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Impact of Diesel and Electricity Price Reforms on Agricultural Gross Domestic Product in Saudi Arabia

Suudi Arabistan'da Dizel ve Elektrik Fiyat Reformlarının Tarımsal Gayri Safı Yurt İçi Hasıla Üzerindeki Etkisi

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Abstract: This study aimed to assess and forecast the effect of energy price reform of diesel and electricity on Saudi agricultural Gross Domestic Product (GDP). The study applied simultaneous equations model (SEM) consisting of four behavioral equations in the logarithmic formula, using the three stages least squared method (3SLS) based on time series data during the period 2000-2018, using EViews software. The estimated SEM were used for forecasting until 2025 using different scenarios. The results of the augmented Dicky Fuller test show that the variables are differenced stationary, that are needed because the applied (3SLS) least squares method assumes the stationarity of the analyzed time series. The results of the estimated SEM indicated that, the quantity of electricity and that of water are the main factors affecting agricultural GDP, and agricultural demand for electricity is inelastic. In addition, an increase of 100% in the number of food processing projects and of the export of agricultural raw materials, would lead to an increase in the agricultural gross product by 5.1% and 1.7% respectively. In that regards the study recommend encouragement of food industry rather than exporting agricultural raw materials. The forecasting models indicated that implementation of the energy price reform plan to agriculture up to phase two (scenario 1) is the best scenario leading to growth rate of 6.5% of gross GDP during the forecasting period of 2020-2025. The full energy price reform plan (scenario 2) will lead to a continuous decrease in agricultural GDP. In addition full price liberalization of electricity (scenario 3) and that of diesel (scenario 4) will decrease the agricultural GDP by 6.6% and 5.7% respectively. The study recommend that the energy price reform to be limited to phase one. Furthermore if the implementation of the

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plan will continue, it recommends separate application of electricity price reform and that of diesel to reduce the negative effect of their joint application on agricultural GDP.

Structured Abstract: Saudi Arabia had implemented many development plans over the past decades, which enhance the economical situation of the country. In vision 2030, The country aims to become one of the top fifteen economies in the world instead of the current 19th. In addition, it attempts to diversify the Gross Domestic Product (GDP) sources and increase the contribution of government income from non-oil sectors to avoid full dependancy on oil sector. Energy price reform plan had been implemented with many phases; the first and second phases had been applied in 2016 and 2018 respectively. The gradual adjustment of domestic energy prices will continue until they reach the level of the international prices in 2025. The agricultural sector is one of the non-oil sectors, which would play a role in achieving the objectives of vision 2030 and at the same time the energy reform would increase the production cost as energy (diesel and electricity) price will increase. Based on that background, this study aimed to assess and forecast the effect of energy price reform of diesel and electricity on Saudi agricultural Gross Domestic Product (GDP).

The study used simultaneous equations model consisting of four behavioral equations in the logarithmic formula for all variables to easily estimate elasticities using EVIEWS statistical package. These equations include agricultural gross product, agricultural consumption of electricity, agricultural consumption of diesel and agricultural consumption of water as endogenous variables. The models were based on time series data during 2000-2018 collected from relevant sources. The estimated model shows that there is no problem of the first order autocorrelation at any equation in the estimated simultaneous model according to the statistical value of Durbin - Watson test. The model results shows that all the explanatory variables included in the model are statistical significant at 0.05 level, except approximately three variables, which were kept for their importance in forecasting and explaining the endogenous variables.

The simultaneous model revealed that the quantity of electricity and that of water are the main factors affecting agricultural GDP as an increase in each one of them by 1% will lead to an increase of about 0.3% and 0.5% in agricultural gross product respectively. While, an increase of 1% on agricultural consumption of diesel led to a decrease of about 0.2% in agricultural gross product. The results also showed that the electricity is necessary factor in Saudi agriculture and demand for electricity of agriculture consumption is inelastic. Where, an increase of 1% in electricity tariff for agriculture sector led to a decrease of about 0.2% in consumption of electricity in agricultural sector. Moreover, there is a positive relationship between agriculture consumption of electricity and the number of food manufacturing projects, where an increase of 1% in food manufacturing products led to an increase of 1.63% in the agriculture consumption of electricity. In addition the study revealed that the demand for diesel in agriculture consumption is inelastic although the demand elasticity sign of diesel is inconsistent with economic theory. This indicates the utmost importance of diesel for irrigation pumps, agricultural vehicles and generators. Furthermore the results depicted that an increase of 1% of cultivated area and of residential water consumption will lead to an increase of about 80% and 0.61% in agricultural consumption of water respectively.

