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IMPACT OF PRICE DISTORTIONS ON POTATO PRODUCTION AND CONSUMPTION IN EGYPT

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ABSTRACT

In order to achieve the research objectives, study period has been split into two periods; a pre-2008 crisis period (2000-2007), which is the period prior to the burst of the global financial crises, and a post-2008 crisis period (2008-2016), which is the period after the global financial crises. Chow test has been applied to measure economic impacts on the study variables. The research also applied econometric analysis by building up a Simultaneous Equations Model in order to measure interactions and overlaps between the study variables using Three Stage Least Square (3SLS), in addition to employing Partial Equilibrium Model to identify imbalances in prices and to assess the value of subsidy received by or taxes imposed on potato producers and consumers in Egypt. The results show through applying F-Chow test statistics to total production revealed no statistically significant difference between the two study periods (2000-2007 and 2008-2016), indicating no break between the two periods. However, when applied to consumption, results revealed a statistically significant difference between the two study periods, indicating a break between the two periods. Findings also revealed that average nominal protection coefficient for potato reached 0.868 during the first period, but declined to 0.842 during the second period, down by 37.83%, which means that potato producers received 87.6% and 84.2% of their product's value in world price over the two periods, respectively, indicating that the government has been imposing taxes on potato producers to subsidize domestic consumers.

Key words: Potato crop, Chow test, Simultaneous Equations, Partial Equilibrium Model.

INTRODUCTION

Achieving food security is one of the key strategic pillars which international economies seek to attain, where maximizing food production under limited cost is considered an international objective most countries seek to realize in order to achieve economic development. And the agricultural sector is considered to be the main sector of food production, efforts are being devoted to boosting the sector's productivity under the constraints of limited arable land areas, limited water resources and rising production costs. Agricultural policy comes on top of the tools used to achieve sustainable development in the agricultural sector given the fact that, when implemented, balance between benefits gained by individuals and the society can be achieved, as well as ensuring benefits for future generations, which finally leads to improving the standard of living for farmers. *(El-Yazeed, 2004)*

Potato crop is one of the main vegetable crops in Egypt in terms of production, consumption and exports given its nutritional value and processing characteristics. Potato represents an important component in human food, and is considered the staple food for many populations at the level of the world, especially in the European continent. Such importance influenced the economics of potato production, where different varieties are produced to meet the needs of domestic and international consumers. *(Ahmed, 2016)*

In Egypt, potato planted area reached 367.63 thousand acres or 18.90% of the total area under vegetable crops, estimated at 1.993 million acres. Total production reached 5.029 million tons representing 25.11% of Egypt's total vegetable production, estimated at 20.025 million tons *(MALR, 2016).* In terms of foreign trade, potato exports value amounted to US$147.15 million or 5.18% of Egypt's total agricultural exports, estimated at US$2.841 billion or 12.37% of Egypt's total exports value, estimated at US$22.975 billion in 2016. *(CAPMAS, 2016)*

Despite the increasingly growing demand for potato, especially processed potato products consumed as fast food, in addition to representing an important source of hard currency that contributes to financing agricultural economic development programs and projects, such strategic crop has been facing some obstacles due to price distortions, which resulted in year-over-year increase in production cost and reduced exports thus negative impacts on the country's hard currency proceeds. Therefore, enhancing Egyptian agricultural exports is considered an important means for accelerating the process of economic development. As such, the research investigates the impacts of price distortions on potato

production and consumption in Egypt, and aims to assess the differences between domestic and international prices of potato, besides measuring the impacts of such differences on potato producers and consumers through building an econometric model based on simultaneous equations to identify key factors influencing potato production, consumption and exports, in addition to estimating the Partial Equilibrium Model to measure the impacts of agricultural price policies on change in governmental revenues, change in hard currency proceeds, change in producer and consumer surplus, in addition to measuring economic efficiency indicators, namely net impact at the level of producer, consumer and the society as a whole. Other objectives include identifying the reasons for price imbalances, estimating the value of subsidy potato producers and consumers receive or taxes imposed on producers, assessing the impact of the governmental intervention policies on potato production and consumption, on government's revenues, in addition to assessing the associated impacts on economic welfare of the society using a set of indicators like net economic loss to potato producers and consumers, as well as changes in producer and consumer surplus to measure gains for each of them.

MATERIALS AND METHODS

The research applied both descriptive and quantitative statistics. The study period has been divided into two periods, a pre-crisis period (2000-2007), which is the period prior to the burst of the global financial crises, and a post-crisis period (2008-2016), which is the period after the global financial crises. Chow test has been applied to measure the economic impacts on the study variables. Dummy variables were used to illustrate whether or not differences exist between the two study, i.e., to identify if the difference is due to the intercept, the regression parameter, or both.

Chow test depends on estimating the sum of squared errors (SSE), from which F Chow can be calculated *(Gregory, 1960)* as follows:

Regression line is first estimated, then regression parameters over the period prior to changes. Results obtained can be used to estimate SSE1 for the first period and **SSE2** for the second period. **(1)**

Also, regression line is estimated for the overall study period, the results of which can be used to estimate SSEt**.** **(2)**

SSE1 and **SSE2** are summed up to obtain SSEu. **(3)**

Difference between SSEt and SSEu is calculated as follows:

$$D = SSET - SSEU \quad (4)$$

According to Chow, calculated F can be obtained from the following formula:

$$F_{Chow} = \frac{D}{K} \div \frac{SSEU}{(N - 2K)} \quad (5)$$

Where,

K = number of study variables

N = number of years

Calculated F Chow is then compared to Table F at any given level of significance and N–2K degrees of freedom. The obtained result is interpreted as same as the results of the commonly know F Test. To identify the source of difference using dummy variables, the research applied the described below model:

$$\hat{Y}t = \alpha + \beta 1\, x + \beta 2\, x + \beta 3\, xD + \varepsilon \quad (6)$$

Where,

Ŷt : the dependent variable

X : the independent variable (time)

ε : Error term

D : a dummy variable that takes the value (0) during the first period and 1 during the second period.

