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A CGE Analysis of the Impact of Agricultural Sector Productivity on the Algerian Economy

أثر مردودية القطاع الفلاحي في الاقتصاد الجزائري
ـ تحليل باستخدام نموذج التوازن العام القابل للحساب ـ

Touitou Mohammed [(1)]:Faculty of Economic, Commerce and Management sciences, (University of Algiers 3). touitoutouitou@yahoo.fr
RIMI Riadh: Faculty of Economic, Commerce and Management sciences, (University of EL-OUED). riadh-rimi@univ-eloued.dz

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Abstract:

The principal focus of this paper is to show the Economic Impact of Increasing the Production Efficiency Parameter in the Agriculture Sector on the Algerian Economy by using a computable general equilibrium Analysis. In this study, different types of simulation are also considered in order to test the response of the economy, for that we used two scenario. The principal objective of this simulation is to examine the linkages of agricultural productivity growth on non-agricultural sectors. Model results indicate that a shift in the scale parameter by 10 percent in the value added function pushes total output, exports, imports and consumption up. Increase in output and employment in the non-agriculture sector is also significant. The effects are more positive when tariff is removed.

Key Words: Agriculture, SAM, Algerian Economy, Computable General Equilibrium Model.

الملخص بالعربية:

تركز هذه الدراسة بشكل أساسي على إظهار التأثير الاقتصادي لزيادة معلمة كفاءة الإنتاج في القطاع الزراعي على الاقتصاد الجزائري باستخدام نموذج التوازن العام القابل للحساب. في هذه الدراسة، يتم أيضًا استخدام أنواع مختلفة من المحاكاة من أجل اختبار استجابة الاقتصاد، لذلك استخدمنا سيناريوهين. الهدف الرئيسي من هذه المحاكاة هو دراسة الروابط بين نمو الإنتاجية الزراعية في القطاعات غير الزراعية. تشير نتائج النموذج إلى أن التغير في مقياس معلمة الكفاءة بنسبة 10 في المائة في دالة القيمة المضافة يدفع إجمالي الإنتاج والصادرات والواردات والاستهلاك إلى الزيادة. زيادة الإنتاج والعمالة في القطاع غير الزراعي كانت مهمة أيضًا. كما أن الآثار تكون أكثر إيجابية عند إزالة التعريفة الجمركية.

الكلمات المفتاحية: الزراعة، مصفوفة المحاسبة الاجتماعية، الاقتصاد الجزائري، نموذج التوازن العام القابل للحساب.

1The sending author

Introduction:

Agricultural sectors play a key role in the economics of any country, is considered as a basic pillar of the national economy and social development. Over the past three decades, its role has become dominant in various economic sectors, including economic growth.

In fact, agriculture is a sector of integration of a given economy and the interactions that upstream and downstream maintain with the different sectors especially agro-food which constitute the strategic segment of the food chain.

According to Mellor (2000), there are few countries where growth in economic activity has not been preceded or accompanied by growth in the agricultural and rural economy.

The economic literature has recently been enriched by important contributions in the analysis of growth processes and agriculture. Several authors have addressed the issue of the contribution of agriculture to economic growth by taking cases from a number of countries. A number of authors have shown the existence of a very significant causal link between agriculture and economic growth and that in a first stage of economic development, which must go through economic growth, the use of agriculture is imperative (Mellor, 1966; Lawrence, 1965; Kuznets, 1964; Krueger, Schiff & Valdes, 1998; Mundlak, Cavallo & Domenech, 1989 with the case of Argentina and Katircioglu for China

In the course of its history, Algerian agriculture has undergone continual restructuring, resulting in new modes of organization, production processes and variable levels of returns. Agriculture has always occupied a prominent place in the economy of Algeria regardless of any economic, legal or other economic transformation. This sector continues, as tradition, to feed most of the Algerian population.

During the last two decades, Algerian agriculture has undergone considerable economic and social changes. They took place following market liberalization efforts under the Structural Adjustment Program (SAP). The successive readjustments of the National Agricultural Development Plan (NADP), launched in 2000, brought new perspectives for agricultural development. This strategy is inspired by the goals of the World Food Summit and the Millennium for Development.

CGE models are a class of economy wide models that are widely used for policy analysis in developing countries. This paper provides a detailed documentation of an applied Computable General Equilibrium (CGE) model of Algeria. The purpose of this paper is to serve as a source of background information for analysts using the model in the context of the current project and in the future.

The applied Algerian model can be used for analyses in a relatively wide range of areas, including agricultural, trade, tax and subsidy policies. It is characterized by a detailed treatment of the labor market and households, permitting model simulations to generate information about the disaggregated impact of policies on household welfare.

As part of the project research activities, the model will be used to analyze trade, fiscal policy, and agricultural issues. The model is built around a 2013 Social Accounting Matrix (SAM) for Algeria, developed in the context of the current project.

