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Analysis of the Relationships Between Agricultural Producer Protection and Macroeconomic Variables in Fragile Five Countries by Bootstrap Panel Causality Test

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ABSTRACT

Agriculture is a leading sector that provides capital accumulation to sustain the economic development processes of developing countries' economies. The low supply and demand elasticity of agricultural products cause fluctuations in agricultural product prices and producer income. Therefore, the first negative reflection of price instability that may arise from fluctuations is generally observed in farmers. Hence, policymakers intervene in the agricultural sector to reduce the instability in agricultural product prices and protect agricultural producers against these effects, as well as the capital accumulation needed for growth and development. Based on this background, this study analyzes the causality relationship between agricultural producer protection (PP) and the macroeconomic variables of Brazil, Indonesia, India, Türkiye, and South Africa, which are referred to as the Fragile Five countries, using the panel bootstrap panel causality test developed by Kónya (2006) with the data between 2000 and 2020. The study findings differ among the countries in the sample. It was determined that there are causality relationships between agricultural PP and economic growth, economic development and inflation variables in all countries involved in this study. Although it is difficult to generalize the main findings of the study to all countries in the sample, it can be concluded that economic growth, economic development and inflation, and agricultural PP variables interact with one another. The study also concludes that the protective and supportive measures for agriculture, a significant sector for the macroeconomic performance indicators of the country's economies, are too important to be neglected.

Keywords: Agricultural economics, Support policy, Subsidies, Food shortages, Economic growth, Inflation

1. Introduction

The agricultural sector, which includes soil cultivation, animal husbandry, fisheries, and forestry, is a critical economic growth dynamic that cannot be ignored by the economies of industrialized and emerging countries (Awokuse & Xie 2015). Furthermore, it makes significant contributions to the economy, particularly at the start of economic growth and development, by feeding the populace and transferring resources to other sectors (Schultz 1964; Kuznets 1972). The fact that agricultural products (food) are both a commercial commodity and a vital resource for human well-being maintains and deepens the sector's role in the economy (Page 2013). The agriculture sector's capital accumulation, in particular, helps the initial stage of the economic growth process. Agricultural products find consumers in international marketplaces, bringing in foreign exchange while improving the country's gross domestic product (GDP). In this regard, the agricultural sector aids in the development of other industries (Johnston & Mellor 1961; Schultz 1964; Schneider & Gugerty 2011; Taylor & Lybbert 2020).

Agriculture growth is a significant tool for regional development and poverty reduction (Johnston & Mellor 1961; Kumar et al. 2011; Oyakhilomen & Zibah 2014; Dogan et al. 2015; Wickramasinghe 2018; and Bekun & Akadiri 2019). However, as globalization spreads the increase in income and welfare, population, and life expectancy around the world has led to an increase in the rate of food consumption. This was particularly apparent in the in the 2000s when food consumption outpaced production (Abbott et al. 2008), resulting in inflationary pressure.

In recent years, the primary battle for policymakers in national economies has been tackling inflation. Inflation in food prices has risen far faster than the consumer price index (CPI) in all regions of the world due to supply interruptions caused by coronavirus disease-2019 (COVID-19) (Valentina 2020; Gruère & Brooks 2021). Many variables, including increases in input costs (Algan et al. 2021), global climatic changes (Pelling et al. 2002; Singh-Peterson & Lawrence 2015), and losses in agricultural output, have caused agricultural output prices to rise globally (Edwards et al. 2011). The increase in food prices, which makes up a significant share in the household's disposable income, has led to a decrease in welfare levels. According to the Food and Agriculture Organization (FAO 2022) report, in February 2022, the food price index increased by an all-time high of 3.9% compared to January 2022 and was 20.7% higher than 2021.

Excessive fluctuations in agricultural product supply or prices have made the agricultural sector more fragile than before and destabilized regional-global markets (Bekkers et al. 2017). This instability exacerbates the CPI increase problem for national economies on a global scale, and if CPI increases caused by food price increases are not addressed, this effect can produce a domino effect and lead to an increase in agricultural product prices (Güloğlu & Nazlıoğlu, 2013). Based on this background analysis, the price increases in agricultural outputs in recent years have seriously affected low-income consumers. These price increases have managed to become a current issue once again, especially in developing countries, as they negatively affect the welfare of low-income consumers (Wodon et al. 2008; Albers & Peeters 2011; Jomo & Chowdhury 2020).