XD = X * D

From equation (6), equations (7) and (8) can be derived to represent the first and second period, respectively:

$$\hat{Y}t = \alpha + \beta 1\, x + \varepsilon \quad (7)$$

$$\hat{Y}t = (a + b2) + (b1 + b3)X + \varepsilon \quad (8)$$

Besides the above described models, the research employed Partial Equilibrium Model to explain imbalances in price *(Mahmoud & Abdallah, 2010)*, volume of subsidy to or tax imposed on potatoes producers and consumers in Egypt, in addition to identifying the impact of governmental intervention policies on production, consumption, government's revenue and the final impact on society's welfare based on computed net economic losses for producers and consumers and change in producer and consumer surplus. Government's revenue has also been measured by identifying changes in government's revenues and hard currency proceeds, in addition to net economic loss for the society. *(Abdallah, 2010)*

$$NELP = 0.5(Qw - Qd) * (Pb - Pd)$$

$$NELC = 0.5(Cw - Cd) * (Pb - Pd)$$

$$Ps = Qd(Pd - Pb) - NELP$$

$$Cs = Cd(Pb - Pd) - NELC$$

$$GR = NELP - NELC - Ps - Cs$$

$$FE = Pb(Qw - Qd + Cd - Cw)$$

$$NET = Ps + Cs + GR$$

NELP= Net Economic Loss in Production — NELC= Net Economic Loss in Consumption

PS= Change in Producer Surplus — CS= Change in Consumer Surplus

GR= Change in Government's Revenue — FE= Change in Foreign Exchange

NET=Net Effect — Qd= Quantity produced at farm price

Qd= Quantity produced at border price — Pb= Border Price — Pd=Farmgate price

Cw= Quantity consumed at border price — Cd= Quantity consumed at farmgate price

Sources of –Data: The research relied on published and unpublished secondary data from various sources,

including the Ministry of Agriculture and Land Reclamation (MALR), the Central Agency for Public Mobilization and Statistics (CAPMAS), the National Planning Institute, websites of Food and Agriculture Organization of the United Nations, the United Nations and the World Bank, in addition to other websites specialized in publishing data statistics. The research also used some references and researches relevant to the study subject.

RESULTS AND DISCUSSION

Current Situation of Potato Crop

Evolution of Total Production: Results of applying F-Chow test to total production, presented in Table-1, indicate that no statistically significant difference exist between the two study periods 2000-2007 and 2008-2016, i.e., no break between the two period. Therefore, different forms of general regression equations have been estimated, the results of which revealed that the form that best fits in terms of economic and statistical criteria is the linear form for the overall period (2000-2016). Estimation results indicate that the total production followed a statistically significant increasing trend at an annual rate of 221.18 thousand tons representing 6.56% of the period's average production. Coefficient of determination reached 0.938, i.e., 93.8% of the variation in total production over the study period is due to variables influenced by time. Accordingly, it can be said that the achieved results did not reflect the impacts of global financial crisis on total production of potato.

Evolution of Total Consumption: Results of applying F-Chow test to total consumption, presented in Table-1, indicate a statistically significant difference between the two study periods 2000-2007 and 2008-2016, i.e., a break exists between the two periods. It was therefore necessary to identify the source of difference between the two periods using dummy variables. Results regarding the first and second study period revealed that total consumption followed increasing trends at annual rates of 63.35 and 119.01 thousand tons, respectively, representing 3.13% and 3.06% of the average consumption for the two periods, respectively. Coefficient of determination reached 0.953, which means that 95.3% of the variation in total potato consumption over the study period (2000-2016) is due to variables influenced by time. It can therefore be said that total potato consumption followed an increasing trend over the second period at rate lower than the first period.

Evolution of Exports: Results of applying F-Chow test to total potato exports, presented in Table-1, indicate that no statistically significant difference exist between the two study periods 2000-2007 and 2008-2016, i.e., no break between the two period. Therefore, different forms of general regression equations have been estimated, the results of which revealed that the form that best fits in terms of economic and statistical criteria is the linear form for the overall period (2000-2016). Estimation results indicates that total exports followed a statistically significant increasing trend at an annual rate of 18.2 thousand tons representing 4.99% of the period's average exports quantity. Coefficient of determination reached 0.436, indicating that 43.6% of the variation in total exports over the study period is due to variables influenced by time. It can then be said that the achieved results did not reflect the impacts of global financial crisis on potato exports.

Evolution of Farmgate Price: Results of applying F-Chow test to farmgate price of potatoes, presented in Table-1, indicate a statistically significant difference between the two study periods 2000-2007 and 2008-2016, i.e., a break exists between the two period. It was therefore necessary to identify the source of difference between the two periods using dummy variables. Results regarding the two periods revealed that farmgate price followed diminishing trends at annual rates of US$8.48/ton and US$2.01/ton, respectively, representing 5.81% and 1.04% of the average farmgate price for the two periods, respectively. Coefficient of determination reached 0.752, indicating that 75.2% of the variation in farmgate price over the study period (2000-2016) is due to variables influenced by time. Accordingly, it can be said that farmgate price followed a diminishing trend over the two periods, which can be attributed to the negative impacts of the global financial crisis on the world price of potato, especially during the second period.

