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Do Agricultural Supports Affect Production? A Panel ARDL Analysis of Turkey

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ABSTRACT

One of the controversial issues in the trade negotiations carried out with the World Trade Organization deals with agricultural supports related to production, which is claimed to disrupt the market system by creating an imbalance in supply and demand in the domestic market and to cause world trade contraction. In this context, the aim of this study is to examine the production effect of the deficiency payments and land-based direct supports widely used in Turkey. The study conducts a panel autoregressive distributed lag analysis for 11 selected agricultural products (wheat, corn, sunflower, seed cotton, paddy, soybean, canola, safflower, tea, dried beans, and olives) for the 2002-2019 period. The findings from the study are as follows: i) Increases in deficiency payments and land-based direct supports increase short and long run production. However, land-based direct supports have less of an effect on production. ii) While increases in input prices have a negative short run effect on production, the long run effect is the opposite. iii) Agricultural product price is not an important indicator for producers. This finding can be explained by the fact that farmers accept agricultural supports as a complement to the price variable in their production decisions. iv) Increases in the minimum wage added to the model based on Turkey's structural characteristics have a negative long run impact on production. v) No statistically significant relationship exists between the number of tractors used to represent agricultural mechanization and the amount of production.

Keywords: Production effects of the agricultural supports, Decoupled payments, Deficiency payments, Land-based direct supports, Minimum wage

1. Introduction

Agricultural supports are one of the policy tools that guide production and producers as well as an important matter of contention. The distorting effect agricultural supports have on production in domestic and foreign trade in particular have caused them to be questioned globally. A certain discipline was established through the World Trade Organization (WTO) Uruguay Round, in particular with regard to agricultural supports' distorting effect on trade, thus aiming to increase transparency and predictability in international trade policy (OECD 2001).

The Agreement on Agriculture (AoA) signed at the end of the Uruguay Round significantly limited coupled payments, which directly affect production and trade and are also known as the Amber Box. Starting in 1995, developed countries agreed to cut decoupled payments in this context by 20% within 6 years, and developing countries including Turkey by 13% within 10 years. Underdeveloped countries were exempted from making any cuts. Meanwhile, WTO member countries were allowed freedom in implementing decoupled payments, supports that have little or no effect on production and trade and also known as the Green Box (WTO 2016).

Whether or not an agricultural support is allocated is directly linked to its impact on production and trade. Agricultural supports are decoupled if they have no or minimal impact on production and trade. According to the AoA, decoupled payments must compensate the following criteria.

- Support must be provided through a publicly funded government program that does not include transfers from consumers,
- The support does not have the effect of providing price support to the producers,
- Support must comply with certain criteria and measures set out in the AoA.

For example, direct payments to producers, decoupled income supports and rural development supports are decoupled payments (WTO 1994).

After the AoA, developed countries in particular started taking some serious steps with regard to coupled agricultural supports. The United States of America (USA) under the 1996 Farm Act began to implement Production Flexibility Contract (PFC) and Market Loss Assistance (MLA) supports in this context independent of current output level. The 2002 Farm Act contributed to the institutionalization of decoupled payments by introducing counter-cyclical payments (CCP) in the USA (Westcott & Young, 2004). Meanwhile, the European Union (EU) decreased market price supports under the 1992 McSharry Reforms of the Common Agricultural Policy (CAP) while increasing direct supports targeting producers' income. The Agenda 2000 CAP Reforms drew attention to environmental and market-oriented support policies (Castellano-Alvarez et al. 2021).

The transition process in agricultural supports began in the early 2000s in Turkey. Budget deficits and imbalances in the domestic market caused by the market price supports that had been implemented until that time are seen as the reason behind the economic crises Turkey has been experiencing. This is why agricultural support reforms in Turkey, unlike in other countries, are based on economic crises. In this context, Turkey has turned to land-based direct payments targeting income from production-based price supports to deficiency payments (Demirdogen & Olhan 2017). The reasons for such a policy change are to reduce the impact supports have on production and to ensure the dominance of market signals while deciding on production (Egri 2014).

Currently, the supports granted by developed countries in particular are independent of price variations due to their distorting effect on domestic and foreign trade. Variables such as income level, planted area, and constant production levels are targeted instead. However, this has been accompanied by debates on whether the supports granted by developed countries are actually decoupled. Studies have shown even supports that are claimed to be decoupled to be able to affect production. In fact, agricultural supports are one of the most controversial issues in the Doha Round, which is still taking place within the WTO (Ritcher 2015).

Turkey's agricultural support does not directly affect the price system. On the other hand, land-based direct payments are based on planted area, while deficiency payments are based on agricultural output. Theoretically, it is expected that the production effect of land-based direct payments is less than output-based supports. This is an important discussion topic for Turkey, because both support policy have an important role in Turkey's agricultural support policy. Thus, this study indicates the production effect of land-based direct payments and deficiency payments applied in Turkey.

This study uses the panel autoregressive distributed lag (ARDL) analysis as the econometric method and discusses the effect the land-based direct supports and deficiency payments implemented in Turkey between 2002 and 2019 have had on 11 products. The study is expected to contribute to the relevant literature in the following aspects: i) Comparatively analyzing the degree to which deficiency payments and land-based direct supports are decoupled is an important innovation, because the level to which both supports are decoupled has great importance for production policies and WTO negotiations. ii) Econometrically analyzing the production effect of deficiency payments and land-based direct supports to cover a wide product group for Turkey in general is an important distinction in the study. iii) This first use of the panel ARDL method, which provides consistent and robust short and long run results even in with a limited number of the observations is an important innovation for the literature. iv) The effects minimum wage and agricultural mechanization have on agricultural production has also been shown by taking into account Turkey's unique situation.