Agriculture is crucial in many developing nations for decreasing poverty and hunger (OECD 2005). Food price increases may spark social discontent by lowering the per capita income (GDPC) of the inhabitants in this group of countries living in countries that spend a large amount of their income on food. As a result, the agricultural sector indisputably affects the macroeconomic factors such as economic growth (Gollin 2010). It is a fundamental determinant of CPI and welfare, particularly economic growth. For these reasons, factors arising from the unique structure of the agricultural sector (such as the uncertainty of climatic conditions, the amount of agricultural output, fluctuations in supply-demand and prices, inadaptability for competition, and being an important source of income for the government) necessitate the active intervention of the state in the agricultural sector. Although the economic activities in today's world operate in the form of a free market, the fragile structure of the agricultural sector does not provide much opportunity for this. Especially with the 2008 crisis, many researchers began to discuss seriously the idea of returning to Keynes to solve the crisis. This understanding, which is conceptualized as "Keynes Resurrected", has led to the emergence of fiscal policy as an important and effective policy tool and the re-emergence of debates concerning state interventionism (Alesina 2012). Therefore, almost every developed and developing country adopts the intervention (support) in agriculture as an active policy tool for economic and social reasons (Stiglitz 1987; OECD 2005; Lundberg 2005; Birner & Resnick 2010; Albers & Peeters 2011; Searchinger et al. 2020). Policymakers support the agricultural sector with various market regulations such as direct support for agricultural production, tax advantages, technology and knowledge transfers, measures to protect markets, non-tariff barriers, quantity restrictions, and price supports (Andreosso-O'Collaghan 2003; Lundberg 2005; Clapp 2017; Searchinger et al. 2020). The major goal of such tools is to promote agricultural development and expand overseas agricultural commerce (Vozarova & Kotulic 2016). Thus, the housing need is fulfilled first, and excess supply is traded internationally. This, in turn, helps to solve the problem of insufficient capital accumulation, which is the most serious impediment to economic growth and development in emerging countries. These initiatives may help to lessen the recent food-induced CPI rises that have hit national economies.

When the prices of agricultural products are more unstable than the prices of products produced by other sectors outside of agriculture, the first negative reflection of price instability, which may arise from fluctuations, is usually on the farmers. Therefore, one of the reasons for governments to intervene in the agricultural sector is to reduce the instability in agricultural product prices and protect agricultural producers against these effects (Özdemir 1989).

Economic development is one of the ultimate goals of the economies of developed and developing countries. It can, however, only be achieved with stable economic growth momentum. There is a consensus that the capital accumulation that can be obtained in the agricultural sector, which is indicated for the first stage of economic development, leads to economic growth, and economic growth leads to economic development (Schultz 1964; Kuznets 1972; Taylor & Lybbert 2020). Additionally, it is among the issues that have been discussed recently that the agricultural sector is a fundamental sector for increasing welfare, reducing poverty and hunger, as well as the means by which the increase in output prices of this sector negatively affects household welfare (Wodon et al. 2008; Bekun & Akdiri 2019; Jomo & Chowdhury 2020). These effects are experienced far more in underdeveloped and developing countries. Based on these discussions, the extent to which the protective measures applied to the agricultural sector affect the economies has led some researchers to turn their attention to this area.

Studies on the effects of agricultural support on macroeconomic performance are limited in the literature. Among these studies, Balisacan & Roumasset (1987) examine the relationship between the calculated nominal protection rates of major grains and economic development with the 1979-1981 period data of 68 countries. The researchers concluded a strong relationship between economic development and agricultural protection. The study conducted by Köse & Meral (2021) for Türkiye determined no relationship between agricultural support and economic growth. On the other hand, Albers & Peeters (2011) reported that agricultural supports have a reducing effect on food inflation in their study of the period of 2002-2010 in 9 countries in the Mediterranean region. Caracciolo et al. (2014) investigated the links between the world and national prices of some important staple crops such as maize, rice, and wheat in 4 developing countries. They found no direct correlation between wheat and rice subsidies and the world prices of these products. However, subsidies for maize seeds have an impact on global prices (Caracciolo et al. 2014). Furthermore, the benefits of agricultural support in the agricultural sector both enhance food supply and lower food prices and this is projected to aid in poverty reduction (Oyakhilomen & Zibah 2014).

Gollin (2010) emphasizes that the increase in agricultural productivity is the first and most important source of economic growth in many developing countries. To this end, studies on this topic have been carried out in the form of the contribution of various agricultural supports to agricultural productivity. Having investigated the effects of agricultural supports on agricultural productivity and agricultural growth in the literature, Hennessy (1998), Skuras et al. (2006), McCloud & Kumbhakar (2008), Henningsen et al. (2009), Terin et al. (2013), Gu (2014), Gautam (2015), Ela et al. (2016), Vozarova & Kotilic (2016), Erdal et al. (2021), Canbay (2021) determined that the government's agricultural support policies positively impact agricultural productivity. On the other hand, Bezlepkina & Oude (2006), Nastis et al. (2012), and Uslu & Apaydın (2021) suggested that supports for the agricultural sector have negative effects on agricultural productivity. In addition, Rad-Tüzün & Aslan (2018) reported that agricultural supports have positive effects on some products and negative effects on others. Kalabak & Aslan (2021) found that this effect is limited. Besides, Yıldız (2017) reached the findings of bidirectional causality between the variables in their study, while Roe et al. (2002), and Uslu & Apaydın (2021) could not find a statistically significant relationship between the variables. As can be deduced from the literature, the findings of the studies on the subject, which are few in number, reveal different results. The reasons for the different results mainly stem from the rate differences between the countries/groups of countries discussed in terms of agricultural support from GDP, the fragile structure depending on climatic conditions, and technological infrastructure deficiencies for the sector. In addition to these reasons, marketing strategy mistakes, input price increases due to cyclical developments, the lack of physical and human capital, and the inability to consistently maintain the implemented support plans lead to differentiation in results.