Evolution of Consumer Price: Results of applying F-Chow test to consumer price of potato, presented in Table-1, indicate that no statistically significant difference exist between the two study periods 2000-2007 and 2008-2016, i.e., no break between the two period. Therefore, different forms of general regression equations have been estimated, the results of which revealed that the form that best fits in terms of economic and statistical criteria is the linear form for the overall period (2000-2016). The estimated form revealed that total exports followed a statistically significant increasing trend at an annual rate of US$21.32/ton representing 5.92% of the average consumer price for the two periods, respectively. Coefficient of determination reached 0.820, indicating that 82% of the variation in consumer price over the study period is due to variables influenced by time. Accordingly, it can be said that the achieved results did not reflect the impacts of the global financial crisis on consumer price of potato.

Evolution of World Price: Results of applying F-Chow test to the world price of potato, presented in Table-1,

indicate a statistically significant difference between the two study periods 2000-2007 and 2008-2016, i.e., a break exists between the two periods. It was therefore necessary to identify the source of difference between the two periods using dummy variables. Results regarding the two periods revealed that farmgate price followed increasing trends at annual rates of US$19.76/ton and US$1.61/ton, respectively, representing 8.87% and 0.49% of the average world price for the two periods, respectively. Coefficient of determination reached 0.877, i.e., 87.7% of the variation in world price of potato over the study period 2000-2016 is due to variables influenced by time. Accordingly, it can be said that world price of potato followed an increasing trend over the second period, but at a rate lower than the first period, which can be attributed to the negative impacts of the global financial crisis.

Evolution of Planted Area: Results of applying F-Chow test to potato planted area, presented in Table-1, indicate that no statistically significant difference exist between the two study periods 2000-2007 and 2008-2016, i.e., no break between the two period. Therefore, different forms of general regression equations have been estimated, the results of which revealed that the form that best fits in terms of economic and statistical criteria is the linear form for the overall period (2000-2016). The estimated form revealed that potato planted area followed a statistically significant increasing trend at an annual rate of 18.54 thousand acres representing 5.77% of the period's average planted area. Coefficient of determination reached 0.927, indicating that 92.7% of the variation in potatoes' planted area over the study period is due to variables influenced by time. It can be said that the achieved results did not reflect the impacts of the global financial crisis on potato planted area.

Econometric Model Used in Determining Major Economic Variables Influencing Potato Exports: Applying Ordinary Least Square (OLS) to Simultaneous Equation Models results in biased and inconsistent parameters given the fact that such models contain interactions between endogenous variables in the one side, and between endogenous and exogenous variables from the other side. Hence, it was important to search for another econometric estimation method appropriate for the Simultaneous Equation Model to be estimated. *(*Attiah, 2005*)*. A Simultaneous Equation Model is the model in which the equilibrium value of at least one of its endogenous variables cannot be determined without using all the equations in the model simultaneously, where endogenous variables in the model are interchangeably correlated, i.e., the dependent variable in the first equation might exist as one of independent variables in the second equation. This means that the dependent variable plays a double role, an influenced variable in the first equation and an influencing variable in the second equation. (Al-Batran, 2003). Such equations are also called Structural Equations, where they present the basic structure of the study subject. In addition, the model comprises two types of variables; endogenous variables, which are the variables determined inside the model, or variables that depend on internal forces, and exogenous variables, which are variables determined outside the model, i.e., variables that depend on forces other than the model forces. *(Christopher, 2007)*

In order to build the model on sound basis, it is important to give a brief description of the identification problem. The Identification Problem has to do with being able to solve for unique values of the parameters of the structural model using values of the parameters of the reduced form of the model. It is considered of the basic problems encountered in building econometric models, where it focuses on how to measure each equation in the structural model, which enables us identify whether or not the model is properly built to give unique values of the parameters of the structural model from the data set used. *(Gregory, 1988)*. An equation in the model is said to be exactly identified or just identified when the total number of variables in the model less the total number of variables in the equation to be identified equals the number of endogenous variables in the equation minus one. In case higher, the model is said to be over identified, and in case less, the model is said to be under identified. *(Howard 1989)*. Given the model conditions, OLS cannot be applied. Rather, the Two-Stage Least Square (2SLS) or Three-Stage Least Square (3SLS) are the best methods to estimate the parameters given the fact that they can be applied to the model as a whole and not to one equation only. *(Khalifa, 2001).*

Table 1. Evolution of Variables Influencing Potato Production over the Two Study Periods 2000-2007 and 2008-2016.