The estimated simultaneous model were used for forecasting the effect of the energy price reform plan on the endogenous variables up to 2025 with the gradual energy price reform (four scenarios) after testing the predictability of the estimated model using estimation of the coefficient of inequality by application of Theil's μ -statistic. The forecasting models indicated that implementation of the energy price reform plan to agriculture up to phase two (scenario 1) is the best scenario leading to growth rate of 6.5% of gross GDP during the forecasting period of 2020-2025. It also revealed the full energy price reform plan (scenario 2) will lead to a continuous decrease in agricultural GDP. In addition full price liberalization of electricity (scenario 3) and that of diesel (scenario 4) will decrease the agricultural GDP by 6.6% and 5.7% respectively. The study recommended that the energy price reform to be limited to phase one. Furthermore if the implementation of the plan will continue, it recommends separate application of electricity price reform and that of diesel to reduce the negative effect of their joint application on agricultural GDP.

Keywords: Agricultural Gross Product, Energy and Water Consumption, Energy Pricing Policy Reform, Saudi Vision 2030, Simultaneous Equations Model.

Öz: Bu çalışma, dizel ve elektrik enerji fiyat reformunun Suudi tarımsal Gayri Safı Yurtiçi Hasıla (GSYİH) üzerindeki etkisini değerlendirmeyi ve tahmin etmeyi amaçlamaktadır. Çalışmada, EVIEWS yazılımı kullanılarak 2000-2018 dönemindeki zaman serisi verilerine dayanan üç aşamalı en küçük kareler yöntemi

(3SLS) kullanılarak logaritmik formülde dört davranış denkleminden oluşan eşzamanlı denklem modeli (SEM) uygulanmıştır. Tahmini SEM, farklı senaryolar kullanılarak 2025 yılına kadar tahmin için kullanıldı. Artırılmış Dicky Fuller testinin sonuçları, uygulanan (3SLS) en küçük kareler yöntemi analiz edilen zaman serilerinin durağanlığını varsaydığı için gerekli olan değişkenlerin sabit farklılaştırıldığını göstermektedir. Tahmin edilen SEM'in sonuçları, elektrik miktarının ve su miktarının tarımsal GSYİH'yi etkileyen ana faktörler olduğunu ve elektrik için tarımsal talebin esnek olmadığını göstermiştir. Ayrıca, tarımsal hammadde ihracatında ve gıda işleme projelerinin sayısında% 100'lük bir artış, tarımsal gayri safi hasılda sırasıyla% 5,1 ve% 1,7 artışa yol açacaktır. Bu bağlamda çalışma, tarımsal hammadde ihraç etmek yerine gıda endüstrisinin teşvik edilmesini önermektedir. Tahmin modelleri, enerji fiyatı reform planının ikinci aşamaya kadar (senaryo 1) uygulanmasının, 2020-2025 tahmin döneminde brüt GSYİH'nin% 6,5'i oranında büyüme oranına yol açan en iyi senaryo olduğunu gösterdi. Tam enerji fiyatı reform planı (senaryo 2), tarımsal GSYİH'da sürekli bir düşüşe yol açacaktır. Buna ek olarak, elektriğin (senaryo 3) ve dizelin (senaryo 4) tam fiyat serbestleştirilmesi, tarımsal GSYİH'yi sırasıyla% 6,6 ve% 5,7 oranında azaltacaktır. Çalışma, enerji fiyatı reformunun birinci aşama ile sınırlı olmasını önermektedir. Ayrıca, planın uygulanmasının devam etmesi halinde, ortak uygulamalarının tarımsal GSYİH üzerindeki olumsuz etkisini azaltmak için elektrik fiyat reformunun ve dizelin ayrı ayrı uygulanmasını tavsiye etmektedir.