To that end, this paper investigates the causality relationships between economic growth, economic development, and inflation, which are macroeconomic performances of protective policies toward producers in the agricultural sector. The main hypothesis of the study is that the practices aimed at protecting the producers in the agricultural sector lead to an increase in the amount of output, which eventually suppresses the rate at which inflation increases as well as contributes to economic growth and development. For this purpose, the panel bootstrap causality test developed by Kónya (2006) is used with data from 2000 to 2020 for the Fragile Five (Brazil, Indonesia, India, Türkiye, and South Africa). Considering the overall economic performance of the Fragile Five countries in 2020, the Indian economy shrank by 7.25%, South Africa by 6.43%, Brazil by 4.05%, and Indonesia by 2.06% compared to the previous year. Among these countries, only the Turkish economy grew by 1.79% (World Bank 2022a). With the exception of Türkiye, the GDPC (constant 2015 US$) of the Fragile Five tends to decrease again in 2020 when compared with the previous year. In addition, the GDPC data of these countries for 2020/2021 is far below the OECD average. Among these countries, the GDPC from highest to lowest is ordered as Türkiye, Brazil, South Africa, Indonesia, and India (World Bank 2022b). The annual inflation rates indicate that while Brazil's annual inflation rate was 3.21% in 2020, this rate increased to 8.30% in 2021. Annual inflation for 2020 and 2021 rose from 1.92% to 1.56% in Indonesia, from 5.56% to 4.89% in India, from 12.27% to 19.59% in Türkiye, and from 3.21% to 4.61% in South Africa (OECD 2022a). Figures regarding the share of the agricultural sector in GDP in 2020 reflect that it is 5.9% in Brazil, 13.70% in Indonesia, 18.31% in India, 6.68% in Türkiye, and 2.52% in South Africa (World Bank 2022c). In addition to being among the developing countries, major economic problems such as high inflation, unstable growth, and lack of capital are the common features of the Fragile Five (Kırca & Canbay 2020). The fundamental reason for selecting these countries as the study's sample group is that the agricultural sector is critical to their economies, and their economic performance is still volatile. This is a unique study since there are very few studies in the literature that focus on the links between agricultural producer protection (PP) and macroeconomic variables. It also differs from the others in that the subject is tested for the first time in the context of the Fragile Five, the time span under consideration, and the method employed.

2. Material and Methods

2.1. Material

For this study, the 2000 and 2020 period of the Fragile Five (Brazil, Indonesia, India, Türkiye, and South Africa) is discussed in the model. This period is used in the model due to the restriction of the time series of the agricultural PP variable of some countries in the sample of the research. In the model, PP, GDP, GDPC, and CPI variables are used. GDP represents economic growth, and economic development is represented by the GDPC variables used in the model. Although there are many indicators of economic development, GDPC is among the most commonly used (Şaşmaz & Yayla 2018). In addition, one of the main reasons for choosing GDPC as an indicator of economic development as a variable in the model is the use of this variable to represent economic development in the studies of Kuznets (1955) and Grossman and Krueger (1991).

Among the variables, PP was obtained from the Organization for Economic Co-operation and Development (OECD 2022b) database, and GDP (World Bank 2022d), GDPC (World Bank 2022b), and CPI (World Bank 2022e) were accessed on the World Bank database. PP is defined as the ratio between the average price received by producers (measured at the farm gate), including net payments per unit of current output, and the border price (measured at the farm gate). For instance, a coefficient of 1.10 suggests that farmers, overall, paid prices that were 10% above international market levels. This indicator reflects the level of price distortions and is measured by the Producer Nominal Protection Coefficient expressed as the ratio of farm price to the border reference price. GDP data are in constant 2015 prices, expressed in US dollars. GDPC is based on purchasing power parity. Data are constant with 2017 international dollars. Logarithms of both variables were taken and included in the analysis. The data of CPI (2010=100) are period averages.

Descriptive statistics of the variables of the countries are given in Table 1.

Table 1- Descriptive statistics

Variables	*PP_Brazil*	*PP_Indonesia*	*PP_India*	*PP_Türkiye*	*PP_ South Africa*
Mean	1.03	1.17	0.83	1.27	1.03
Median	1.03	1.18	0.83	1.28	1.02
Max.	1.06	1.34	0.93	1.41	1.11
Min.	1.00	0.87	0.72	1.06	1.00
Std. Dev.	0.02	0.12	0.06	0.09	0.02
Jarque-Bera	2.26	1.24	1.26	1.43	6.76
J-B Prob.	0.32	0.53	0.53	0.48	0.03
Variables	*GDP_ Brazil*	*GDP_ Indonesia*	*GDP_ India*	*GDP_ Türkiye*	*GDP_South Africa*
Mean	28.08	27.20	28.03	27.20	26.42
Median	28.16	27.21	28.06	27.14	26.46
Max.	28.25	27.67	28.62	27.64	26.60
Min.	27.80	26.70	27.40	26.68	26.12
Std. Dev.	0.15	0.32	0.39	0.31	0.15
Jarque-Bera	2.48	1.55	1.41	1.40	2.29
J-B Prob.	0.28	0.46	0.49	0.49	0.31
Variables	*GDPC_ Brazil*	*GDPC_ Indonesia*	*GDPC_ India*	*GDPC_ Türkiye*	*GDPC_ S.Africa*
Mean	9.82	17.15	11.10	9.67	11.21
Median	9.84	17.16	11.11	9.62	11.25
Max.	9.95	17.51	11.57	9.97	11.29
Min.	9.64	16.78	10.62	9.28	11.04
Std. Dev.	0.10	0.24	0.31	0.22	0.08
Jarque-Bera	1.97	1.60	1.42	1.41	3.46
J-B Prob.	0.37	0.44	0.49	0.49	0.17