2. Material and Methods

2.1. Agricultural supports in Turkey and literature review

Minimum price policies have been the main theme of agricultural support policies implemented up to the 2000's. Minimum price policies were first started with wheat in 1932, with the number of supported products increasing to 26 by 1992. However, the excess supply and financing problem created by minimum price policies led to the need for transformations in agricultural supports (Cakmak et al. 1999). As a matter of fact, at the beginning of 2000, land-based direct supports and deficiency payments began widely being used (Yuceer et al. 2020).

Direct supports are income payment made to producers without establishing a direct relationship between production amount and payment. Because the state does not intervene directly in prices, the market mechanism determines prices (Yukseler 1999). Direct supports are one of the least costly economic support tools because they have a minimal impact on production (Winters 1988).

Deficiency payments are a support policy tool used to bring prices to a reasonable level when the cost of production exceeds the market price. In deficiency payments, the prices consumers pay are not interfered with. Therefore, cost problems such as storage and product disposal are eliminated through the subsidy's market-distorting effect (Cakmak et al. 1998). In addition, while deficiency payments are given directly according to the production amount of a particular product, the land-based direct payments are paid according to planted area. Theoretically, payments based on output affect production more than supports based on planted area (OECD 2005).

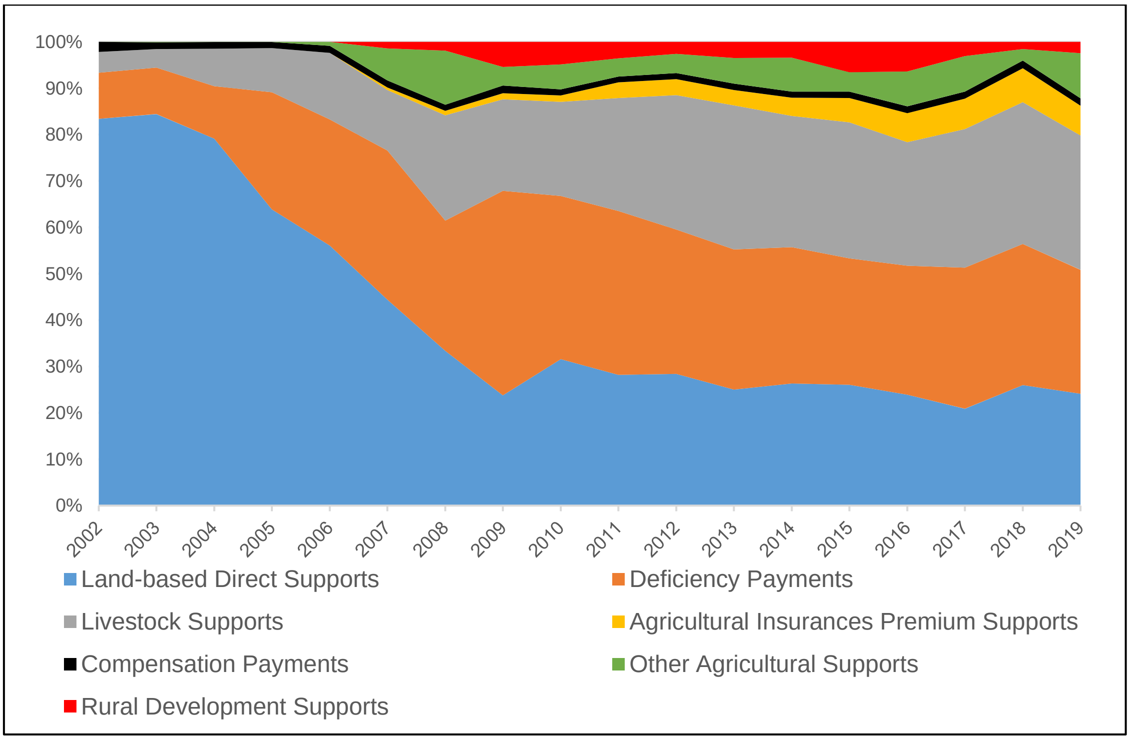
One of the objectives of the agricultural supports is to ensure continuity in the agricultural production. As a matter of fact, concerns about food safety that came to the fore with the COVID-19 pandemic, the increase in food prices and the breaking of the link between agricultural inputs and outputs brought sustainability in agricultural production back to the world agenda (Arumugam et al. 2021). Thus, the agricultural supports are still an important policy tool. In this context, Table 1 shows the quality and quantity of agricultural supports provided in Turkey between 2002 and 2019.

Table 1- Agricultural Supports Provided in Turkey (in millions of TL)

Years	*Agricultural Support Type*							
	Land-based Direct Supports	*Deficiency Payments*	*Livestock Supports*	*Agricultural Insurances Premium Supports*	*Compensation Payments*	*Other Agricultural Supports*	*Rural Development Supports*	*Total*
2002	1 558	186	83	0	41	0	0	1 868
2003	2 253	268	106	0	39	3	0	2 669
2004	2 443	350	249	0	44	1	0	3 087
2005	2 352	928	352	0	47	2	0	3 681
2006	2 661	1 290	678	2	72	40	0	4 743
2007	2 461	1 782	722	31	84	382	79	5 541
2008	1 953	1 646	1 330	55	80	683	109	5 856
2009	1 078	2 002	895	59	76	181	246	4 537
2010	1 858	2 071	1 192	80	76	320	284	5 881
2011	1 996	2 503	1 727	239	90	280	249	7 084
2012	2 166	2 378	2 216	263	98	319	195	7 635
2013	2 189	2 642	2 721	290	120	479	307	8 748
2014	2 406	2 690	2 589	357	122	666	312	9 142
2015	2 605	2 726	2 935	528	139	415	655	10 003
2016	2 694	3 128	3 002	704	168	845	718	11 259
2017	2 696	3 927	3 847	853	197	986	393	12 899
2018	3 747	4 391	4 403	1 060	239	362	219	14 421
2019	4 157	4 602	4 993	1 104	271	1 671	424	17 222

Source: Republic of Turkey, Ministry of Agriculture and Forestry

As can be seen in Table 1, the total amount of agricultural supports in 2019 was 17.2 billion TL, of which 4.1 billion TL was for land-based direct supports, 4.6 billion TL for deficiency payments, and 4.9 billion TL for livestock supports. Figure 1 shows the proportional distribution and change in agricultural supports provided in Turkey between 2002 and 2019. The percentage of land-based direct payments, deficiency payments and livestock supports have of the total support in 2019 was 24.1%, 26.7%, and 30.1%, respectively.



