficient.

Theodoridis and Psychoudakis (2008), by studying the level of output-oriented technical efficiency (TE) in 165 cows' farms, indicated that their TE increased with their size. Valergakis (2000), by using data from 120 dairy cows' farms, concluded that the family farms, who owns between 70 and 150 cows, and have an average annual milk yield 7 tonnes/cow, were the most efficient, based on technical and economic parameters. Mitsopoulos (2012), based on a sample of 123 dairy cows' farms, found that management failures on farms negatively affected both the amount and quality of outputs (milk).

Overall, Data Envelopment Analysis (DEA) tends to show that focusing on animal production by increasing farm size in terms of the number of cows kept within the limits set by the available quantities of the production factors, increasing the amount of available time spent – especially the farmer's own work hours – on effectively monitoring and managing livestock, and investing more in animal farming while reducing investment in home-grown feedstuffs, would improve the farms' TE. This makes farms more efficient and clearly indicates that milk production in Greece could be increased significantly from its present levels at an unchanged level of investment.

Taking all of the above into consideration, this paper was considered appropriate due to the relative paucity of research undertaken in Greece. The surveys that have been conducted concerning the efficiency of the dairy cow sector have not taken into account numerical indicators describing the financial and operational situation of a holding. This paper aims to examine the current state of dairy cow farming in Greece, to identify factors that affect its profitability, and to analyse the efficiency of farms, making use of the non-parametric Data Envelopment Analysis (DEA) method.

It also assesses the economic viability of dairy cattle farms by quantifying the technical efficiency of their processes, with a view to suggesting measures that may serve to improve competitiveness.

Methodological framework

Technical efficiency is defined as the deviation of the observed product of a production unit from the maximum product that the unit could, in theory, produce and is related to the techniques of the manager's administrative capacity. The level of technical efficiency of a production unit, in the present analysis of a dairy farm, is estimated as the deviation of the farm under study from the potential ceiling of the possibilities afforded by the applied production technology.

The TE of a production unit is considered to be comprised of three elements (Fare *et al.,* 1994): 1. TE which refers to the ability of a production unit to operate (or not) within the limits of the potential of the manufacturing technology it uses; 2. Scale Efficiency (SE) which refers to the ability of a production unit to operate at the optimum size, that is to maximise the average product using the existing manufacturing technology and 3. Allocative Efficiency (AE) which refers to the ability of a production unit to use its inputs at optimum levels at a given market price for these inputs and a given manufacturing technology.

Based on Farrell's (1957) pioneering article, several approaches to efficiency measurement have been developed. Among these, Stochastic Frontier analysis (SFA) models and Data Envelopment Analysis (DEA) models have proved to be an extremely useful tool in the measurement of the technical efficiency of production units. The stochastic frontier approach was initiated by Aigner *et al.* (1977) and Meeusen and van der Broek (1977), while DEA approach was proposed by Charnes *et al.* (1978). Many authors in economic literature have dealt with the two approaches.

DEA is a linear programming method that calculates the frontier production function of a set of decision-making units (farms in our case) and evaluates the relative technical efficiency of each farm, allowing us to make a distinction between efficient and inefficient farms. Those identified as "efficient" are given a rating of one, whereas the degree of technical inefficiency of the rest is calculated on the basis of the Euclidian separation of their input–output ratio from the frontier (Coelli *et al.,* 1998).

The formulation of the present study is input oriented, solving the following model:

$$Max\theta = \sum_{r=1}^{s} y_{rj} u_r - \sum_{i=1}^{m} x_{ij} v_i, \quad (1)$$

s.t.:

$$\sum_{r=1}^{s} y_{rj} u_r - \sum_{i=1}^{m} x_{ij} v_i \leq 1, j = 1, \ldots, n,$$

$$\sum_{r=1}^{s} u_r + \sum_{i=1}^{m} v_i = 1, \quad (2)$$

$u_r \geq$ for $r = 1, ..., s$

$v_i \geq$ for $i = 1, ..., m$

where yi is the (k×l) vector of outputs produced and xi is the (m×l) vector of inputs used for unit i. Y is the (k×n) vector of outputs and X is the (m×n) vector of outputs of all n units included in the sample Λ is a (n×l) vector of weights and Θ is a scalar with boundaries of one and zero that determines the efficiency score of each Decision Making Units (DMU) (where 1 DMU = 1 farm).

Data Description and Model Specification

The data for the empirical analysis was gathered from a sample of 118 dairy farms in Central Macedonia, Greece. The choice of this particular area for study was due to the fact that almost half of the cow milk production in Greece comes from this region. The sample size was determined through a random stratified sampling. The research data was collected by using questionnaires and personal interviews with the "heads" of the dairy cow farms during the years 2018-2019. The sampled farms accounted for all types typically operating in the region, from small family farms to larger modern ones. The questionnaire completion time was estimated at 60 minutes for each dairy cow farm. The data obtained from the questionnaires were first introduced in Microsoft Office 2010 and specifically in Excel program and then, for the statistical analysis, SPSS24 was used. The variety of breeding conditions in this area allows the generalisation of the research results with no significant deviation from reality (Aggelopoulos *et al.,* 2015).