Table 1- Continued

Variables	*CPI_ Brazil*	*CPI_ Indonesia*	*CPI_ India*	*CPI_ Türkiye*	*CPI_ S.Africa*
Mean	107.59	100.19	107.72	113.00	105.02
Median	100.00	100.00	100.00	100.00	100.00
Max.	172.77	154.08	184.32	263.22	164.05
Min.	52.53	44.01	54.33	20.59	59.89
Std. Dev.	38.14	35.85	44.44	65.21	33.50
Jarque-Bera	1.47	1.46	2.06	2.03	1.68
J-B Prob.	0.47	0.48	0.35	0.36	0.42

2.2. Method

In this study, in which the relationships between the variables in the model are examined, the relationships between the variables are tested with the panel bootstrap causality test developed by Kónya (2006). In this test, the existence of a cointegration relationship between the variables is not mandatory, and at the same time, there is no need to focus on the stationarity levels of the variables. This test, however, does have two important prerequisites. The first is the existence of cross-section dependence in the models, while the other prerequisite is that the coefficients of the models are heterogeneous.

Among the cross-sectional dependence test, the BP_{LM} test developed by Breusch & Pagan (1980), the CD_{LM} test developed by Pesaran (2004), the LM_{adj} test developed by Pesaran et al. (2008), and finally determined by LM_{BC} tests developed by Baltagi (2012) are frequently used tests. In order to determine the homogeneity/heterogeneity of the coefficients, the $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ test statistics suggested by Pesaran & Yamagata (2008) are generally used.

Holding the view that the seemingly unrelated regression (SUR) estimator is more effective than ordinary least squares estimator, Kónya (2006) developed a causality test based on this SUR estimator developed by Zellner (1962). In fact, each equation in the SUR system is based on Sims's (1980) Vector Autoregressive (VAR) approach. The relationships between the variables used in the study are modeled using the SUR system as follows (Kónya 2006):

$$\left.\begin{array}{l} PP_{1,t} = \varphi_{1,1} + \sum_{l=1}^{ml\_PP_1} \alpha_{1,1,l} PP_{1,t-1} + \sum_{l=1}^{ml\_GDP_1} \beta_{1,1,l} GDP_{1,t-1} + \xi_{1,1,t} \\ PP_{2,t} = \varphi_{1,2} + \sum_{l=1}^{ml\_PP_1} \alpha_{1,2,l} PP_{2,t-1} + \sum_{l=1}^{ml\_GDP_1} \beta_{1,2,l} GDP_{2,t-1} + \xi_{1,2,t} \\ \vdots \\ PP_{N,t} = \varphi_{1,N} + \sum_{l=1}^{ml\_PP_1} \alpha_{1,N,l} PP_{N,t-1} + \sum_{l=1}^{ml\_GDP_1} \beta_{1,N,l} GDP_{N,t-1} + \xi_{1,N,t} \end{array}\right\} \quad 1$$

$$\left.\begin{array}{l} GDP_{1,t} = \varphi_{2,1} + \sum_{l=1}^{ml\_GDP_2} \beta_{2,1,l} GDP_{1,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{2,1,l} PP_{1,t-1} + \xi_{2,1,t} \\ GDP_{2,t} = \varphi_{2,2} + \sum_{l=1}^{ml\_GDP_2} \beta_{2,2,l} GDP_{2,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{2,2,l} PP_{2,t-1} + \xi_{2,2,t} \\ \vdots \\ GDP_{N,t} = \varphi_{2,N} + \sum_{l=1}^{ml\_GDP_2} \beta_{2,N,l} GDP_{N,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{2,N,l} PP_{N,t-1} + \xi_{2,N,t} \end{array}\right\} \quad 2$$

$$\left.\begin{array}{l} PP_{1,t} = \varphi_{3,1} + \sum_{l=1}^{ml\_PP_1} \alpha_{3,1,l} PP_{1,t-1} + \sum_{l=1}^{ml\_GDPC_1} \beta_{3,1,l} GDPC_{1,t-1} + \xi_{3,1,t} \\ PP_{2,t} = \varphi_{3,2} + \sum_{l=1}^{ml\_PP_1} \alpha_{3,2,l} PP_{2,t-1} + \sum_{l=1}^{ml\_GDPC_1} \beta_{3,2,l} GDPC_{2,t-1} + \xi_{3,2,t} \\ \vdots \\ PP_{N,t} = \varphi_{3,N} + \sum_{l=1}^{ml\_PP_1} \alpha_{3,N,l} PP_{N,t-1} + \sum_{l=1}^{ml\_GDPC_1} \beta_{3,N,l} GDPC_{N,t-1} + \xi_{3,N,t} \end{array}\right\} \quad 3$$