Like most other CGE models, the Algerian CGE model is solved in a comparative static mode. It provides a simulation laboratory for doing controlled experiments, changing policies and other exogenous conditions, and measuring the impact of these changes. Each solution provides a full set of economic indicators, including household incomes; prices, supplies, and demands for factors and commodities (including foreign trade for the latter); and macroeconomic data.

The model is built around a 2013 SAM for Algeria. Most of the model parameters are set endogenously in a manner that assures that the base solution to the model exactly reproduces the values in the SAM – the model is "calibrated" to the SAM. (The remaining parameters, a set of elasticities, are set exogenously.) However, as opposed to the SAM, which is a data framework that records payments, the model contains the behavioral and technical relationships that underlie these payments (Thorbecke 1985).

1- Literature review: The Role of Agriculture in Economic Development

The question of the importance of agriculture in development has been the subject of much study in the economic literature. Some economists believe that agriculture does not play an active role in the development process (Byerlee, De Janvry & Sadoulet, 2009; Brooks, 2009; Timmer, 1988; to name but a few). According to them, economic development in a country is inevitably accompanied by a decrease in the share of agriculture in employment and GDP. This could be explained by the fact that the elasticity of demand for non-farm goods in relation to income is greater than that of agricultural goods. Thus, investing in the agricultural sector was not a priority to stimulate development. Fisher (1939) was one of the first economists to support this point of view, which was later formalized by Lewis (1955) and Kuznets (1957).

For Lewis (1955), the development process results in a shift in the production factors of the agricultural sector characterized by low productivity due to the use of traditional production techniques, to the industrial sector marked by high productivity. This theory served to justify the priority given to industrialization in the development policies to the detriment of agriculture (sector taxation). (Kirkpatrick & Barrientos, 2004).

Unlike previous authors, others argue that agriculture plays an active role in the development process. One of the earliest theories supporting this point of view was developed by Fei and Ranis (1961) and Jorgenson (1961). With dualistic models that divide the economy into two sectors, namely, the modern sector characterized by profit maximization and the accumulation of physical capital, and the traditional sector dominated by subsistence agriculture, these authors show that agriculture is the lever of development of the industrial sector. In fact, there is a surplus of labor in the traditional sector that can be transferred to the modern sector without the risk of a decrease in agricultural production.

On the other hand, the growth of the industrial sector could be strangled when all the surplus of the labor force of the agricultural sector is absorbed. In addition, continued migration of workers from the agricultural sector to industry could lead to higher relative prices for agricultural products. On the basis of these ideas, Johnston and Mellor (1961) show that industrialization is preceded by a phase of dynamic growth in the agricultural sector. They identify some active roles of successful farming in the development process that are summarized in four points. First of all, agriculture provides the manpower necessary for the functioning of modern sector enterprises as well as the foodstuffs needed to feed this labor force thus preventing food prices and wages to rise. Secondly, the agricultural sector is a market for the sale of products from the industrial sector. That is why an increase in rural household income with the growth of agricultural production is vital to provide a market for locally manufactured goods (Adelman, 1984). In addition, through exports of agricultural goods, accumulated currencies can be used to finance imports of capital goods. Finally, since agriculture is

a large sector in the developing countries, it is the only one able to mobilize the necessary savings to finance the industrial sector.

From the 1990s, several models of endogenous growth including the agricultural sector were developed to analyze the role of agriculture in development. Matsuyama (1991) develops an endogenous growth model in two sectors. In contrary in Mellor (1966), Schultz (1964), and Hayami and Ruttan (1971), Matsuyama's (1991) theoretical investigations allow us to qualify the important role of agriculture in dynamics growth and hence that of development.

For their part, Martin and Mitra (2001), based on an empirical analysis, refute the idea that the growth of agricultural productivity is slow. They use panel data from 50 countries over the period 1967-1992 and find that growth in productivity levels is faster in agriculture than in the industrial sector. They also show a convergence of agricultural productivity at the international level because of the rapid diffusion of innovations.

Gollin, Parente and Rogerson (2002) use a neoclassical model in which they integrate the agricultural sector to model the structural transformations that accompany development (agriculture is declining and the industrial sector is expanding). They conclude that low agricultural productivity can delay industrialization and development.

2- The Agriculture sector in Algeria

2-1 The Part of Agriculture in the Algerian Economy

The best economic indicator that can guide us on the participation of agriculture is undoubtedly the part of the latter in the formation of the GDP. It can be seen that the greater part of agriculture in the composition of the GDP is important and more one tends to consider that this country is an agricultural vocation. The more a country does not have suitable conditions for the practice of agriculture, the more it is part of the GDP is therefore insignificant.

Qatar and Kuwait are significant examples with 0, 1 and 0.3%. It is recognized that the contribution of agriculture is close to 23% of GDP in low-income countries, 10% in intermediate countries and 2% in high-income countries.

If we consider the evolution of agricultural participation in GDP since independence, we can only observe a chronic collapse of the agricultural sector in the Algerian economy. Currently, Algerian agriculture contributes 10% of GDP.