Source: Republic of Turkey Ministry of Agriculture and Forestry

Figure 1- Agricultural Supports Provided in Turkey (%)

Turkey, especially in the recent years, increased agricultural supports to a great extent. According to OECD data, Turkey is the country granting the most agricultural support compared to GDP among the OECD countries. This ratio was approximately 1.5% for the 2019. This situation brings the production effect of the agricultural supports to the agenda given by Turkey (Bayraktar & Bulut 2016).

Early studies on the effect of agricultural supports and the limitation of this effect go all the way back to the end of the Second World War, when there was surplus supply. For instance, in order to limit the effect agricultural supports have on production, Nicholls & Gale (1946) proposed that agricultural supports be made according to a fixed production level. Swerling (1959) stated that supports can be given with respect to producer income. Nash (1961) proposed an unconditional income-based payment. Meanwhile, Van Donkersgoed (1988) stated that providing supports for rural development purposes would limit the production effect.

Although Organization for Economic Co-operation and Development (OECD) Committee of Ministers officially attempted first steps for distorting effect of agricultural supports on international trade in 1987, WTO regulated agricultural supports with the AoA in 1994 (OECD 1998). In the AoA, agricultural supports with the lowest production impacts were considered independent of production, and member states could freely provide these supports. However, this situation was accompanied by research on the effect these newly applied supports had on production.

Hennessy (1998) claimed that decoupled payments cannot be fully decoupled even if they are not related to production. According to Hennessy, decoupled payments can raise production through taking more risk by farmers with the increase in income (wealth effect) and reducing uncertainty in the income (insurance effect). If decoupled payments change the slope of the supply curve, demand shocks can increase output. This definition is called effectively decoupled (Cahill 1997) and also accepted by the OECD (2000).

In the following period, developed countries took crucial steps regarding decoupled payments. For example, Adams et al. (2001) investigated the production effect PFC and MLA supports had for 8 products in the USA. According to the analysis, a 1 unit increase in PFC and MLA supports increases planted areas by 0.026 acre. The effect of product price and agricultural credits on the planted area was statistically insignificant. Frandsen et al. (2003) made a projection for the EU covering 1997-2013 and found wheat production would decrease by 6.9%, grain production by 5.6% and oilseed production by 8.9% if internal support was eliminated. Anton & Mouel (2004) investigated the production effect of CCP and loan deficiency payments for the USA and pointed out that both payments increased production. Beckman & Wailes (2005) examined the effect direct supports and CCP have on rice production in the USA. Their results showed direct supports to be decoupled. Goodwin & Mishra (2005) surveyed 4 125 farmers to investigate the effect of direct payments and CCP on corn, wheat and soybeans. While 21% of the farmers stated that direct payments affect their production decision, 12.3% of farmers pointed out that CCP affects their production decision. Goodwin & Mishra (2006) investigated the effect Agricultural Market Transition Act (AMTA) and MLA supports provided between 1998-2001 in the USA. The results from that study showed a one-dollar increase in AMTA supports to increase the planted area of corn by 0.92 acres, of soybean by 0.61 acres, and of wheat by 0.36 acres; only the results for wheat were statistically insignificant. Each dollar per acre increase in MLA payments was statistically significant for corn, increasing its planted area by 5.7 acres; these increases were insignificant for soybeans and wheat. Katranidis & Kotakou (2008) investigated the impact the reforms in the EU, CAP had on Greece's cotton production for 1994-2002. Their study's findings showed the production effect of decoupled payments to be low. Key & Roberts (2008) calculated that for each 1% increase in decoupled supports, the planted area of eight agricultural product increased between 0.014% and 0.027 %. According to the findings from O'Donoghue & Whitaker (2010), who analyzed 11 agricultural products in the USA, direct supports increase planted area by 9%-16%. Weber & Key (2012) calculated the effect direct supports given to 10 agricultural products in the USA have on the amount of production and planted area for 1997, 2002, and 2007. Accordingly, 1% increase in direct supports increases country-wide production by 0.20% and planted area by 0.19% acre. When the same analysis was made for the Heartland Region, 1% increase in direct support was found to increase production by 0.29% and planted area by 0.27% acre. Becker & Judge (2014) examined rice production in Arkansas, Mississippi, and the Gulf Coast in the USA. Their findings show that for each 1% increase in direct supports, rice planted areas had increased by 0.19%, 0.08% and 0.092% for each respective region, as well as a 1% increase in conjuncture supports to increase production by 0.046%, 0.040% and 0.028%, also respectively. Haß (2021) simulated the effects of the coupled and decoupled payments given to sugar beet in the EU. Accordingly, the simulated increase in sugar production of EU countries providing coupled support raised totals 258 000 tonnes of sugar (5.7%), while sugar production in EU countries without coupled payments declined by only 21 000 tonnes (0.2%).