$$\left.\begin{array}{l} GDPC_{1,t} = \varphi_{4,1} + \sum_{l=1}^{ml\_GDPC_2} \beta_{4,1,l} GDPC_{1,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{4,1,l} PP_{1,t-1} + \xi_{4,1,t} \\ GDPC_{2,t} = \varphi_{4,2} + \sum_{l=1}^{ml\_GDPC_2} \beta_{4,2,l} GDPC_{2,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{4,2,l} PP_{2,t-1} + \xi_{4,2,t} \\ \vdots \\ GDPC_{N,t} = \varphi_{4,N} + \sum_{l=1}^{ml\_GDPC_2} \beta_{4,N,l} GDPC_{N,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{4,N,l} PP_{N,t-1} + \xi_{4,N,t} \end{array}\right\} \quad 4$$

$$\left.\begin{aligned} PP_{1,t} &= \varphi_{5,1} + \sum_{l=1}^{ml\_PP_1} \alpha_{5,1,l} PP_{1,t-1} + \sum_{l=1}^{ml\_CPI_1} \beta_{5,1,l} CPI_{1,t-1} + \xi_{5,1,t} \\ PP_{2,t} &= \varphi_{5,2} + \sum_{l=1}^{ml\_PP_1} \alpha_{5,2,l} PP_{2,t-1} + \sum_{l=1}^{ml\_CPI_1} \beta_{5,2,l} CPI_{2,t-1} + \xi_{5,2,t} \\ &\vdots \\ PP_{N,t} &= \varphi_{5,N} + \sum_{l=1}^{ml\_PP_1} \alpha_{5,N,l} PP_{N,t-1} + \sum_{l=1}^{ml\_CPI_1} \beta_{5,N,l} CPI_{N,t-1} + \xi_{5,N,t} \end{aligned}\right\} \quad 5$$

$$\left.\begin{aligned} CPI_{1,t} &= \varphi_{6,1} + \sum_{l=1}^{ml\_CPI_2} \beta_{6,1,l} CPI_{1,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{6,1,l} PP_{1,t-1} + \xi_{6,1,t} \\ CPI_{2,t} &= \varphi_{6,2} + \sum_{l=1}^{ml\_CPI_2} \beta_{6,2,l} CPI_{2,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{6,2,l} PP_{2,t-1} + \xi_{6,2,t} \\ &\vdots \\ CPI_{N,t} &= \varphi_{6,N} + \sum_{l=1}^{ml\_CPI_2} \beta_{6,N,l} CPI_{N,t-1} + \sum_{l=1}^{ml\_PP_2} \alpha_{6,N,l} PP_{N,t-1} + \xi_{6,N,t} \end{aligned}\right\} \quad 6$$

Model 1 is used to test the causality relationship from GDP to PP, from PP to GDP in Model 2, from GDPC to PP in Model 3, from PP to GDPC in Model 4, from CPI to PP in Model 5, and from PP to CPI in Model 6.

N represents the number of countries (i=1, 2, 3, ..., 5) expressed in the equations, and t represents the time interval (t=2000, 2001, 2002, 2003, ..., 2020). In addition, "ml" represents the lag length and $\xi_{1,1,t}$, $\xi_{1,2,t}$,..., $\xi_{1,N,t}$, $\xi_{2,1,t}$, $\xi_{2,2,t}$,..., $\xi_{2,N,t}$, $\xi_{3,1,t}$, $\xi_{3,2,t}$,..., $\xi_{3,N,t}$... are the error terms which are supposed to be white noises.

In Kónya's (2006) panel bootstrap causality test, Wald test statistics are calculated using the VAR equations estimated for each country in the SUR system above. However, critical values for each country are derived by the bootstrap method. The following hypotheses are tested by comparing the calculated Wald test statistics with the critical values calculated by the bootstrap method. By applying constraints to the coefficients as shown below, causality relationships between the variables can be determined.

If not all $\beta_{1,N,l}$s are zero, but all $\alpha_{2,N,l}$s are zero; there is unidirectional Granger causality from GDP to PP. If not all $\alpha_{2,N,l}$s are zero, but all $\beta_{1,N,l}$s are zero; there is unidirectional Granger causality from PP to GDP. If all $\beta_{1,N,l}$s and $\alpha_{2,N,l}$s are zero; there is no causality relationship between GDP and PP. If neither $\beta_{1,N,l}$s nor $\alpha_{2,N,l}$s are zero; there is bidirectional Granger causality. Similarly, if not all $\beta_{1,N,l}$s are zero, but all $\alpha_{2,N,l}$s are zero; there is unidirectional Granger causality from GDPC to PP. If not all *s* are zero but all s are zero; there is unidirectional Granger causality from CPI to PP.

3. Results and Discussion

Table 2 shows the results of the cross-sectional dependence and homogeneity test, which is the prerequisite of the Kónya (2006) panel bootstrap causality test.