In this study, the input-oriented model is used, because in Greece there is a lack of milk production, the country does not cover the national consumption and an increase in production is required to restore the balance of supply and demand. The model includes, as inputs, the number of cows, the area of cultivated land (in acres of equivalent irrigated land), human labour (in hours), total variable costs (in €) and the annual costs of fixed capital, while output used gross income (in €).

Results

According to Tables 1 and 2, the mean technical efficiencies estimated for the CRS (constants returns to scale) and VRS (variable returns to scale) DEA approaches are 0.693 and 0.754 respectively, indicating that 30.7% and 21.6% equiproportional decreases of inputs are possible, given the level of outputs and the production technology. The mean technical efficiencies of the DEA models indicate that there is substantial inefficiency among the dairy farms in the sample, a finding which confirms initial expectations. Thirty farms are fully technically efficient in terms of the VRS model and eighteen farms are fully technically efficient under the CRS model. The technical efficiency scores estimated under the CRS DEA frontier are equal to or less than those calculated under the VRS DEA model. This

Table 1: Frequency distribution of technical and scale efficiency from the DEA models.

Efficiency Score	Data Envelopment Analysis					
	CRS		VRS		SE	
	Number of farms	%	Number of farms	%	Number of farms	%
< 0.4	10	8.5	4	3.5	1	0.8
0.4-0.5	8	6.8	11	9.3	0	0.0
0.5-0.6	24	20.3	15	12.7	4	3.5
0.6-0.7	22	18.6	20	16.9	1	0.8
0.7-0.8	17	14.4	20	16.9	8	6.8
0.8-0.9	10	8.5	8	6.8	15	12.7
0.9-1.0	9	7.6	10	8.5	71	60.2
1.0	18	15.3	30	25.4	18	15.3
Total	**118**	**100.0**	**118**	**100.0**	**118**	**100.0**

Source: Own calculations

Table 2: Descriptive statistics of TE and SE of DEA models.

Efficiency	CRS	VRS	SE
Mean	0.693	0.754	0.920
Minimum	0.179	0.193	0.359
Maximum	1.000	1.000	1.000
Standard Deviation	0.207	0.204	0.113

Source: Own calculations

relationship, as stated above, is used to obtain the measure of scale efficiency SE. The scale efficiency index for the sample ranges from 0.359 to 1.000 with a sample mean and standard deviation of 0.920 and 0.113, respectively. It is used as an interpretative tool to show the optimum amount by which productivity can be increased, within a given manufacturing technology, if the decision-making unit, in this case the dairy cows' farm, moves to the technical optimal productive scale (TOPS). On the other hand, the analysis reveals weaknesses and problems in the sector, which pertain to the management and structure of the dairy cows' farms.

Moreover, nine farms according to the CRS and ten farms according to the VRS model achieve a TE greater than 0.9, and that shows that 7.6 and 8.5% of the farms respectively exhibit satisfactory efficiency without necessarily being regarded as fully efficient. The scale efficiency is 0.92 with a standard deviation of 0.113. This indicates that farms have the potential to reduce inputs by 8% without changing the output level if they make the appropriate size adjustments with the standard technology and output level.

According to Table 3, the average technically efficient farm raises 150 cows, and each cow produces 7,445 kg milk year. The average farm cultivates 0.67 acres of irrigated soil equivalent for feed production and uses 49 hours of human labour.

An analysis of the statistics reveals that the mean score of gross margin in efficient farms is about 3,661 €/cow. The gross revenue in efficient farms is 1,678 €/cow and there is profit that is 1,118 €/cow. The land expenses are 18 €/cow, the labour expenses are 176 €/cow, the costs for purchased feed in efficient farms amount to 1,641 €/cow, accounting for about 83% of total variable costs and 64.5% of total production costs. The annual production costs of fixed capital for the average efficient operation are 366 €, indicating 14.4% of the total production costs. The share of fixed costs in total production costs for efficient farms can be characterised as low, as the dairy sector belongs to the production sectors with a high percentage of fixed costs, mainly due to the high investment in buildings.

Discussion

According to other studies using the DEA model to measure the efficiency of Greek dairy sector, Theodoridis and Psychoudakis (2008) reported similar results to ours, while Siafakas *et al.* (2019) reported less mean technical efficiency obtained of both VRS and CRS DEA model (0.549 and 0.676, respectively) and a lower scale efficiency (0.823).