However, similar studies have been conducted in Turkey on the production effect of agricultural supports. For instance, Aktas et al. (2015) calculated the effect of market price supports and input supports for 12 countries using OECD data for 1995-2010. Their study's findings showed a 1% increase in both support types to increase this ratio by 0.005%; only the result for Turkey was negative. Demirdogen et al. (2016) investigated the effect deficiency payments and input supports had on corn and cotton production in Turkey's Ceyhan and Yuregir regions of Adana Province for 2008-2012. Their findings show input support to be more effective on production compared to deficiency payments. Yildiz (2017) examined the effect agricultural supports made from the Turkey central government budget had on agricultural production for 2006-2016 using quarterly data. As a result of the causality analysis, a long run correlation was found between agricultural supports and the level of agricultural production. Dogan et al. (2018) examined the effect deficiency payments had on the planted areas of wheat, barley, and corn. The causality analysis using data from 1994-2016 showed deficiency payments to affect the planted areas of barley and maize but not wheat. Canbay (2021), who investigated production effect of agricultural supports between 1995 and 2018 in Turkey, found a statistically significant and positive relationship between agricultural supports and production in the short and long run. On the other hand, Erdal et al. (2021) and Erdal et al. (2020) showed that agricultural supports have effect not only on crop production but also on livestock existence.

The literature shows that, despite the qualitative transformations, agricultural supports are an important variable affecting production. This study, unlike previous ones, aims to fill an important gap in the literature by concentrating on the decoupled degree of deficiency payments and land-based direct supports for the first time. In addition, the use of Panel ARDL, which provides consistent and robust results in the short and long run even in situations where the number of observations is limited due to frequent policy changes, will bring a different methodological perspective to the literature. Finally, the relationship between minimum wage, agricultural mechanization and agricultural production is explained by taking into account the unique situation of Turkey for the first time.

3. Data, Model and Methodology

3.1 Data and model

This study examines the production effect of deficiency payment supports and land-based agricultural supports. The latter has the highest percentage of total supports at 65%; 33% of the remaining supports are livestock, and approximately 3% are rural development supports. The study examines supports over 11 agricultural products: wheat, corn, sunflower, seed cotton, paddy, soybean, canola, safflower, tea, dried beans, and olives. The period under review is 2002-2019, when land-based direct supports and deficiency payments had mainly been used. The study uses annual and nominal data. The reason for using nominal data is the expectation that farmers will act by looking at nominal data.

The data for the variables of number of tractors (representing production amount), product price, diesel price, and agricultural mechanization have been obtained from the Turkish Statistical Institute (TurkStat), support amount data from the Ministry of Agriculture and Forestry, fertilizer price data from the Agricultural Credit Cooperatives of Turkey and minimum wage data from the Ministry of Labour and Social Security.

Two different models have been created to measure the production effect of agricultural supports. The first model is shown in Equation (1):

$$PR_{it1} = \beta_0 + \beta_1 DefPay_{it} + \beta_2 DirSup_{it} - \beta_3 Fuel_{P_{it}} - \beta_4 Fer_{P_{it}} + \beta_5 P_{it} + \varepsilon_{it} \tag{1}$$

Where; *PR* is the dependent variable of the model showing the annual production amount. The independent variables are *DefPay* (deficiency payment supports), *DirSup* (land-based direct supports), *Fuel* (fuel price), *Fer* (fertilizer price), and *P* (price of the relevant product). In determining the variables, studies of Weber & Key (2012), Goodwin & Mishra (2006), Goodwin & Mishra (2005) and Adams et al. (2001) were benefited.

Considering Turkey's unique situation, the variables of *MinSal* (minimum wage) and *Mech* (agricultural mechanization), which are considered to be effective on agricultural production, were then added to the first model to create the second model shown in Equation (2):

$$PR_{it,2} = \beta_0 + \beta_1 DefPay_{it} + \beta_2 DirSup_{it} - \beta_3 Fuel_{P_{it}} - \beta_4 Fer_{P_{it}} + \beta_5 P_{it} - \beta_6 Min_{Sal_{it}} + \beta_7 Mech_{it} + \varepsilon_{it} \quad (2)$$

Where: ε_{it} ; in both models shows the independently distributed error term for all time periods.

While deficiency payments are given on the production level of a specific product, direct payments are paid according to land where any product is planted. Deficiency payments and direct payments are expected to affect the production positively. Therefore, the β_1 and β_2 coefficient signs are shown as positive. However, deficiency payments are expected to affect production more than direct supports because deficiency payments aim directly at the output while direct payments aim at the planted area. β_3, β_4 and β_6 coefficient signs are expressed as negative, since increase in input prices, which causes an increase in production costs, is expected to adversely affect production. β_5 coefficient sign is shown as positive, since theoretically, increases in product prices are expected to encourage production. β_7 coefficient sign is positive since the agricultural mechanization variable is expected to positively affect production through increase in agricultural productivity.

3.2. Methodology

In agricultural production, previous year prices are an important factor for producers. Therefore, Panel ARDL analysis which is a dynamic model including lagged values of the variables is preferred. Panel ARDL analysis also allows to the separation short and long run effect of independent variables on the dependent variable (Pesaran et al. 1999). In other words, Panel ARDL analysis offers important opportunities to display short and long run results of the variables that are effective in agricultural production. Panel ARDL analysis also presents robust results even when the number of observations is limited. Another reason for choosing Panel ARDL analysis is the limited number of observations in the study. In addition, in the Panel ARDL analysis, it is not necessary for the variables to be stationary at the same level, provided that they do not exceed second degree differentiations (Pesaran et al. 1999). All these reasons demonstrate that Panel ARDL Analysis is a suitable method for this study.