Table 2- Cross-section dependence (CSD) test and slope homogeneity (SH) tests results

Tests	*CSD*				*SH*	
Models	BP_{LM}	CD_{LM}	LM_{BC}	LM_{adj}	$\tilde{\Delta}$	$\tilde{\Delta}_{adj}$
Model 1	23.99* (0.007)	3.12* (0.001)	3.00* (0.002)	-0.36 (0.713)	6.54* (0.001)	7.13* (0.001)
Model 2	158.21* (0.001)	33.14* (0.001)	33.01* (0.001)	12.54* (0.001)	5.84* (0.001)	6.37* (0.001)
Model 3	23.78* (0.008)	3.08* (0.002)	2.95* (0.003)	0.99 (0.318)	6.14* (0.001)	6.69* (0.001)
Model 4	42.17* (0.001)	7.19* (0.001)	7.07* (0.001)	4.75* (0.001)	5.71* (0.001)	6.22* (0.001)
Model 5	21.91* (0.001)	2.66* (0.001)	2.53* (0.001)	-0.19* (0.841)	3.83* (0.001)	4.17* (0.001)
Model 6	201.99* (0.001)	42.93* (0.001)	42.80* (0.001)	14.21* (0.001)	5.59* (0.001)	6.10* (0.001)

*Indicates cross-sectional dependence and heterogeneity at 1% and 5% statistical significance level. Figures in (parentheses) are probability values

Test results in Table 2 show that there is a cross-sectional dependence in all the models. In Model 1, Model 3, and Model 5, except for the LM_{adj} test developed by Pesaran et al. (2008), findings on three cross-sectional dependencies were obtained, while in the other four models results on four cross-sectional dependencies were acquired. The BP_{LM} test can be used when the time dimension is larger than the cross-sectional dimension (t>N), while the CD_{LM} test can be used when both the time dimension is larger than the cross-sectional dimension and the cross-sectional dimension is larger than the time dimension (t>N, N>t). Since it is (t>N) in all study models, the BP_{LM} test can be taken as a reference. However, in CD_{LM} and LM_{BC} test results cross-sectional dependence was detected in all models. According to these results, shocks that can occur in any of the five countries included in the model may affect other countries in the future. Moreover, as can be seen in Table 1, the homogeneity test results of the slope coefficients of Pesaran & Yamagata (2008) in all models are significant at the 1% level. Therefore, the alternative hypothesis, the slope coefficients, is heterogeneous. As a result of the findings obtained from the tests in Table 2, there is no obstacle to performing the Kónya (2006) panel bootstrap causality test.

The causality results between PP and GDP are presented in Table 3.

Table 3- Causality between PP and GDP

H_0: GDP is not the Granger causality of PP (Model 1)					
Countries	***Coefficients***	***Test statistics***	***Critical values***		
	GDP	***Wald***	***10%***	***5%***	***1%***
Brazil	-0.078	8.057***	6.838	10.29	17.365
Indonesia	0.266	8.346**	5.876	8.492	14.779
India	0.03	1.221	8.817	12.605	22.472
Türkiye	-0.134	9.040***	6.459	9.566	16.841
South Africa	-0.186	27.197*	5.166	7.905	16.51
H_0: PP is not the Granger causality of GDP (Model 2)					
Countries		***Test Statistics***	***Critical Values***		
	PP	***Wald***	***10%***	***5%***	***1%***
Brazil	0.56	6.289***	6.169	9.421	17.602
Indonesia	0.03	0.987	6.956	11.474	27.316
India	0.09	2.116	6.135	9.474	19.847
Türkiye	0.27	9.434***	6.963	10.389	21.934
South Africa	0.35	13.097**	7.483	11.496	25.582

*,**,***Indicate rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively

According to the test results in Table 3, there is a bidirectional causality relationship between PP and GDP variables in Brazil, Türkiye, and South Africa. However, there is a positive causality relationship to PP in GDP in Indonesia. In Model 1, there is a negative causality from GDP to PP in Brazil, Türkiye, and South Africa, and in Model 2, positive causality from PP to GDP in Brazil, Türkiye, and South Africa.

While the agricultural sector has an important share in the economies of countries that are in development efforts at the beginning, this weighted share is replaced by the manufacturing and service sectors as the countries develop. In the development literature, this change is referred to as a natural and structural transformation (Polat 2011). The main reason for this structural transformation is the low-income demand elasticity of agricultural products compared to industrial and high-tech products (Fisher 1939). Additionally, as countries' income levels increase, the total demand shifts relative to industrial and high-tech products, and foreign trade rates follow a course against agricultural products (Singer 1950; Prebish 1962). The primary reason why economic growth negatively affects PP in Brazil, Türkiye, and South Africa may be that as the economies of the countries grow, more importance is given to sectors with high added value, especially manufacturing and service industry, rather than the agricultural sector. Particularly, under the same conditions, the share of the agricultural sector in national income or total production decreases (Uslu & Apaydın 2021). This may also be a possible result of reducing the share of agricultural support in GDP proportionally. PP increases economic growth in Brazil, Türkiye, South Africa, and Indonesia. The protection policies applied to the producers in the agricultural sector contribute to the country's GDP and the increase in productivity.

The causality results between PP and GDP per capita are given in Table 4.