Variable	Period	Regression coefficients with Dummy Variables				Average period	R^{-2}	F- CHO	D . W	Rate of Change (%)			Growth Rate		
		B0	B_1X	B_2D	B_3DX			F model		First Period	Second Period	Total Period	First Period	Second Period	Total Period
Total Production (1000 Tons)	Overall period	1380 (9.18)**	221.18 (15.07)**	–	–	3371.28	0.938	1.05 227.16**	2.09	–	–	221.18	–	–	6.56
Total Consumption (1000 Tons)	Dummy Variables	1741.6 (9.14)**	63.35 (1.68).	595.04 (-1.29).	55.66 (1.13) .		0.953	5.76* 87.04**	2.041	–	–	–	–	–	–
	1st	1741.6	63.35	–	–	2026.63				63.35		–	3.13		–
	2nd	2336.64	119.01			3883.72					119.01			3.06	
Exports Q (1000 Tons)	Overall Period	200.94 (3.67)**	18.2 (3.41)**	–	–	364.74	0.436	0.51 11.60**	2.22	–	–	18.2	–	–	4.99
Farmgate Price Lagged One Year (US$/ton)	Dummy Variables	184.104 (13.18)**	-8.48 (-3.07)**	34.83 (1.03).	6.47 (1.79) .		0.752	7.91** 13.12**	1.88	–	–	–	–	–	–
	1st	184.104	-8.48	–	–	145.95				-8.48	–	–	-5.81	–	–
	2nd	218.93	-2.01	–	–	193					-2.01			-1.04	
Consumer Price (US$/ton)	Overall Period	168.51 (6.39)**	21.32 (8.28)**	–	–	360.4	0.82	1.69 68.56**	1.28	–	–	21.32	–	–	5.92
World Price (US$/ton)	Dummy Variables	133.95 (6.40)**	19.76 (4.77)**	176.59 (3.49)**	-18.15 (-3.36)* *		0.877	3.59* 30.79**	2.39	–	–	–	–	–	–
	1st	133.95	19.76	–	–	222.86				19.76	–	–	8.87	–	–
	2nd	310.54	1.61	–	–	331.5					1.61			0.49	
Area (1000 Acres)	Overall Period	154.34 (11.18)**	18.54 (13.76)**	–	–	321.16	0.927	0.89 189.20**	2.08	–	–	18.54	–	–	5.77

Source: Calculated From Data in Table 1 in the Annex

Testing for the best fit model depends on the degree of identification of the simultaneous equation model (E). Testing for the identification problem in the model built using the three endogenous variables indicates that the first, second and third equations are exactly identified. Accordingly, the optimal statistical method to estimate relationships in the model is the Three-Stage Least Square (3SLS) in the logarithmic form. In addition, Cochrane–Orcutt estimation has been applied to the linear model to deal with serial correlation in the error term, especially that the model relied on time series data. The following part presents and discusses the results of estimating structural relationships, in addition to elasticities that reflect endogenous variable's response to potential variations in the exogenous variables.

$$TPt = C(1) + C(2) * QCt + C(3) * QEt + C(4) * FP(t-1) + C(5) * CAt$$

$$QCt = C(6) + C(7) * TPt - C(8) * QEt - C(9) * CPt + C(10) * POPt$$

$$QEt = C(11) + C(12) * TPt - C(13) * QCt + C(14) * WPt + C(15) * CAt$$

Where,

TP_t : Total Production of Potato (1000 Tons)
QC_t : Total Potato Consumption (1000 Tons)
QE_t : Potato Exports Quantity (1000 Tons)
$FP_{(t-1)}$: Lagged Farmgate Price (US$/ton)
CP_t : Consumer Price (US$/ton)
WP_t : World Export Price (US$/ton)
POP_t : Population (1000 inhabitants)
CA_t : Total Planted Area (1000 acres)

The model comprises three endogenous variables: (QE_t ‘ QC_t ‘ TP_t), and five exogenous variables: ($FP_{(t-1)}$ ‘ CP_t‘ WP_t‘ POP_t‘ CA_t). The model has been estimated using Three Stage Least Square (3SLS) in the linear and double log forms. Results indicate that double log regression is the best fit form in terms of statistical criteria. Table-2 presents the results obtained regarding model estimation and goodness-of-fit measures, including adjusted R-squared (R^2), which indicates how much independent variables can explain variations in the dependent variable. The table also presents F value for each equation, which indicates the significance for each equation in the model at 1% level. Results obtained from each equation are interpreted as follows:

Total Production of Potato: Equation (1) in Table-2 presents the factors influencing total potato production in Egypt. Adjusted R-squared value indicates that potatoes consumption in thousand tons, potato exports in thousand tons, lagged farmgate price in US$/ton and total potato planted area in thousand acres explain 99.9% of the variations in total potato production, with the remainder variations due to other factors outside the model. It can also be noted that potato consumption, lagged farmgate price and total planted area proved statistically significant, which means that 1% increase in potato consumption leads to 0.07% increase in total production, 1% decline in last year’s farmgate price leads to 0.034% increase in total production, and 1% increase in potato planted area leads to 1.09% increase in total potato production. However, potato exports quantity did not prove to have a statistically significant impact.

Total Consumption of Potato: Equation (2) in Table-2 presents the factors affecting potato consumption in Egypt. Adjusted R-squared value indicates that total potato production in thousand tons, potatoes exports in thousand tons, consumer price in US$/ton and population number explain 91.39% of the variations in total potato consumption, with the remainder variations due to other factors outside the model. It can also be noted that potato production and consumer price in US$/ton proved statistically significant, based on which 1% increase in potatoes production leads to 0.83% increase in potato consumption and 1% decline in consumer price leads to 0.34% increase in total consumption. Potato exports quantity and population number did not prove to have a statistically significant impact.

Potato Exports Quantity: Equation (3) in Table-2 presents the factors affecting Egypt’s potato exports. Adjusted R-squared value indicates that total potato production in thousand tons, potatoes consumption in thousand tons, export price in US$/ton and potatoes planted area in thousand acres explain 56% of the variations in potato exports quantity, with the remainder variations due to other factors outside the model. It can also be noted that quantity consumed of potato and world price of potato proved statistically significant, which means that 1% decline in potato consumption leads to 1.42% increase in potato exports and 1% increase in consumer price leads to 1.11% increase in potato exports. Potatoes planted area and production did not prove to have a statistically significant impact.