Firstly, horizontal cross-section dependency was tested. In case the shocks affect all cross-section units, parameter estimations that don't take into consideration the presence of inter-unit correlations become biased and inconsistent (Pesaran 2004). The Breusch & Pagan Lagrange multiplier test (LM test), which is used to determine whether a cross-sectional dependence exists between units, tests the basic hypothesis of no correlation between units (Baltagi et al. 2012). The Pesaran cross-section dependence (CD) test is recommended as an alternative to the LM test to determine the presence of inter-unit dependence in cases where the cross-section size is smaller than the number of observations ($T < N$). The Pesaran CD test is calculated as shown in Equation (3) (Pesaran 2004).

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \quad (3)$$

In case of cross-section dependency, second generation unit root tests are applied. In this context, a different method was developed by Pesaran (2007) to eliminate the correlation between units. In this method, the cross-sectional mean of the lagged value and first difference of the series for each unit is added to the Dickey Fuller (DF) or augmented Dickey Fuller (ADF) regression equation. The cross-sectional augmented Dickey Fuller (CADF) regression equation can be represented as follows:

$$\Delta Y_{it} = \alpha_i + \rho_i \bar{Y}_{i,t-1} + d_0 \bar{Y}_{t-1} + d_1 \Delta \bar{Y}_t + \mu_{it} \quad (4)$$

In the CADF test, the unit root test statistics (CIPS) that are valid for the entire panel are calculated after calculating the individual unit root parameters for each cross-section. The calculation method of CIPS is shown in Equation (5):

$$CIPS\ (N,T) = \underline{\tau} = 1/N \sum_{i=1}^{N} \bar{\tau}\,(N,T) \quad (5)$$

In addition, the *P* statistic as calculated by Maddala & Wu (1999) and the *T* statistical value for the entire panel can be calculated as shown in Equation (6):

$$P(N,T) = -2 \sum_{i=1}^{N} ln\,(\rho_{iT})$$

Making stationarity by addressing a difference causes the long run relations among series to weaken. Cointegration analysis assumes a stationary linear combination of non-stationary series to be possible even if the series are not stationary (Wooldridge 2012).

The Pedroni cointegration test allows diversification and heterogeneity of the cointegration vector for the explanatory variables. In addition, Pedroni presented seven cointegration tests in order to show the effects within and among groups in the panel data (Pedroni 1999).

While no cointegration exists for any cross sections in the null hypothesis of the Pedroni cointegration test, a cointegration relationship is present in the alternative hypothesis. In the Kao cointegration test handles the DF and ADF tests have been handled in two ways. DF type tests can be calculated from their estimated residues as shown in Equation (7) (Baltagi & Kao 2001).

$$y_{it} = \alpha_i + \beta x_{it} + e_{it} \quad (7)$$
$$y_{it} = y_{it-1} + u_{it}$$
$$x_{it} = x_{it-1} + \varepsilon_{it}$$

In tests used to analyze the long run relationship among series, all series should be stationary at the same level. Therefore, Pesaran & Shin (1999) and Pesaran et al. (2001) developed the panel ARDL approach, which allows the cointegration test to be applied to series at varying degrees of integration.

Pesaran et al. (2001) proposed a boundary test with two stages. The first stage investigates whether long run relationships exist among the variables in the model. In the second stage, the error correction model provides the short run equation among variables and is estimated using Pesaran & Shin's (1999) panel ARDL method with the error terms obtained from the long run equation of the model.

When the series are stationary at different levels, the panel ARDL (p, q_1, q_2,…,q_n) model to be estimated is shown in Equation (8) under the assumption that the number of units is I = 1, 2, …, N with time period t =1, 2, …, T (Pesaran et al. 1999):

$$y_{it} = \sum_{J=1}^{p} \lambda_{ij}\, y_{i,t-j} + \sum_{J=0}^{q} \delta'_{ij}\, x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (8)$$

Equation (9) is reached when the time series observations for each group are aggregated.

$$\Delta y_i = \phi_i y_{i,t-1} + X_i\beta_i + \sum_{J=1}^{p-1} \lambda^*_{ij}\, \Delta y_{i,t-j} + \sum_{J=0}^{q-1} \Delta X_{i,-j}\delta^{*\prime}_{ij} + \mu_i \iota + \varepsilon_{it} \quad (9)$$
$$y_i = (y_{i1}, y_{i2}, \dots, y_{iT})'$$

Where: i = 1, 2, …, N, i. is the Tx1 vector of the group's observations on the dependent variable and $X_i = (x_{i1}, x_{i2}, \dots, x_{iT})'$ is the bit Txk matrix of the observations varying between units and time periods.

Panel ARDL analyses use the mean group (MG) estimation method developed by Pesaran & Smith (1995), the pooled mean group (PMG) estimation method developed by Pesaran et al. (1999), and the dynamic fixed effects (DFE) estimator to estimate the long run coefficients of the model. Which methods will be used is decided by the Hausman test. The Hausman test is based on the consistency, efficiency, and accuracy of the results when selecting among the estimators (Samargandi et al. 2015).

4. Empirical Findings

Firstly, regarding the presence of correlations between the units that make up the panel, the cross-section dependency test was performed first, and the results are shown in Table 2.

Table 2- Results of the Cross-Section Dependency Tests

Variables	*Cross-Section Dependency Tests*ᶧ							
	Breusch-Pegan LM		***Pesaran Scaled LM***		***Bias-Corrected Scaled LM***		***Pesaran CD***	
	Stat.	***Prob.***	***Stat.***	***Prob.***	***Stat.***	***Prob.***	***Stat.***	***Prob.***
PR	293.8436	0.0000*	22.77284	0.0000*	22.42909	0.0000*	13.41372	0.0000*
Def_Pay	549.8977	0.0000*	47.18664	0.0000*	46.84289	0.0000*	22.82688	0.0000*
P	816.6761	0.0000*	72.62297	0.0000*	72.27922	0.0000*	28.54858	0.0000*

ᶧSignificance levels are denoted as follows: *; 1%, **; 5%, ***; 10%

According to the findings, the null hypothesis stating that the variables do not include cross-sectional dependence has been rejected at the 1% significance level. For this reason, second-generation unit root tests should be applied to the variables containing cross-sectional dependence.