Anahtar Kelimeler: Tarımsal Brüt Ürün, Enerji ve Su Tüketimi, Enerji Fiyatlandırma Politikası Reformu, Saudi Vision 2030, Eşzamanlı Denklemler Modeli.

Introduction

Saudi Arabia has adopted many development plans over the past decades, resulted in a predominated economical position of the country. In vision 2030, The country aims to become one of the top 15 economies in the world instead of the current 19th. In addition, it attempts to diversify its Gross Domestic Product (GDP) sources and increase the contribution of government income from non-oil products to reach 530 billion riyals by 2030 (Kingdom vision, 2017 a). The agricultural sector is one of the non-oil sectors, which would play a vital role in achieving the objectives of vision 2030. In that regards, the Kingdom aims to increase the value of water and electricity subsidy decrease from zero in 2015 to 200 billion riyals in 2030 (Kingdom vision, 2017 b). This may increase the agricultural production cost, and hence decreasing the agricultural production , leading to lower the contribution share of agricultural sector to GDP.

At the international level there are many literature concerning the econometric analysis of the impact of price policy reform, whether at agricultural sector level such as (Helfand 2003; Jensen & Tarr, 2003; El Benni et al. 2012) or at the national level such as (Moshiri 2015; Acharya and Sadath 2017; Breisinger et al. 2019; Groot & Oostveen, 2019). As well, there are many previous literature interested in the energy price reform on the Saudi economy and its welfare as in Atalla et al. (2018) that estimated the demand for gasoline as a function of per capita real income , real gasoline price and other non-economic factors such as improvement of energy efficiency over time. The results explained that the increase in gasoline price will not lead to a significant reduction in demand, but this decrease will reduce the traveled distances, which gains social welfare through reducing greenhouse gas emissions, air pollution, accidents and congestion. Gonand et al. (2019) analyzed the impact of energy price reform that implemented at the end of 2015 on Saudi Arabian intergenerational welfare. The results showed that raising energy prices will lead to a direct increase in energy expenditure and indirect increase in Saudi national income resulting from decreasing domestic demand for oil and promoting oil exports. Furthermore, it is demonstrated that the additional oil income associated with the increase in domestic energy prices tends to be relatively more beneficial to future generations if it is recycled through public investment. Groissböck and Pickl (2018) analyzed the impact of diesel price reform in Saudi Arabia to achieve goals of energy and climate policy. Results found that the retail diesel price exceeded 20% of the expected international wholesale diesel prices. Moreover, considering emissions penalties to minimize emissions. Matar and Anwer (2017) combined the diesel prices reform that used in power plants with

the implementation of alternative scenarios of electricity pricing for the Saudi households. The results indicated that increasing the prices of electricity for households and industrial diesels gain yearly about \$ 12 billion and decrease natural gas used by power utilities, allowing gas to flow to other industries. Additionally, it is found that the marginal value of natural gas will fall at higher levels of electricity prices.

The government had started the implementation of energy price reform plan with many phases; the first and second phases has been applied in 2016 and 2018 respectively. The gradual adjustment of domestic energy prices will continue until they reach the level of the international energy prices in 2025 (Pre-Budget Statement 2019). Regarding agricultural sector, energy price reform includes firstly, Adjusting diesel price as it is the main energy for agricultural vehicles (tractors and harvesters), generators and agricultural machinery. Secondly, it include adjusting the electricity price for agricultural consumption. It worth mentioning that there is no water tariff for agricultural consumption in the Kingdom. This study aims to assess the impact of Saudi price policy reform of energy (diesel and electricity) on the agricultural gross domestic product.