Accordingly, it can be said that the estimated structural relationships are statistically significant and revealed the positive, clear and significant interaction between endogenous variables. Where 1% increase in potato consumption leads to 0.07% increase in total production, 1% decline in lagged farmgate price leads to 0.034% increase in total production, 1% increase in potato planted area leads to 1.09% increase in total potato production, 1% increase in potato production leads to 0.83% increase in potato consumption, 1% decline in consumer price leads to 0.34% increase in total consumption, 1% decline in potatoes consumption leads to 1.42% increase in potato exports, and finally, 1% increase in consumer price leads to 1.11% increase in potato exports.

Table 2. Results of Estimating the Reduced Form of the Econometric Model used to Determine Major Economic Variables Influencing Egyptian Potato Exports over the Period 2000-2016.

Eq. No.	Dependent Variable	Model Equation	R^2	F	Durbin-Watson Stat.
1	Total Potato Production (1000 Tons)	Log TPt = 0.676 + 0.066 Log QC_t – 0.014 Log QE_t – 0.034 Log $FP_{(t-1)}$ + 1.088 Log CA_t (5.71)** (2.87)** (-1.76) (-2.09)* (4.67)**	0.999	299.7**	2.80
2	Total Potato Consumption (1000 Tons)	Log QCt = 1.53 + 0.834 Log TPt + 0.129 Log QEt – 0.342 Log CPt – 0.314 Log POPt (0.41) (4.16)** (1.65) (-2.16)* (-0.32)	0.913	43.22**	1.37
3	Potato Exports (1000 Tons)	Log QEt = 6.55 – 8.21 Log TPt + 1.42 Log QCt + 1.11 Log WPt + 10.82 Log CAt (1.84) (-1.51) (2.86)** (2.93)** (1.81)	0.560	6.10**	1.74

Where, Values between parentheses refer to calculated t * Significant at 0.05 level ** Significant at 0.01 level
Source: calculated from the Annex 1 and 3

Nominal Protection Coefficient (NPC) & Results of Estimating Partial Equilibrium Model

Price Protection Indicators

Nominal Protection Coefficient (NPC): Direct or indirect governmental intervention in the markets of agricultural products leads to imbalances between domestic and international commodity prices, represented in border prices. It was therefore necessary to estimate Nominal Protection Coefficient (NPC) to measure price distortions or deviations between farmgate prices and border prices. Border price reflects the actual direct value of opportunity cost that the country might incur or benefit from. A value of NPC that equals one means no internal taxes or protection, i.e., the country follows a neutral policy. A value of NPC greater than one indicates internal protection and subsidy to producers. Finally, a value of NPC less than one indicates that implicit tax is imposed on producers.

It is clear from Table-3 that average Nominal Protection Coefficient for potato during the first period reached 0.868, then declined to 0.842 during the second period, down by 37.83%. This means that potatoes producers received 87.6% and 84.2% of their product's value over the two periods, respectively. In other words, the government has been imposing taxes [(1)] on potato producers in favor of domestic consumers during the first period, where farmgate price recorded values less than the values of border price along the time series, with 2004 recording the highest decline, where potato producers received only 55.5% of their product's value in world price, while 2002 recorded the lowest decline, where potato producers received 90.5% of their product's value in world price. During the second period, the government has been imposing taxes on producers in favor of domestic consumers, with 2004 recording the maximum value, where potato producers received around 68.9% of their product's value in world price, while the lowest decline was recorded in 2012, during which potato producers received 89.8% of their product's value in world price. However, potato producers received governmental subsidy in 2000, 2001 and 2009, where nominal protection coefficient reached 1.43, 1.132 and 1.287 for the mentioned years, respectively.

Nominal Rate of Protection: Nominal rate of protection is an indicator that measures the degree of governmental intervention, either by imposing taxes on producers, offering them subsidy, or not. A nominal rate of protection that equals zero means neither taxes are imposed on producers, nor internal protection or subsidy; a value greater than zero means producers receive internal protection or subsidy; finally, a value less than zero means an implicit tax is internally imposed on producers. It can be noted from Table-3 that the calculated average nominal rate of protection for the first period is -0.132, but then increased to -0.158 during the second period, indicating that taxes imposed on potato producers increased by 19.29%. This result means that taxes imposed on potato producers during the two periods reached 13.2% and 15.8%, respectively. It can also be noticed that nominal rate of protection for the years 2000, 2001 and 2009 returned positive values [(**)], indicating that the government used to offer subsidy to potato producer during that period.

[1]Taxes in this research refer to direct taxes, like real estate taxes on farmlands, and indirect or implicit taxes, like taxes on production and exports.

Table 3. Farmgate Price and Border Price in thousand US$ per Ton, Nominal Protection Coefficient and Nominal Rate of Protection for Potato Producers over the Period 2000-2016.