Table 4- Causality between PP and GDP per capita

H_0: GDPC is not the Granger causality of PP (Model 3)					
Countries	***Coefficients***	***Test statistics***	***Critical values***		
	GDPC	***Wald***	***10%***	***5%***	***1%***
Brazil	-0.100	4.417	7.971	11.276	21.540
Indonesia	0.409	8.873***	6.316	9.124	17.778
India	0.056	2.160	9.660	13.358	22.256
Türkiye	-0.248	11.382**	7.409	10.779	18.307
South Africa	-0.299	12.807**	6.829	10.116	27.448
H_0: PP is not the Granger causality of GDPC (Model 4)					
Countries		***Test statistics***	***Critical values***		
	PP	***Wald***	***10%***	***5%***	***1%***
Brazil	0.59	11.194**	5.760	8.285	16.298
Indonesia	0.02	0.541	6.087	9.853	24.434
India	0.06	1.484	5.697	8.611	15.936
Türkiye	0.36	8.920**	5.816	8.744	17.375
South Africa	0.39	9.020***	6.366	9.517	19.437

,*Indicate rejection of the null hypothesis at the 5 and 10 percent levels of significance, respectively

According to the current findings in Table 4, a bidirectional causality relationship was observed between PP and GDPC variables in Türkiye and South Africa. The direction of these relationships is negative from GDPC to PP and positive from PP to GDPC. The existence of a positive and unidirectional causality relationship from GDPC to PP in Indonesia and from PP to GDPC in Brazil was found.

According to Ernst Engel's (1857) law, as consumer income rises, the share of the budget devoted to basic items drops, while the share assigned to luxury goods rises. As a result, increasing welfare and income levels with economic development raise household luxury expenditure. According to Engel's Law, it is possible that the share of consumption for food, which is the basic need, in income decreases. As a result of all these developments, the support for the agricultural sector may decrease or cause it to remain weaker than before. In particular, the study findings for Türkiye and South Africa can be based on Engel's law. In Indonesia, economic development leads to increased protective measures for farmers. Indonesia's basic agricultural policy is primarily aimed at meeting domestic demand,

and the government follows a protective policy, especially in the agricultural sector, against producers (Poernomo 2017). Policies to protect producers in Brazil, Türkiye, and South Africa both positively affect economic growth and lead to economic development.

Finally, the causality results between PP and CPI are presented in Table 5.

Table 5- Causality between PP and CPI

H_0: CPI is not the Granger causality of PP (Model 5)					
Countries	***Coefficients***	***Test statistics***	***Critical values***		
	CPI	***Wald***	***10%***	***5%***	***1%***
Brazil	-0.01	14.783**	6.187	9.168	16.212
Indonesia	0.01	9.069**	5.732	8.133	14.846
India	0.01	2.519	8.483	12.141	20.944
Türkiye	-0.01	11.891**	6.480	9.124	16.122
South Africa	-0.01	6.355***	5.270	7.967	14.396
H_0: PP is not the Granger causality of CPI (Model 6)					
Countries		***Test statistics***	***Critical values***		
	PP	***Wald***	***10%***	***5%***	***1%***
Brazil	-78.73	15.379*	5.177	7.706	14.061
Indonesia	2.40	0.415	4.984	7.514	14.770
India	-34.947	36.731*	5.137	7.472	14.308
Türkiye	-28.00	6.096***	5.201	7.716	15.064
South Africa	-15.10	0.854	5.677	8.445	16.238

*,**,***Indicate rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance, respectively

In Table 5, a negative and bidirectional causality relationship was found between PP and CPI variables in Brazil and Türkiye. A negative and unidirectional causality relationship from PP to CPI was also observed in India. Therefore, the measures to protect the farmers in these three countries have a reducing effect on inflation. As Özdemir (1989) states, policymakers apply policies to reduce production costs to prevent agricultural producers from increasing income and food price fluctuations. According to our study findings, the practices aimed at protecting farmers decrease during periods of increased inflation in both countries. In addition, negative causality from CPI to PP in South Africa and positive and unidirectional causality in Indonesia were determined. Furthermore, in South Africa's inflationary climate, farmer protection protections are being reduced. This result can be seen as the possibility that inflationary pressure will impair the effectiveness of preventive measures. In Indonesia, rising inflation exacerbates protective measures.

4. Conclusions

In this study, the causality relationships between agricultural PP and GDP, GDPC, and CPI variables in the agricultural sector were investigated using the panel bootstrap causality test developed by Kónya (2006) with the data of the Fragile Five from between 2000 and 2020. The study findings determined a bidirectional causality relationship between agricultural PP and GDP in Brazil, Türkiye, and South Africa. This relationship is negative from economic growth to agricultural PP and positive from PP to economic growth. A positive causality relationship was found from GDP to PP in Indonesia. When the relationships between PP and economic development variables are examined, there is a bidirectional causality relationship in Türkiye and South Africa. The direction of these relations is negative from economic development to PP and positive from PP to economic development. There is a positive and unidirectional causality relationship from economic development to PP in Indonesia and from PP to economic development in Brazil. Finally, a negative and bidirectional causality relationship was found between PP and CPI variables in Brazil and Türkiye. A negative and unidirectional causality relationship from PP to CPI was also observed in India. Besides, a negative and unidirectional causality relationship from CPI to PP was found in South Africa and positive in Indonesia.

There was no causal relationship found in the analytical findings between the variables other than the CPI variable of the PP variable in India. As a result, India's farmer-protection policies have little effect on inflation. Agriculture, on the other hand, is a major economic activity for India, one of the world's most densely populated countries, for a variety of reasons, including considerable employment opportunities. Despite this, India's abundance of food production legislation has a negative impact on the agriculture sector. Additionally, the State Agricultural Produce Markets Regulation prevents successful farming ventures. While agricultural price policy and related instruments have motivated farmers to adopt new technologies to increase the physical and economic access to food, they have also restricted private sector initiatives and produced a few other economic challenges (Malaisamy 2021).