Material And Methods

Data collection:

The study based on time series data published electronically in the World Bank database and in Saudi government institutions including the General Authority for Statistics, Saudi Arabian Monetary Authority, Ministry of Environment, Water and Agriculture during the period 2000-2018. Data of diesel consumption in agriculture sector is not published; therefore the study used an indicator of diesel consumption of the Saudi farm machinery that evaluated by Al-Hamed et al. (2011). The study was based on 191 farms from eight important agricultural areas (Qassim, Medina, Tabuk, Hail, Jouf, Riyadh, Baha, and Jazan) with eight agricultural companies. The diesel consumption index for both farms and companies was estimated at 3.43 and 0.13 liter/hour/ hectare respectively. This study relied on their weighted average of 3.297 liter/hour/ hectare.

Data Analysis:

The study used simultaneous equations model to analyze the impact of policy reform of electricity and diesel tariff on agricultural gross product. Henneberry and Khan (2000) stated that the simultaneous equations model is suitable for analyzing the mutual effect between model variables to avoid econometrics problems. The proposed simultaneous equations model consists of the following four behavioral equations in the logarithmic formula for all variables to easily estimate elasticities and mitigate multicollinearity problem (Yuandong et al. 2013).

Four equations were constructed and solved simultaneously to determine the impact of price policy reform of electricity and diesel on agricultural gross product, as shown below with table (1) explaining the variables symbols. These equations include agricultural gross product, electricity consumption in agricultural sector, diesel consumption in agricultural sector and agricultural consumption of water as endogenous variables.

$$AGP_i = f(ACE_i, ACD_i, ACW_i, FER_i, LOA_i, CAR_i, EXP_i) \dots \dots \dots (1)$$

$$ACE_i = f(ACD_i, NFP_i, ETF_i, EMI_i) \dots \dots \dots (2)$$

$$ACD_i = f(CAR_i, ACE_i, TRA_i, EMP_i, NFP_i, DTF_i) \dots \dots \dots (3)$$

$$ACW_i = f(ACD_i, CAR_i, EMI_i, IMP_i, ICW_i, RCW_i, TPW_i, EMP_i) \dots \dots \dots (4)$$

Table 1: The Used Variables Symbols in The Model and Their Meanings

Symbol	Meaning	Variables Type
AGP_i	value of agricultural gross product at constant prices for 2010 (billion Saudi Riyals) of year i	endogenous
ACE_i	quantity of electricity sold for agricultural consumption (giga watt hours) of year i	endogenous
ACD_i	the agricultural consumption of diesel (million liters / hour)of year i	endogenous
ACW_i	agricultural consumption of water (million m3) of year i	endogenous
FER_i	the Fertilizer consumption of year i (kilograms per hectare of arable land)	exogenous
LOA_i	total loans of Agricultural Development Fund (million Saudi Riyals) of year i	exogenous
CAR_i	cultivated area (million hectares) of year i	exogenous
EXP_i	agricultural raw materials exports (% of merchandise exports) of year i	exogenous
NFP_i	number of manufacturing food projects	exogenous
ETF_i	value of agriculture electricity Tariff (halala/kilowatt hours) of year i	exogenous
TRA_i	agricultural machinery, tractors per 100 sq. km of arable land of year i	exogenous
DTF_i	value of diesel Tariff (halala/liter) of year i	exogenous
ICW_i	industrial water consumption (million m3) of year i	exogenous
RCW_i	residential water consumption (million m3) of year i	exogenous
TPW_i	Total water productivity (constant 2010 US\$ GDP per cubic meter of total freshwater withdrawal) of year i	exogenous
EMP_i	number of employee in agricultural sector (1 employee) of year i	exogenous

Source: Author's preparation.

The system of equations above contains four endogenous variables, each endogenous variable with its own determinants or exogenous variables (other endogenous variables and predetermined variables). Identification condition is very important to obtain unique estimates of the simultaneous equation model (Nugroho, 2017). Table (2) shows that each equation is over-identified because the excluded variables are greater than the number of endogenous variables less one. Therefore, the proposed simultaneous equation model is over identified. Thus the three-stage least squares model (3SLS) is the appropriate technique to estimate the simultaneous model using EVIEWS statistical package.