Table 3 shows the results from the second-generation unit root test. According to the findings, while PR_{it} is stationary at the level, the first-order differences for $DirSup_{it}$ and P_{it} are stationary. In the next step, both models were analyzed with the Pedroni and Kao cointegration tests to examine whether the variables are cointegrated**.** Table 4 presents the results from the cointegration tests for both models.

Table 3- Results of the Second-Generation Unit Root Tests

Variables	***Lag***	***Maddala and Wu*** ⸸				***Peseran*** ⸸ ***(CIPS)***			
		Trend excluded		***Trend included***		***Trend excluded***		***Trend included***	
		χ^2	***Prob.***	χ^2	***Prob.***	***Zt-bar***	***Prob.***	***Zt-bar***	***Prob.***
PR	0	34.944	0.039**	65.725	0.000*	-2.140	0.016	-1.439	0.075***
	1	34.645	0.042**	41.363	0.007*	-2.958	0.002*	-2.918	0.002*
Def_Pay	0	13.787	0.909	28.871	0.149	-1.554	0.060***	0.541	0.706
	1	23.949	0.350	14.487	0.883	0.867	0.807	3.843	1.000
P	0	0.455	1.000	9.433	0.991	-0.477	0.317	1.039	0.851
	1	0.268	1.000	15.669	0.832	-0.641	0.261	0.751	0.774
Primary Differences									
PR	0	260.516	0.000*	212.946	0.000*	-6.155	0.000*	-5.231	0.000*
	1	63.129	0.000*	36.376	0.028**	-4.102	0.000*	-2.386	0.009*
Def_Pay	0	254.070	0.000*	284.375	0.000*	-8.954	0.000*	-9.206	0.000*
	1	62.391	0.000*	54.581	0.000*	-0.715	0.237	-0.859	0.195
P	0	96.699	0.000*	83.387	0.000*	-5.162	0.000*	-3.608	0.000*
	1	60.433	0.000*	53.241	0.000*	-1.031	0.151	0.779	0.782

⸸The significance levels are denoted as follows: *; 1%, **; 5%, ***; 10%

Table 4- Results of the Cointegration Tests

Model 1 ⸸	***Stat.***	***Prob.***	***Weighted Stat.***	***Prob.***
Panel-v Statistic	-1.457243	0.9275	-2.317253	0.9898
Panel-rho Statistic	2.129174	0.9834	3.322190	0.9996
Panel-PP Statistic	-5.034373	0.0000*	-2.829790	0.0023*
Panel-ADF Statistic	-4.310517	0.0000*	-1.999547	0.0228
Between-dimensions				
Group -rho Statistic	4.159058	1.0000	-	-
Group-PP Statistic	-5.290071	0.0000*	-	-
Group-ADF Statistic	-3.016186	0.0013*	-	-
Model 2⸸	**Stat.**	**Prob.**	**Weighted Stat.**	**Prob.**
Panel-v Statistic	-2.769146	0.9972	-3.308102	0.9995
Panel-rho Statistic	2.922129	0.9983	3.641252	0.9999
Panel-PP Statistic	-4.106087	0.0000*	-3.861696	0.0001*
Panel-ADF Statistic	-4.377019	0.0000*	-3.648529	0.0001*
Between-dimensions				
Group -rho Statistic	4.613099	1.0000	-	-
Group-PP Statistic	-4.200117	0.0000*	-	-
Group-ADF Statistic	-3.419192	0.0003*	-	-

The significance levels are denoted as follows: *1%, **5%, ***10%.

According to the Pedroni cointegration results from Table 4, the null hypothesis H_0, which states no cointegration to exist among the series, is rejected. When examining the group statistics, those apart from the group-rho statistic are seen to be significant at the 1% level. After Pedroni Cointegration test, Kao cointegration test was used and results are presented in Table 5.

Table 5- Results of the Kao Cointegration Test

Model 1⸸	ADF	**t-Stat.**	**Prob.**
		-2.843520	0.0022*
	Residual Variance	0.603933	
	HAC Variance	0.422462	
Model 2⸸	ADF	t-Stat.	Prob.
		-3.102577	0.0010*
	Residual Variance	0.603174	
	HAC Variance	0.410215	

⸸The significance levels are denoted as follows: *1%, **5%, ***10%.

The Pedroni and Kao cointegration tests in Tables 4 and 5 show the presence of a cointegration relationship among the series at the 1% significance level for both models.

Table 6 shows the results from the Hausman test performed for deciding which of the PMG, MG, and DFE estimators estimated by the panel ARDL are the most effective.

Table 6- Results of the Hausman Test

Variables	*Coefficients*		*(b-B)*	*St. Error*
	(b)	*(B)*		
	MG	*PMG*	*Difference*	
Model 1				
Def_Pay	-0.0439904	0.1091276	-0.153118	0.509349
Dir_Sup	0.381128	0.1779722	0.2031558	1.08979
Fuel_P	-0.5833855	0.2106551	-0.7940406	2.280452
Fer_P	0.7148702	0.4243131	0.2905571	1.101366
P	0.1605679	0.1131583	0.0474096	1.504058
Model 2				
Def_Pay	-5.504829	0.16895	-5.673779	1.71e+20
Dir_Sup	3.377491	0.221532	-3.599023	1.38e+20
Fuel_P	11.75163	0.4125583	11.33907	3.60e+20
Fer_P	-2.938338	0.6282212	-3.566559	1.19e+20
P	-18.12046	0.1286967	-18.24915	5.12e+20
Mech	5.570274	-0.1823304	5.752604	2.12e+20
Min_Sal	11.04657	-0.3466583	11.39322	2.81e+20

The obtained results indicate that the PMG estimator has the most efficient estimators. In this context, the Panel ARDL results of both models are given in Table 7.