Among the countries included in the model, South Africa is the one that is most susceptible to drought. This puts small-scale farmers in a difficult position, especially in the agricultural sector, which already has a weak infrastructure. For instance, in 2015, agricultural production in South Africa decreased by 8.4% due to drought and by 15% in livestock herd stock. This, of course, adversely affect farmers' agricultural outputs and incomes (Matlou et al. 2021). For this reason, farmers need assistance to alleviate the detrimental consequences of these shocks. The South African government is an important supporter of agriculture, which is seen as critical to all of these difficulties and economic development. Although governmental investments in agriculture have expanded since 2004-2005, the rate of growth has recently slowed and infrastructure spending has been prioritized (Mncina & Agholor 2021). In a study conducted in South Africa, the government's activities to support the agricultural sector, including drought period, led to an improvement in the welfare of small-scale farmers. However, it is thought that introducing these support measures only during periods of drought will not be enough for the sector's future (Matlou et al. 2021).

In the last ten years, Türkiye has continued to make necessary internal and external structural reforms to increase income level and productivity by increasing the use of sustainable natural resources with comprehensive government support and policy interventions in agriculture. Due to the fragile nature of agriculture, policies directing the producers in line with the demand of market conditions have been adopted instead of policies involving government intervention in the prices of products that adversely affect the market price formation. Although agricultural support in Türkiye has always increased based on the current prices, the increase in support has not been sustainable and has stayed below the targeted figures. The fundamental issue in Türkiye's agricultural sector is the lack of agricultural structural frameworks and the frequent changes in support policies (Demirtas 2021). Additionally, despite many beneficial improvements in the agricultural sector and subsidies, the number of farmers and agricultural lands supported by support instruments account for a small portion of the total data. At the same time, the quantity of support supplied to producers is a very small proportion of total agricultural support, raising concerns about the sustainability of agriculture in Türkiye (Yeni & Teoman 2022).

In Indonesia, policymakers follow a protective policy against producers, particularly in the agricultural sector, and the government control rice price policies and thus effectively controls domestic rice prices. These protective measures can drive the price of agricultural output much higher than the social price (shadow). Therefore, farmers get more profit. This causes agricultural production output to be cheaper overall. Indonesia's basic agricultural policy is primarily aimed at meeting domestic demand. The way in which agricultural products can be exported is through a series of regulations. In particular, there is a need to reorganize the agricultural system, strengthen agricultural technology and support an adequate institutional system as a whole. However, in this case, output prices may approach world market prices (Poernomo 2017).

As a crucial agricultural producer and exporter, Brazil provides a low level of support and protection to agriculture. Support to producers in Brazil was 2.6% of gross farm income in 2016-18. This level is well below the Organization for Economic Co-operation and Development (OECD) average. This support is 5.7% in the 2000-2002 period. Total support for agriculture, including producer support and general services, fell to 0.4% of GDP (OECD 2019).

Underdeveloped countries must import new techniques and technology from developed ones in order to achieve economic growth and development. The quantity of foreign exchange obtained from exports determines an impoverished country's ability to meet its purchases. The ability of these countries to increase their foreign exchange income depends on their competitiveness in international markets. However, each state aims to produce its food needs domestically to reduce its dependence on foreign countries. Additionally, the negative effects of the instability in the prices of agricultural products may prevent the enterprises from turning into modern agricultural enterprises, as well as hinder the development of the agricultural sector. As a result of this, a country's growth/development rate decreases or does not increase. Eliminating these negative effects on agricultural product prices forces governments to interfere in agricultural product pricing first to accelerate agricultural growth and thereafter to offer general development (Özdemir 1989).

Most farmers in developing countries are low-income, small-scale businesses. The farmers in these countries face unfair competition against agricultural products that receive high support from developed countries. This is one of the biggest obstacles to agricultural development in developing countries (Sharma & Das 2018). For this reason, developing countries need to show sufficient interest in the agricultural sector, supporting the acceleration of industrialization, economic growth, and development (Schultz 1964; Kuznets 1972).

In this context, it is necessary to increase the supportive, protective, regulatory, and stable measures for agriculture. Only in this way can the increase in capital accumulation of small-scale farmers, who are predominantly active in this group of countries, bring output efficiency, economic growth, development, and price stability.

In the databases of state institutions or international organizations, the data on agricultural support are not detailed in a way that can support academic research. Existing data, on the other hand, include cuts in both country and time dimensions. All these constraints do not allow the analysis of the effects of agricultural support on macroeconomic performance indicators for a longer period of time and for wider country groups. However, despite this limitation, this study is significant as it is an additional study to the few existing studies on the effects of agricultural support policies on macroeconomic indicators. In addition, this study sets an example for other researchers, and the potential results that could be obtained by them could encourage new studies in the field and guide policymakers. Moreover, in the analysis period of the study, a single year from 2019 to 2020 corresponds to the COVID-19 pandemic. Considering the data in the OECD database during this 1-year period, a slight decline is observed in the support applied to producers in all countries except Brazil. It is considered that this period did not have much effect on the results of the analysis part of the study. Hence, conclusions on the effects of the COVID-19 pandemic can only be made if micro-scale data are available.

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