Year	Farm price P_d (1000 US$)	Border price P_b (1000 US$)	Nominal Protection Coefficient (NPC)	Nominal Rate of Protection (NPC-1) %
2000	0.181	0.126	1.43	0.43
2001	0.158	0.14	1.132	0.132
2002	0.141	0.156	0.905	-0.095
2003	0.122	0.169	0.724	-0.276
2004	0.112	0.202	0.555	-0.445
2005	0.12	0.165	0.729	-0.271
2006	0.149	0.233	0.637	-0.363
2007	0.216	0.261	0.83	-0.17
First Period's Average	**0.15**	**0.181**	**0.868**	**-0.132**
2008	0.178	0.229	0.775	-0.225
2009	0.19	0.148	1.287	0.287
2010	0.194	0.223	0.87	-0.13
2011	0.215	0.285	0.754	-0.246
2012	0.181	0.202	0.898	-0.102
2013	0.206	0.269	0.768	-0.232
2014	0.169	0.245	0.689	-0.311
2015	0.188	0.225	0.837	-0.163
2016	0.17	0.243	0.701	-0.299
Second Period's Average	**0.188**	**0.23**	**0.842**	**-0.158**
% Change between the two periods	**25.326**	**26.585**	**-2.942**	**-0.225**

Nominal Protection Coefficient (NPC) = Farmgate Price ÷ Border Price
Nominal Rate of Protection (%) = Nominal protection coefficient (NPC)-1
Source: Calculated from the Annex-2

Efficiency Indicators: Economic efficiency can be measured using three indicators, namely, net economic loss in production, net economic loss in consumption, net economic loss for the society (net impact on exports).

Net Economic Loss in Production: Results presented in Table-4 reveal that net economic loss in potato production during the first period (2000-2007) recorded an average of US$24.42 million, but then increased to US$ 31.38 million during the second period, up by 28.52%. It can also be noticed that years during which the imposed taxes are higher, net economic loss in production is also higher, and vice versa. Net economic loss and implicit taxes imposed on producers recorded maximum values of US$80.48 million and 44.5% in 2004 during the first period. By contrast, net economic loss and implicit taxes recorded minimum values of US$1.358 million and 9.5% during 2002, respectively. In regards to the second period, net economic loss and implicit taxes recorded maximum values of US$69.37 million and 31.1% during 2014, respectively, while recorded minimum values of US$4.85 million and 10.2% in 2012, respectively. The low value of net economic loss for producers during the first period can be attributed to the high farmgate prices of potato that recorded values close to the border prices. On the other hand, the high value of net economic loss for producers during the second period can be attributed to farmgate prices that recorded values less than the border prices, which resulted in a lower volume of production at the prevalent domestic farmgate price compared the volume of production at border price. This result means that production resources are not efficiently allocated, i.e., they are allocated to less productive activities, as shown in the Annex-1.

Net Economic Loss in Consumption: Results in Table-4 reveal that net economic loss in potato consumption during the first period (2000-2007) recorded an average of US$2.93 million, but then increased to US$33.4 million during the second period, up by 1038%. It can also be noticed that years during which the imposed taxes are higher, net economic loss in production are also higher, and vice versa. During the first period, net economic loss recorded a minimum value of US$4.851 million in 2002, during which implicit taxes imposed on producers recorded its minimum value. In regard to the second period, net economic loss recorded a minimum value of US$19.773 million in 2012, during which implicit taxes imposed on producers recorded its minimum value.

Table 4. Results of Applying Partial Equilibrium Model on Potato Crop Grown in Egypt over the Period 2000-2016.

(Value in US$ Million).

Year	NET Economic Loss in Production (NELP)	NET Economic Loss in Consumption (NELC)	Change in Producer Surplus (PS)	Change in Consumer Surplus (CS)	Change in Governmental Revenue (GR)	Change in hard Currency Proceeds (FE)	NET Impact
2000	12.665	-23.749	83.418	-71.578	-0.755	-51.583	11.085
2001	1.797	-6.834	33.322	-26.29	-1.995	-76.222	5.036
2002	1.358	4.851	-30.834	28.14	3.514	-130.593	-6.209
2003	15.921	8.716	-110.967	82.538	3.791	-178.259	-24.637
2004	80.478	6.782	-309.475	172.973	49.242	-392.273	-87.259
2005	23.041	5.115	-164.423	85.943	50.324	-207.827	-28.156
2006	49.114	19.093	-245.312	150.91	26.195	-375.369	-68.207
2007	10.946	9.504	-133.034	98.367	14.217	-240.928	-20.45
First Period's Average	**24.42**	**2.93**	**-109.66**	**65.13**	**18.07**	**-206.63**	**-27.35**
2008	23.43	29.16	-207.517	140.217	14.711	-467.547	-52.59
2009	15.185	-42.996	140.105	-105.662	-6.632	-193.798	27.811
2010	6.874	20.325	-112.049	77.453	7.397	-419.386	-27.199
2011	43.385	42.846	-346.89	224.811	35.848	-701.506	-86.231
2012	4.849	19.773	-102.437	69.795	8.02	-483.812	-24.622
2013	35.372	54.664	-301.66	201.093	10.531	-774.511	-90.036
2014	69.372	60.456	-420.28	251.255	39.197	-835.595	-129.828
2015	15.474	41.673	-196.985	122.973	16.865	-702.167	-57.147
2016	68.455	74.731	-433.855	208.709	81.96	-956.661	-143.185
Second Period's Average	**31.38**	**33.40**	**-220.17**	**132.29**	**23.10**	**-615.00**	**-64.78**
%Change between the two periods	**28.52**	**1038.21**	**100.77**	**103.14**	**27.86**	**197.63**	**136.86**

Source: Annex-2

The high value of economic loss observed during the second period might be attributed to the gap between consumption at border price and consumption at farmgate price, in addition to the higher direct and indirect taxes, which resulted in transferring consumption expenditure from high utility to less utility goods, a situation that led to misallocation of consumption expenditure. On the other hand, the low value of economic loss observed during the first period might be attributed to the high farmgate prices that approached border prices, which led to positive impacts on the efficiency of allocation and rationalization of consumption expenditure, as shown in annex-2.