The data in Table 3 show that the increased farming size (cows per farm) of the high scale-efficient farms has led to 1) increased productivity; 2) higher efficiency of labour and invested capital; 3) reduced production costs and 4) relatively high profitability per livestock unit. Similar conclusions have been reached by Siafakas *et al.* (2019), indicating a corresponding height of average milk production/cow 7,896.3 kg of milk (7,445.3 in our study) on efficient farms.

In an extensive study (200 dairy farms) of Kelly *et al.* (2012) in Ireland where the farming system is mainly pasture-based, the number of cows raised had no effect on the efficiency of the holdings, but only the available hectares of pastureland. The reduced efficiency of such systems is due to the greater need for purchased concentrate feedstuffs per cow. In contrast to the research of Demircan *et al.* (2010) in Turkey, small inefficient farms made almost exclusive use of grazing rather than concentrated feed.

In terms of feeding costs, which is the largest component of variable costs, this is higher in efficient farms than in inefficient ones. This is explained by the greater availability of cultivated land for feed available to inefficient farms.

Table 3: Technical and economic data of the efficient and the inefficient farms.

Decision making units – DMU Output	Average farm (118)	Standard Deviation	Average of efficient farms (30)	Standard Deviation	Average of inefficient farms (88)	Standard Deviation	p
Technical data							
Number of dairy cows	123	310	150	450	108	160	0.223
Milk yield (cow/year)	7,936	6,024.1	7,445.3	1,425.8	6,007.3	1,327.9	0.081
Cultivated land (in acres of equivalent irrigated land)	2	8.6	0.67	3.4	1.38	1.7	0.031
Labour in hours (per cow)	53.2	1,348.9	49	103.2	89.3	114.2	0.432
Economic data							
Land expenses (€/cow)	39.42	40.1	18.1	29.3	43.21	31.08	0.561
Labour expenses (€/cow)	196.4	126.7	176.2	132.4	224.1	149.7	0.482
Variable capital expenses (€/cow)	2,018.9	4,897.7	1,983.4	2,488.6	3,568.2	2,341.8	0.645
- *Value of Purchased Feed (€/cow)*	1,798.7	2,014.6	1,641.9	1,463.2	1,456.8	1,974.5	0.018
- *Other Variable capital expenses* (€/cow)*	372.4	296.3	342.2	301.9	418.4	287.9	0.214
Fixed capital expenses (€/cow)	416.3	333.7	366.5	297.8	329.9	203.4	0.128
Production expenses (€/cow)	3,087.4	2,109.2	2,543.2	1,987.3	3,457.3	2,014.9	0,358
Gross margin (€/cow)	3,657.1	2,807.1	3,661.0	2,423.,7	2,982.4	2,098.7	0.421
Gross revenue (€/cow)	1,638.2	3,417.6	1,678.0	2,596.1	1,432.3	2,110.8	0.396
Profit or Loss (€/cow)	569.7	3,413.5	1,118.0	3,104.3	231.9	2,986.6	0.512

Source: Own calculations

Siafakas *et al.* (2019) in their own study also showed that the farmers with the most cultivated areas failed to ensure the efficient operation of their farms. Corresponding results in terms of the effect of food costs associated with the quality of feed used were shown by Hansson and Öhlmér (2008) who reported technical output efficiency in a sample of Swedish farms of between 86% and 89%.

From the above, we conclude that inefficient dairy cow breeders have attached great importance to their own production of the necessary feed for their farms and less to the effective management of their farms. In essence, the multifunctionality they display makes them stand out as land and cow farmers. Superior business as well as farming management skills are likely to be the cause of efficient farms, because they make efficient use of debt capital. These farmers exploit their invested capital better on livestock farming equipment rather than land cultivation machinery.

Conclusions

This paper has applied the DEA methodology as an analytical tool to explore, at the microeconomic level, the potential shortcomings in the efficiency of Greek dairy cow farms that may be holding the sector back and hindering its future growth. Taking into consideration the importance of the dairy cow sector, it is possible to understand that the performance of the sector can have a marked effect on the agricultural development in Greece.

The analysis of farm efficiency showed that there could be significant improvements in the sector through the reorganisation of farm inputs. The economic development of every inefficient farm is feasible because for each inefficient farm, there is at least another efficient one. Given the existing technology, most farms exhibit serious technical inefficiency and can, in theory, reduce inputs by more than 30% in the short run and by 25% in the long run, maintaining in both cases the same level of output.

In conclusion, the inefficient holdings should reduce – to a lower or higher extent depending on the class of performance – the expenses of variable and fixed capital, the hours of labour and acres of cultivated land. The reduction of labour hours can be achieved by using mechanised production (e.g. installation of milking systems), and a modernisation of the facilities for ergonomic purposes should lead to a reduction of this cost component. Moreover, to reduce the feed cost, a well-balanced and inexpensive feeding is recommended. The knowledge of animal feed contents in nutritious ingredients and their suitability as well as efficient feeding and storage facilities of animal feed should lead to the improvement of the used animal feed. Furthermore, the cultivation of the land for feed production should lead to the reduction of the inefficient farms.