Table 2: The Order Condition of The Proposed Simultaneous Equation Model

Equation number	K	M	K – M Excluded Variables	G – 1 Endogenous Variables less one	Identification of equation*
1	16	8	8	3	over identified
2	16	5	11	3	over identified
3	16	7	9	3	over identified
4	16	9	7	3	over identified

K: Number of variables in the model (both endogenous and exogenous)

M: Number of variables included in the considered equation

G: Total number of equations (endogenous variables)

* If $K - M > G - 1$, the equation is over identified

Source: Author's calculation based on above simultaneous equation model.

The estimated simultaneous model will be used for forecasting the endogenous variables up to 2025 with the gradual energy price reform. It should be noted that before forecasting, the predictability of the estimated model, must be tested (Karawi, 2018). This is achieved by the following methods:

- 1- Comparison between actual and estimated values for every endogenous variable in the simultaneous model, where, the smaller the gap, the better predictability of the model. According to (Pant, 1990), this method is not sufficient for testing predictability for the modest relationship with the accuracy of prediction.
- 2- Estimation of the coefficient of inequality is done using Theil's μ -statistic. The lower the value of Theil statistic, approaching zero, the more efficient the predictability of the model (Theil1966).

$$\mu = \sqrt{\frac{1/N \sum_{t=1}^N (\hat{Y}_t - Y_t)^2}{1/N \sum_{t=1}^N (\hat{Y}_t)^2 + 1/N \sum_{t=1}^N (Y_t)^2}}$$

Where, μ denotes Theil statistic, N denotes the number of observations, Y_t and $\hat{Y}_t$ denote actual and estimated values of the endogenous variable, respectively.

The Saudi Ministry of Finance did not disclose the future phases of the Energy Price reform Plan up to 2025, where the first and second phases were implemented in 2016 and 2018 respectively. The rest of the plan phases are supposed to be completed and the energy prices continue to rise gradually to reach the world price in 2025. thus the study proposes four different scenarios as follows:

- The first scenario supposed that the second phase of the energy price reform plan applied in 2018 will be adopted till 2025.
- The second scenario assumed the gradual price reform of energy (diesel and electricity) till it reached full liberalization in 2025. This is achieved by increasing the price of diesel and electricity by 100% and 200% in 2020-2021 and 2022-2023 respectively. In 2024-2025 the price of diesel and electricity will be increased by 300%, resulting in an equivalent international price.

In order to determine whether price liberalization of diesel or that of electricity has greatest impact on Saudi gross agricultural product, the study conducted the third and the fourth scenarios as follows:

- The third scenario assumed the gradual price reform of electricity until it reach full liberalization in 2025. This is achieved by increasing the price of electricity by 100% and 200% in 2020-2021 and 2022-2023 respectively. In 2024-2025 the price of electricity will be increased by 300%, resulting in an equivalent international price.
- The fourth scenario assumed the gradual price reform of diesel until it reach full liberalization in 2025. This is done by increasing the price of diesel by 100% and 200% in 2020-2021 and 2022-2023 respectively. In 2024-2025 the price of diesel will be increased by 300%, resulting in an equivalent international price.

Results and Discussion:

1- Stationary examination of the available data

In order to determine the appropriate simultaneous equations model to analyze the impact of policy reform of electricity and diesel tariff on agricultural gross product, it is important to exam the stationary of the available data which is time series data from 2000 to 2018. The unit root tests are needed because the applied (3SLS) least squares method assumes the stationarity of the analyzed time series. Table (3) shows the results of the Augmented Dicky Fuller test as one of a unit root tests.