Net Economic Loss for the Society (Net Impact): Results regarding variation in economic loss for the society, which is the outcome of economic loss for the producer and consumer, are presented in Table-4. It is clear that net economic loss for the society declines as implicit taxes imposed on producers decline. Results indicate that net economic loss for the society recorded an average of US$27.35 million for the first period, of which net economic loss for the producer and consumer represent 89.29% and 10.71%, respectively. However, average net economic loss for the society increased during the second period to a high of US$64.78 million, up by 136.86% compared to the first period's average, of which net economic loss for the producer and consumer represent 48.44% and 51.56%, respectively.

It can be observed that years during which the value of imposed taxes decline net economic loss for the society also declines, and vice versa. Results indicate that net economic loss for the society during the first period reached a minimum value of US$6.21 million in 2002, during which implicit taxes also reached minimum. During the second period, net economic loss for the society reached a minimum value of US$24.62 million in 2012, during which implicit taxes also reached minimum.

Welfare Indicators: Two indicators are used to measure welfare over the two study periods; these are change in producer surplus and change in consumer surplus.

Change in Producer Surplus: Results in Table-4 indicate that average loss in producer surplus for the first study period reached US$109.66 million, while reached US$220.17 million for the second period, up by 100.77%. It can also be noticed that burden beard by producers decline as implicit taxes decline, and vice versa, where the lowest burden producers' beard was that recorded in 2002 (US$30.83 million), while the highest burden producers' beard was that recorded in 2004 (US$309.48 million). Other years during which producers received subsidy, specifically in 2000 and 2001, they realized surpluses estimated at US$83.42 million and US$33.32 million, respectively. As for the second period, the lowest burden producers beard was that recorded in 2012 (US$102.44 million), while the highest burden beard was that recorded in 2016 (US$433.855 million). Such result means that potato producers realized gains in the years during which they received subsidy under governmental protection policy measures, as shown in Table-4.

Change in Consumer Surplus: Results in Table-4 indicate that average loss in consumer surplus for the first study period reached US$65.13 million, while reached US$132.29 million for the second period, up by 103.14%. It can also be noticed that burden beard by consumers decline as implicit taxes decline, and vice versa, where the highest burden consumers beard was that recorded in 2004 (US$172.97 million), while the lowest burden beard was that recorded in 2002 (US$28.14 million). Other years during which consumers received subsidy, specifically in 2000 and 2001, surplus realized reached US$71.58 million and US$26.29 million, respectively. As for the second period, the lowest burden consumers beard was that recorded in 2014 (US$251.26 million), while the highest burden beard was that recorded in 2012 (US$69.79 million). In 2009, the year during which producers received subsidy, consumers realized a surplus of US$105.66 million, which means that potato consumers realized gains due to consuming large quantities at low prices.

Governmental Revenue Indicators: Two indicators are used to measure welfare over the two study periods; these are change in government's revenue and change in the country's foreign currency proceeds.

Change in Government's Revenue: Results in Table-4 indicate that average government's revenue reached US$18.07 million for the first period, while reached US$23.10 million for the second period, up by 27.86%. It can also be noticed that the highest government's revenue during the first period was that realized in 2005 (US$50.324 million), the year during which implicit tax imposed on potato producers reached maximum. As for the second period, the highest value of government's revenue was that realized in 2016 (US$81.96 million), the year during which implicit tax imposed on potato producers reached maximum. However, losses in governmental revenue, estimated at US$0.755 million, US$1.995 million and US$6.632 million, were recorded in 2000, 2001 and 2009, respectively, which are the years that witnessed governmental subsidy.

Change in the Country's Foreign Currency Proceeds: Results in Table-4 indicate that average foreign currency proceeds declined by US$206.63 million during the first period, while declined by US$615 million during the second period, pushing deficit up by 197.63%. It can also be noticed that deficit in foreign currency proceeds

increases as taxes imposed increase. The highest deficit during the first period was that recorded in 2004 (US$392.27 million), while the highest deficit during the second period was that recorded in 2016 (US$956.66 million). The higher decline in foreign currency proceeds during the second period can be attributed to the higher volume of production at the prevalent farmgate or domestic price, the increase in volume of consumption due to the real decline in domestic prices compared to world prices, coupled with the decline in potatoes exports during that period, which all led to lower exports value.

Recommendations: Given the fact that farmers are principal partners in the process of agricultural development, training and guidance should be provided to teach them apply exports-oriented production programs, where knowledge of farming methods are usually inherited from one generation to another.

i. It is important to promote expansion in planting such high-quality varieties that meet international quality standards in terms of color, texture and solid contents. It is also important to ensure that agricultural products are free from pesticide and fertilizers residues, which can be achieved with the help of the Egyptian Organization for Standardization and Quality affiliated to the Ministry of Trade and Industry.
ii. Attention should be devoted to designing and implementing programs that aim to improve yield per acre as one of the main factors influencing economic efficiency.
iii. It is very important to applying contract farming to potato producers.
iv. Tightening control-over-export procedures, in addition to equipping harbors and airports with refrigerators to store agricultural commodities targeted for exports

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Annex 1. Descriptive Statistics of Variables used in the Econometric Model.

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Total Production (1000 tons) Y1	**17**	1769.91	5029.02	3371.28	279.69	1153.19
Total Consumption (1000 tons) Y2	**17**	1756.00	4495.00	3009.79	245.57	1012.51
Exports Quantity (1000 tons) Y3	**17**	156.63	637.43	364.74	33.75	139.16
Lagged Farmgate Price (US$/ton) X1	**17**	112.20	216.30	170.00	7.81	32.21
Consumer Price (US$/ton) X2	**17**	188.32	588.94	360.40	28.83	118.86
World Price (US$/ton) X3	**17**	164.98	374.93	280.38	16.71	68.88
Population X4	**17**	63976.00	91023.00	76246.65	2017.72	8319.29
Total Area (1000 Acres) X5	**17**	185.37	456.13	321.16	23.58	97.24

Annex 2. Evolutions of Some Economic Variables on Potato Crop Grown in Egypt over the Period 2000-2016.