Table 7- PMG Panel ARDL Regression Results

Variables	*First Model*[ɫ]				*Second Model*[ɫ]			
	Long run estimation				*Long run estimation*			
	Coef.	*St. Error*	*t-Stat.*	*Prob.*	*Coef.*	*St. Error*	*t-Stat.*	*Prob.*
Def_Pay	0.177972	0.070267	2.532.811	0.0128**	0.221532	0.076092	2.911.371	0.0046*
Dir_Sup	0.109128	0.049123	2.221.499	0.0285**	0.168950	0.056509	2.989.802	0.0037*
Fuel_P	0.210655	0.101463	2.076.186	0.0403**	0.412558	0.128950	3.199.375	0.0020*
Fer_P	0.424313	0.133224	3.184.953	0.0019*	0.628221	0.166196	3.779.993	0.0003*
P	0.113158	0.102582	1.103.104	0.2725	0.128697	0.108987	1.180.841	0.2411
Mech	-	-	-	-	-0.182330	0.205195	-0.888571	0.3769
Min_Sal	-	-	-	-	-0.346658	0.180746	-1.917.936	0.058***
Variables	**Short run estimation**				**Short run estimation**			
Cointeq01	-0.720429	0.135497	-5316944	0.0000*	-0.732724	0.152099	-4817411	0.0000*
D(Def_Pay)	0.288277	0.174398	1.652.988	0.1013	0.281516	0.170280	1653256	0.1021
D(Dir_Sup)	0.178551	0.068923	2.590.600	0.0109**	0.209458	0.069593	3009736	0.0035*
D(Fuel_P)	-0.276946	0.142532	-1.943.051	0.0547***	-0.238423	0.144505	-1649924	0.1028
D(Fer_P)	-0.044743	0.193255	-0.231521	0.8174	-0.261590	0.161843	-1616314	0.1099
D(P)	-0.537364	0.436143	-1.232.081	0.2207	-0.259699	0.376227	-0.690271	0.4920
C	0.090427	0.077410	1.168.152	0.2454	-	-	-	-
D(Mech)	-	-	-	-	-0.469318	0.318651	-1.472.830	0.1447
D(Min_Sal)	-	-	-	-	-0.327104	0.227534	-1.437.606	0.1544
C	-	-	-	-	0.204048	0.102370	1.993.247	0.0496**

Note: The maximum length of lag is 1; [ɫ]The significance levels are denoted as follows: *1%, **5%, ***10%.

The error correction coefficients in the equations of Models 1 and 2 are respectively -0.72 and -0.73 and are significant with an error margin of 1%. This result means that 72% of the short run imbalances in the first model and 73% in the second model are eliminated over the long run.

According to the results, the findings from both models are similar. This is important in terms of showing that the findings from both models are robust and consistent. Production effect of the both kinds of supports is positive in the short and long run in line with expectations. According to Model 1, a 1% increase in deficiency payments increases production by 0.28% in the short run and by 0.17% in the long run. A 1% increase in land-based direct supports increases production by 0.17% in the short run and 0.10% in the long run. According to the results from Model 2, while a 1% increase in deficiency payments increases production by 0.28% in the short run, it increases by 0.22% in the long run. A 1% increase in land-based direct supports increases production by 0.20% in the short run and 0.16% in the long run. In the short run, the results are statistically significant, considering that the probability values of deficiency payments in both models are slightly above 10%. The results confirm the hypothesis that deficiency payments and land-based direct supports affect the production.

The results for fuel and fertilizer, which are used as input items, are similar for both models. Accordingly, while the coefficients are negative in the short run, they become positive in the long run. However, the short run results for the variable of fertilizer in Model 1 are statistically insignificant. The findings show that the increase in input prices negatively affects production in the short run, but this trend is reversed over the long run. The findings show that the expectations regarding increase in the production costs are not valid especially in the long run.

In addition, the variable of price, which has negative coefficients in the short run and positive in the long run, is statistically insignificant in both models. In other words, the hypothesis that increases in product prices raise production is rejected.

While the effect of minimum wage on agricultural production in Model 2 is statistically insignificant in the short run, it is negative and significant with a 10% probability in the long run. Accordingly, a 1% increase in minimum wage reduces agricultural production by 0.34% in the long run. The results reflect the expectation that increases in the minimum wage affect production negatively, especially in the long run.

Representing agricultural mechanization, the effect of the number of tractors on production as used in Model 2 is found to be statistically insignificant for both the short and long run. According to the results, the hypothesis that agricultural mechanization affect production positively is rejected.