Table 3: Augmented Dicky Fuller Test

Variable (in Logarithm formula)	Level - I(0)			Frist deference - I(1)		
	Intercept	Trend and Intercept	None	Intercept	Trend and Intercept	None
AGP_i	0.229	-1.968	-3.119	-3.236*	4.239*	-1.837
ACE_i	0.653	-3.867*	2.989	-5.491*	-5.281*	-4.939*
ACD_i	-1.222	-2.377	-0.959	-3.882*	-3.769*	-3.899*
ACW_i	-1.623	-2.563	-0.276	-1.539	-3.091*	-3.114*
FER_i	-1.253	-2.477	0.842	-3.823*	-3.693*	-3.817*
LOA_i	-3.736	-4.521*	-1.091	-5.169*	-5.258*	-5.099*
CAR_i	-1.222	-2.378	-0.959	-3.881*	-3.769*	-3.899*
EXP_i	-1.898	-2.843	0.657	-5.914*	-5.653*	-5.918*
NFP_i	0.150	-2.664	0.525	-5.981*	-5.599*	-0.754
TRA_i	-1.354	-2.677	-2.254*	-4.578*	-5.007*	-4.128*
DTF_i	-1.242	-0.964	0.193	-3.759*	-4.409*	-3.873*
ICW_i	-1.878	-1.712	0.493	-3.442*	-3.667*	-2.049*
RCW_i	0.208	-1.739	2.827	-2.005	-1.490	-3.397*
TPW_i	-0.931	-0.988	0.916	-4.629*	-4.441*	-2.882*
EMP_i	-0.026	-2.254	-1.245	-2.973*	-2.874*	-2.769*

* represents rejection on the null hypothesis of a unit root at the 5% level.

The results of the augmented Dicky Fuller test clearly show that the variables are not stationary at level. However, all the variables are differenced stationary. Then, the stationarity assumption of (3SLS) least squares method has been achieved.

2- Estimation of the simultaneous equations model:

Table (4) shows the best fitted estimated equations using the three-stage least square regression method. This is achieved after excluding some explanatory variables according to correlation matrix to mitigate the multicollinearity problem, excluding statistically insignificant variables.

Table 4: Results of The Simultaneous Equations Model

Equation number	Explanatory variables	Coefficient	t-Statistic	Probability	Adjusted R-squared	D.W
(1) AGP_i	EXP_i	0.0173	1.98*	0.050	0.83	0.29
	LOA_i	0.0038	0.872	0.387		
	ACE_i	0.3069	6.29*	0.000		
	ACD_i	-0.2562	-5.03*	0.000		
	ACW_i	0.5154	5.12*	0.000		
(2) ACE_i	ETF_i	-0.245	-2.91*	0.000	0.87	1.91
	NFP_i	1.6284	11.45*	0.000		
(3) ACD_i	DTF_i	0.0111	1.38	0.173	0.53	0.45
	TRA_i	0.0210	4.79*	0.000		
(4) ACW_i	CAR_i	80.209	6.26*	0.000	0.68	.68
	TPW_i	-0.1176	-1.32	0.194		
	RCW_i	0.6089	9.09*	0.000		

* indicates significance at 5% level.

Source: Author's calculation.

The above results in table (4) shows that all the explanatory variables included in the model are statistical significant at 0.05 level, except approximately three variables, which were kept for their importance in forecasting and explaining the endogenous variables.

Table (5) shows that there is no problem of the first order autocorrelation at any equation in the estimated simultaneous model according to the statistical value of Durbin - Watson test (DW) as demonstrated in (Syróvátka et al. 2014).

Table 5: Autocorrelation Test For Each Equation in The Simultaneous Model

Equation number	DW	K	dL	dU	Hypothesis of DW test	Result
(1) AGN_i	2.29	5	0.75	2.02	H_0 : non autocorrelation in residual H_1 : negative first-order autocorrelation	$(4 - DW) > dL$ Accept H_0
(2) ACE_i	1.91	2	1.07	1.54	H_0 : non autocorrelation in residual H_1 : positive first-order autocorrelation	DW > dL Accept H_0
(3) ACD_i	1.45	2	1.05	1.54		
(4) ACW_i	1.68	3	0.97	1.69		

DW: the observed value of the Durbin-Watson test statistic.

K: the number of coefficients excluding the intercept.

dL: the tabulated lower bound at the 5% level of significance, N=19.

dU: the tabulated upper bound at the 5% level of significance, N=19.

Source: Author's calculation based on the study results in table 3.