Year	Production 1000 tons Qd	Consumption 1000 tons Cd	Consumer Price US$ 1000	Farmgate Price US$ 1000 Pd	Border Price US$ 1000 Pb	Elasticity Supply of	Elasticity Of demand	Production at Border Price Qw	Consumption at Border Price Cw
2000	1769.91	1756	0.28	0.181	0.126	0.88	0.9	1303.3	881.05
2001	1903.13	1795	0.26	0.158	0.14	0.88	0.9	1708.3	1054.4
2002	1985.32	2222	0.23	0.141	0.156	0.88	0.9	2168.3	1568.6
2003	2039.35	1958	0.21	0.122	0.169	0.88	0.9	2722.6	1584
2004	2546.61	1999	0.22	0.112	0.202	0.88	0.9	4336.5	1848.2
2005	3167.43	2040	0.19	0.12	0.165	0.88	0.9	4199.8	1810.8
2006	2312.79	2004	0.31	0.149	0.233	0.88	0.9	3470.7	1553.9
2007	2760.46	2439	0.32	0.216	0.261	0.88	0.9	3255.5	2009.2
First Period's Average	**2310.63**	**2026.63**	**0.25**	**0.15**	**0.181**	**0.88**	**0.9**	**2895.63**	**1538.76**
2008	3567.05	3282	0.37	0.178	0.229	0.88	0.9	4475.1	2152
2009	3659.28	3503	0.42	0.19	0.148	0.88	0.9	2943.6	1476.7
2010	3643.22	3387	0.41	0.194	0.223	0.88	0.9	4119.4	1978.9
2011	4338.43	3826	0.44	0.215	0.285	0.88	0.9	5578.8	2601.1
2012	4758.04	4367	0.4	0.181	0.202	0.88	0.9	5230.9	2438.9
2013	4265.18	4096.5	0.51	0.206	0.269	0.88	0.9	5398.3	2345.4
2014	4611.07	4096	0.43	0.169	0.245	0.88	0.9	6434.2	2507.2
2015	4955.45	4495	0.52	0.188	0.225	0.88	0.9	5800.4	2219.6
2016	5029.02	3901	0.59	0.17	0.243	0.88	0.9	6913.3	1844
Second Period's Average	**4314.08**	**3883.72**	**0.45**	**0.188**	**0.23**	**0.88**	**0.9**	**5210.4**	**2173.7**
% Change between the two periods	**86.71**	**91.63**	**78.87**	**25.326**	**26.585**	**0**	**0**	**79.94**	**41.27**

Source: - Calculated using on data collected from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics, Bulletin of Agricultural Economics; Different Issues.
The Central Administration for Public Mobilization and Statistics, Foreign Trade Database, Foreign Trade Bulletins; Different Issues

Annex 3. Potato Crop Situation over the Period 2000-2016.

Year	Total Production (1000 tons) Y1	Total Consumption (1000 tons) Y2	Exports Quantity (1000 tons) Y3	Lagged Farmgate Price (US$/ton) X1	Consumer Price (US$/ton) X2	World Price (US$/ton) X3	Population X4	Area (1000 Acres) X5
2000	1769.91	1756	156.63	184.70	284.16	164.98	63976	185.37
2001	1903.13	1795	185.51	180.60	258.60	175.11	65336	196.98
2002	1985.32	2222	229.38	158.10	232.30	197.23	67976	204.08
2003	2039.35	1958	296.29	141.30	214.23	201.42	67976	204.72
2004	2546.61	1999	381.51	122.00	220.69	241.09	69330	257.43
2005	3167.43	2040	392.18	112.20	188.32	208.40	70668	312.04
2006	2312.79	2004	367.13	120.10	311.41	272.79	73009	228.52
2007	2760.46	2439	389.70	148.60	324.22	321.86	73655	266.74
First Period's Average	**2310.63**	**2026.63**	**299.79**	**145.95**	**254.24**	**222.86**	**68991**	**231.98**
2008	3567.05	3282	397.94	216.30	372.33	327.29	75225	339.80
2009	3659.28	3503	215.08	177.80	416.37	297.36	76823	342.19
2010	3643.22	3387	298.56	190.30	414.84	318.53	78728	347.30
2011	4338.43	3826	637.43	193.70	442.49	371.51	80410	405.59
2012	4758.04	4367	262.99	214.60	396.84	308.59	82550	437.83
2013	4265.18	4097	427.91	181.00	513.01	374.93	84629	395.80
2014	4611.07	4096	599.54	206.10	431.50	350.99	86723	425.02
2015	4955.45	4495	554.89	168.80	516.52	307.61	88156	454.11
2016	5029.02	3901	407.97	188.40	588.94	326.70	91023	456.13
Second Period's Average	**4314.08**	**3883.72**	**422.48**	**193.00**	**454.76**	**331.50**	**82696**	**400.42**
% Change between the two periods	**86.71**	**91.63**	**40.92**	**32.24**	**78.87**	**48.75**	**19.87**	**72.61**

Source: Calculated using on data collected from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration for Agricultural Economics, Bulletin of Agricultural Economics; Different Issues.