The conclusion that can be drawn is that if the production system is operated rationally and efficiently, it will improve the competitiveness and consequently the economic sustainability of the cow milk producing sector in Greece.

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BOOK REVIEW

Tibor FERENCZI*

Koester, U. (2020): Foundations of Agricultural Market Analysis and Agricultural Policy

Vahlen Textbooks, Verlag Franz Vahlen GmbH, Munich, Germany, 439p.

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Recently Professor Ulrich Koester's new book has been published by "Vahlen Textbooks" in Munich, Germany. It is based on the original German textbook of the author, which has as much as five updated editions (1st in 1981, 2nd in 1992, 3rd in 2005, 4th in 2010 and 5th in 2016), and is used by various universities in Germany and other German speaking countries as textbook. Its Russian edition was also used for teaching purposes in Ukraine, while an updated Russian edition is currently prepared for publication to be used in "Higher School of Economics" in Russia. Other editions are also under preparation for Serbia and Mongolia. The book itself is more than a textbook as it provides up-to-date theoretical support for agricultural market analysts and policymakers.

The book is 439 pages in length and besides the Introduction and Epilogue sections, consists of two parts, comprising three and five chapters respectively. The first, introductory chapter presents the concept of the author, describes the topic of agricultural market analysis and policy, and outlines the purpose of the book.

In the first part of the book, which consists of three chapters, the author deals with market analysis by discussing the characteristics of demand and supply for agricultural products and agricultural inputs as well as those of agricultural price formation. A significant merit of these chapters is that the author not only presents the basic microeconomic theories but also discusses their respective agricultural applications, providing detailed examples of actual agricultural markets. For instance, the demand for several agricultural products is illustrated by presenting elasticities in some countries and for various typical consumer groups.

The second part deals with agricultural policy in five chapters. The fifth chapter gives a deep analysis of the rationales underpinning agricultural policy together with a detailed discussion of the major policy instruments. Naturally, the author, who has been for half a century an expert on German agricultural policy, discusses the transformation of German agricultural policies very much in detail.

The topic of the sixth chapter is the objectives of agricultural policy, their setting, the choice from alternative policy solutions, some legal forms of them in Germany and in the EU, in correspondence with international agreements. The actors (who are practically decision-makers) of agricultural policy are presented through the specific case of the EU, and some problems of EU policy settings are also discussed.

The seventh chapter, which is the longest one in the book, presents the instruments of EU agricultural policy. The author here provides a detailed analysis of possible changes in agricultural policy under different factors and a broad variety of effects of these changes (e.g. on price and quantity, welfare, distribution, budget, international trade, etc.). This part provides an extremely profound tool for analysis of the policy instruments in agriculture. The author then deals with the reasons for, and problems arising from, the lack of transparency. The last part of this chapter provides a detailed economic analysis pertaining to selected instruments of agricultural policy.

The eighth chapter investigates the political economy of the EU agricultural market policy. The main question of Professor Koester is: "why is the policy as it is?". The author also deals with the different levels of protection in industrialised and developing countries to give a broader perspective and explains EU agricultural policy by the rational behaviour of all groups acting in it. At the end of the chapter, there is a broad political-economic analysis of EU agricultural market policy which provides a context for the findings of the next chapter.

The ninth chapter presents the basic principles of EU agricultural market organisations, introducing the ways of development and perspectives. The tenth chapter is the last one of the book, which is a short epilogue on some current problems and discussions related to agricultural sector as the Brexit, the impact of past decisions and the case of direct income support linked to agricultural land.

The book is excellent for teaching agricultural economics and policy based on its profound microeconomic and political economy theory and applied cases to agriculture. The author's extensive knowledge of the sector can be felt everywhere, and the book also provides good analytical tools for analysis of both agricultural markets and policy instruments.

Naturally, the book has no room to deal with other important agricultural policies as the American, Russian, and Chinese models, where the objectives can be very different from the EU's. However, Professor Koester presents the evolution of demand, supply, and price formation of agricultural products so lucidly and establishes his model of agricultural market analysis so perfectly that his analytical methodology can easily be applied to different countries and circumstances. It is a good challenge for agricultural economics students to apply Professor Koester's logic to other countries like New Zealand, Brazil, or India.

The book is also very useful for agricultural policymakers as they can follow a clear and very detailed theoretical presentation and discussion on the agricultural markets and the process whereby individual instruments affect markets in an international environment. It can also be used by them as an informative reference book.

Studies in Agricultural Economics

Information for authors

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