The first equation (AGP_i) shows that 83% of the variation in the agricultural gross product is explained by the explanatory variables included in the equation. The most important significant variables are the quantity of electricity for agricultural consumption (ACE_i) and agricultural consumption of water (ACW_i). An increase in each one of them by 1% will lead to an increase of about 0.3% and 0.5% in agricultural gross product respectively. While, an increase of 1% on agricultural consumption of diesel (ACD_i) led to a decrease of about 6.2% in agricultural gross product. The agricultural gross product increased by about 0.017 % for 1% increase in export of agricultural raw materials (% of merchandise exports).

The second equation (ACE_i) shows that the electricity is necessary factor in Saudi agriculture and demand for electricity of agriculture consumption is inelastic. Where, an increase of 1% in electricity tariff for agriculture sector (DTF_i) led to a decrease of about 0.2% in consumption of electricity in agricultural sector. Moreover, there is a positive relationship between agriculture consumption of electricity and the number of food manufacturing projects (NFP_i) where an increase of 1% in food manufacturing products led to an increase of 1.63% in the agriculture consumption of electricity.

Equations one and two revealed that encouragement of food industry would have a greater positive effect on Saudi gross agricultural product than that of exporting agricultural raw materials. This is evidence by an increase of the agricultural gross product by 5.1% and 1.7% by the increase of 100% in the number of food processing projects and of the export of agricultural raw materials respectively.

The third equation (ACD_i) shows that an increase of 1% in diesel price for agriculture sector (DTF_i) will lead to an increase of about only 0.01% in agricultural consumption diesel. This means that the demand for diesel in agriculture consumption is inelastic although the demand elasticity sign of diesel is inconsistent with economic theory. This indicates the utmost importance of diesel for irrigation pumps, agricultural vehicles and generators. The equation also shows that an increase of 1% in agricultural machinery, tractors per 100 sq. km of arable land (TRA_i) led to an increase of about 0.02% in agricultural consumption diesel. The two variables (DTF_i) and (TRA_i) explained about 53% of the variation in agricultural consumption of diesel.

The fourth equation (ACW_i) shows that 68% of the variation in the agricultural consumption of water is explained by the explanatory variables included in the equation. It also shows that an increase of 1% of cultivated area and of residential water consumption will lead to an increase of about 80% and 0.61% in agricultural consumption of water respectively while the total Water productivity is insignificant at 5% level.

2- Forecasting:

Predictability of the estimated simultaneous model must be tested using the following methods:

- a- Figures(1), (2), (3) and (4) show that the gap between actual and estimated values for each endogenous variable in the simultaneous model is very small, that reflecting high predictability.

- b- According to our results of Theil's μ -statistic shown in table (6) below, the predictability of the estimated simultaneous model is good. Because the value of Theil's $\square$ -statistic was smaller than one and approaching zero.

Table 6: Theil Inequality Coefficient for Each Equation in The Simultaneous Model

Equation Number	Theil's μ -statistic
(1) AGN_i	0.005989
(2) ACE_i	0.005616
(3) ACD_i	0.000018
(4) ACW_i	0.002051

Source: Author's Calculation Based on Equation (5).

Now, we can use the estimated simultaneous model to forecast the endogenous variables up to 2025 (Table 7 and 8) according to the four scenarios (explained earlier).

Table 7: The Resulting Predictions for First and Second Scenarios by Using The Estimated Simultaneous Model up to Year 2025

	First Scenario				Second Scenario			
	AGP_i	ACE_i	ACD_i	ACW_i	AGP_i	ACE_i	ACD_i	ACW_i
2020	62	5399.1	572.2	18462	57.0	4685.6	572.6	18461.6
2021	62.6	5606.7	572.2	18324	57.5	4865.7	572.5	18323.6
2022	63.1	5817.3	572.2	18324	53.4	4381.3	572.9	18323.6
2023	63.7	6030.8	572.1	18186	53.9	4542.2	572.9	18185.7
2024	64.2	6247.4	572.1	17910	50.3	4226.9	573.2	17910.2
2025	64.7	6466.8	572.1	17773	49.9	4083.5	573.2	17772.6
Change rate %	6.5	29.5	-0.02	-5.2	-17.2	-15.3	0.17	-5.15

Source: Calculated by the researcher.