5. Conclusions and Policy Advice

One of the ways to limit the distorting effect of agricultural supports in domestic and foreign markets is to separate production and supports. As a matter of fact, as a result of the commitments made to the WTO, developed countries in particular have given weight to decoupled payments. However, Turkey has switched from price supports to direct and deficiency payment supports in the early 2000's. This study has analyzed the effect of deficiency payments and land-based direct supports on 11 agricultural products using the Panel ARDL method with annual data from 2002-2019. The study's findings and policy recommendations based on these findings are as follows:

i) Land-based direct supports and deficiency payments implemented in Turkey affect the production. As a matter of fact, even if agricultural supports are decoupled, a great majority of the studies on the production effect of the agricultural supports confirm these findings. To give an example, O'Donoghue & Whitaker (2010), Weber & Key (2012), Becker & Judge (2014), Yildiz (2017), Canbay (2021), Erdal et al. (2021) and Erdal et al. (2020) suggested that the agricultural supports affect production positively. Especially, Katranidis & Kotakou (2008) and Haß (2021) concluded that production effects of coupled payments are more than decoupled payments. Demirdogen et al. (2016) and Aktas et al. (2015) found a very small effect between agricultural production and supports. However, Beckman & Wailes (2005), Goodwin & Mishra (2006) for soybeans and wheat and Dogan et al. (2018) for wheat did not find any significant correlations between the supports and the agricultural production. In fact, the vast majority of studies are regarding direct payments that do not depend on the current output level. However, the results indicates that direct payments affect production. These findings indicate that direct payments are not decoupled. Findings for Turkey indicate that deficiency payments and land-based direct payments increase agricultural production. This is an expected result for Turkey, because deficiency payments depend on output while land-based direct payments depend on production. Therefore, both supports can be used as a policy tool to direct production. However, the positive production effect of supports may pose a disadvantage for Turkey and especially other developed countries in its negotiations carried out with the WTO.

ii) Short and long run effects of the deficiency payments have a greater effect on production than land-based direct supports. In other words, land-based direct supports are more decoupled than deficiency payments because land-based direct supports are paid per acre regardless of what is produced. Indeed, Beckman & Wailes (2005) and OECD (2005) pointed out that land-based direct supports had less production effect compared with output based payments. Also, Haß (2021) found that decoupled payments affect production less. On the other hand, Demirdogen et al. (2016) indicate that the production effects of the deficiency payments are less than input supports while Aktas et al. (2015) concluded that there are negative relationship between market price supports, input supports and agricultural production.

In contrast with these studies, Dogan et al. (2018) did not find any relationship between deficiency payments and wheat production. There can be several reasons why the production effect of deficiency payments are low or insignificant. Methodological differences, such as focusing on one region or agricultural product, limit overall effects of the deficiency payments. In particular, the substitution of products for which the difference payment is paid, limits the results of product-based studies. As a matter of fact, when the deficiency payments are evaluated as a whole, deficiency payments increase production in the short and long run. This being the case, the most effective policy tool in terms of production policy is the deficiency payments. However, output-based supports such as the deficiency payment support is also an important matter of contention for the WTO.

iii) While the increase in input prices affects production negatively in the short run, it has a positive impact over the long run in Turkey. Suh & Moss (2021), Komarek et al. (2017) and Srivastava (2017) concluded that input prices affect agricultural production negatively. On the other hand, Taylor & Koo (2008) emphasized that producers respond to the high input and commodity prices by increasing supply for compensating decrease in farm income. In Turkey, these findings can be explained by the fact that farmers, whose production and income decreased in the short run, increased their production in the long run to compensate for the decrease in their incomes. Various policy measures from tax benefits to supports can be implemented to avoid the negative impact these increases have on input prices.

iv) The relationship between product prices and production is statistically insignificant. Xie & Wang (2017) and Borawska et al. (2021) conducted that agricultural product prices are an important indicator for production, whereas Goodwin & Mishra (2006) and Adams et al. (2001) could not reach a statistically significant relationship between agricultural product prices and production. As a consequence of researches, it can be said that relationship between product price and production level differs from each other according to structural characteristics of the countries. For example, farmers in Turkey can prefer produce more in order to compensate for the decrease in their income. Since agricultural enterprises in Turkey are mostly small-scale family businesses, their income sources are largely dependent on agricultural production. Under such a circumstance, farmers avoid risky attitude by acting according to agricultural supports instead of taking risks by looking at price level in production decisions. Also, disruptions of relative prices of the agricultural products, producers' future expectations regarding product prices and farmers' production habits may also cause distorting effects in the production decisions. These results indicate that agricultural supports, as a variable, play more significant role than product prices in production decision. However, the findings on the production effect of price are not consistent with theory and the results are different in the literature, so more studies on the production effect of product price are needed.

v) Considering Turkey's unique situation, minimum wage variable was added to the model. The long run results from the variable of minimum wage are negative and statistically significant. This situation can be explained by the fact that producers turn to sectors other than agricultural when the minimum wage rises. Again, this situation can be seen as one of the reasons explaining the decreasing trend of agricultural employment in Turkey over the years. Therefore, the minimum wage policy is important not only for workers and employers but also for the agricultural sector and agricultural policy.

vi) Considering Turkey's unique situation, the agricultural mechanization variable was added to the model. The relationship between the number of tractors, which has been used to represent agricultural mechanization and agricultural production is statistically insignificant. The results show that Turkey has reached the saturation point in terms of number of tractors and thus the law of diminishing returns is valid. In fact, Tokgoz (2018) pointed out a similar situation in Turkey in the 1950-1960 periods. During this decade, Turkey started to implement liberal economic policies and number of imported tractor increased significantly. The increasing number of tractors had a positive impact on agricultural production until the mid-1950s. However, in the late of 1950s, current account deficit and spare parts supply problems caused an adverse change. Using the number of tractors to represent agricultural mechanization in the model may also mean that the production effect of the number of tractors is sufficiently utilized as a result of the investments and incentives made in this field. For this reason, incentives should be determined by looking at the positive production effects obtained from agricultural machinery of varying quality and technologies in order to increase agricultural production and productivity.

As a result, the production effect of deficiency payments applied in Turkey is higher than land-based direct supports. At this point, the issue that the uncertainty in the agricultural incentive policy can affect the production decisions by guiding producers toward risky behaviours stands out as a subject worth investigating in terms of guiding policymakers.

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