The forecasting result based on the first scenario shows that there will be a continuous increase of Saudi gross agricultural product with a growth rate of 6.5% during the forecasting period. The Saudi gross agricultural product will be equal to 62.0 and 64.7 billion Saudi Riyal in 2020 and 2025 respectively. This increase is attributed to the increase in electricity consumption with an annual growth rate of 29.5% during the forecasting period.

Implementation of full energy price reform plan (scenario 2) will lead to continuous decrease in agricultural gross product with a growth rate of -17.2%. The Saudi agricultural gross product will be equal to 57 and 49.9 billion Saudi Riyal in 2020 and 2025 respectively. This decreasing trend is attributed to the decrease in consumption of electricity and water by decreasing rate amounted to 15.3% and 5.2% respectively during the forecasting period. This is will occur in spite of increasing the consumption of diesel which is amounted to 0.17% (Table 7).

Table 8: The Resulting Predictions for Third and Fourth Scenarios by Using The Estimated Simultaneous Model up to Year 2025

	Third Scenario				Fourth Scenario			
	AGP_i	ACE_i	ACD_i	ACW_i	AGP_i	ACE_i	ACD_i	ACW_i
2020	59.4	4685.6	572.2	18461.6	59.5	5399.1	572.6	18461.6
2021	59.9	4865.7	572.2	18323.6	60.1	5606.7	572.6	18323.6
2022	57.9	4381.3	572.2	18323.6	58.2	5817.3	572.9	18323.6
2023	58.4	4542.2	572.1	18185.7	58.8	6030.8	572.9	18185.7
2024	56.4	4083.5	572.1	17910.2	56.9	6247.4	573.2	17910.2
2025	56.8	4226.9	572.1	17772.6	57.3	6466.8	573.2	17772.6
Change rate %	-6.6	-15.3	-0.02	-5.2	-5.7	29.5	0.17	-5.2

Source: Calculated by the researcher.

Table (8) reveals that the forecasting result of full liberalization of electricity price to reach the international price in 2025, with no reform in diesel price (Scenario three), will result in

decreasing electricity consumption with an annual rate of -15.3% during the forecasting period. This will be reflected on decreasing consumption of diesel and water by an annual rate of 0.02% and 5.2% respectively. This in turn will lead to an annual decrease of agricultural gross product by 6.6%.

Implementation of Scenario four (full liberalization of diesel price only), will lead to increasing rate of diesel consumption amounted to 0.17% during the forecasting period. This is followed by 5.2 % annual decreasing rate of water consumption, coupled with annual increase in electricity consumption by 29.5%. The net result will be a decrease in agriculture gross product by 5.7% during the forecasting period (Table 8).

Based on the above discussion it is clear that scenario one is the only one scenario which will result in increasing Saudi gross agricultural product during the forecasting period of 2020-2025. In addition Scenario two yields the worst impact on Saudi gross agricultural product. Moreover the results indicate that scenario three and four have less negative effect on Saudi gross agricultural product compared to the second scenario, with scenario four has the least adverse impact on Saudi gross agricultural product.

Conclusion

- The simultaneous equation model revealed that an increase of 100% in the number of food processing projects and of the export of agricultural raw materials, would lead to an increase in the agricultural gross product by 5.1% and 1.7% respectively. In that regards the study recommend encouragement of food industry rather than exporting agricultural raw materials.
- The study forecasting models indicated that scenario one is the best scenario leading to an increase of Saudi gross agricultural product. Therefore, the study recommended implementation of the energy price reform plan to agricultural sector up to phase two. In addition, further research is recommended to assess the impact of the energy price reform plan on the residential and industrial sectors.

- In case of continuing the application of the energy price reform plan, the study results recommended individual application of price reform plan of electricity and of diesel to reduce the negative effect of their application together.
- The results concluded that diesel is more necessary (important) to agricultural sector compared to electricity, as full price liberalization of electricity will decrease its consumption by 15.3% reflecting on decreasing the agricultural gross product by 6.6%. Where the full price liberalization of diesel will increase its consumption by 0.17% resulted in decreasing agricultural gross product by 5.7%.

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