The agricultural sector has been eroded in a chronic and regular way since independence. While it was considered as the driving sector of the economy in terms of its value added of 2.1 billion dinars in 1963, it rose to 9.9 billion in 1980 while at the same time the total GDP was multiplied by 12 for the same period.

Agriculture contributes about 10% of GDP and employs 10.8 of the active population.

The tertiary sector contributes over 40% of GDP and employs nearly 60% of the labor force.

Industry contributes 47% of GDP and employs almost a third of the labor force. The oil and gas sector accounts for the majority of budgetary revenues and almost all operating revenues.

The agricultural sector has seen its production fall by 30% in recent years, despite reform policies and public investments. Agriculture has suffered the hardships of short-term easing solutions favored by successive governments. The oil rent has made it possible to cope with massive imports of agri-food products. Consumption has been sustained and continues to be supported by exclusive oil and gas revenues. Algerian

decision-makers must perceive the collapse of international oil prices as a severe warning that is a strong signal for efficient revival of the agricultural sector.

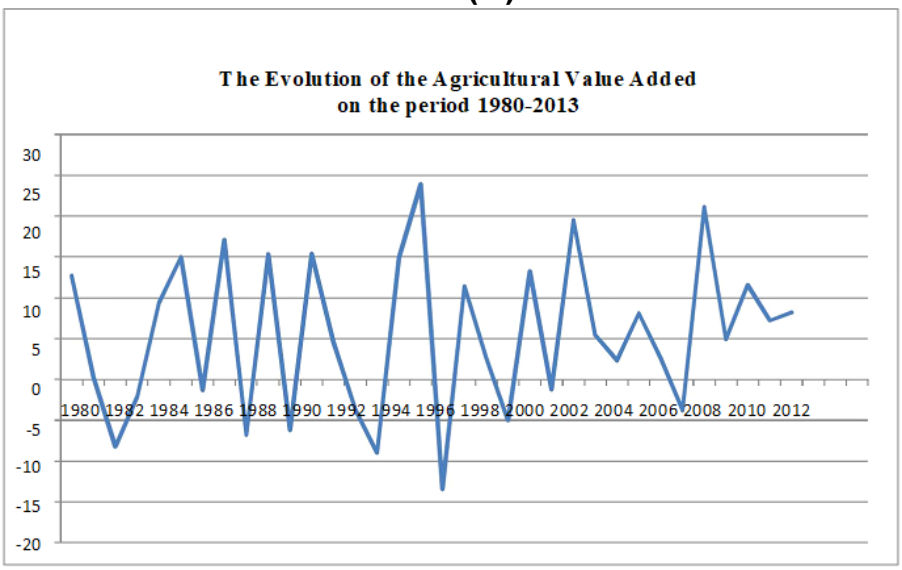
2-2 Weight of agriculture in employment

Employment is one of the major concerns of the public authorities for the establishment of a seine and solid economic policy. In the mid-1960s, Algeria adopted a development strategy focused mainly on the issue of employment because of the prevailing unemployment rate at that time which was close to 33%, but also the imperative to satisfy the projected employment demands of post-independence generations arriving at the labor market by 1980 "Thus public enterprises and the Administration recruited beyond their needs, leading to an artificial situation of almost full employment. From this point of view, the strategy was a success because the unemployment rate was divided by three: it dropped from 32.9% in 1966 to less than 11% in 1984 "(Arhab, 2005).

2-3 The part of agriculture in the value added

Since independence, the agricultural sector has not only undergone major changes in its structure and dynamics, but also in its operation. These changes and mutations have affected the value produced each year.

Figure 01: The Evolution of Agricultural Value Added over the period 1980-2013 (%)



Source: The authors' calculation by using World Bank data.

The evolution of agricultural value added grew by 24% in 1995, compared to 2013, the agricultural sector performed well, exceeding that of 2013 which was 9%.

The examination of growth rates over a ten-year period (Figure 01) shows that the erratic nature of the evolution of agricultural production, with a succession of growth peaks and sharp declines in activity. In addition to natural phenomena (rainfall, alternation of production), this development can be explained by the fact that the sector is largely financed by the State. At the time of the subsidies, the farmers produce and essentially put the lands in irrigation, but once the subsidy is drawn, they abandon the lands leaving in fallow.

2-4 Weight of agriculture in other sectors of activity

Agriculture can have more or less effect on other sectors of activity. At the national level, it is interesting to show the relations between the different branches of activity since each branch uses for its intermediate consumption products from the other branches. Agriculture uses fertilizers from industry and services such as rental services or veterinary services. It uses itself its own products as intermediate consumption such as seeds. In addition, agriculture can generate significant training effects in the rest of the economy. For the year 2011, out of a total amount of 4,697, 455 million DA of all products 289,305 million DA, or 6.2% are consumed by the agricultural sector. The agriculture branch consumes nearly 22% of agro-food products (60 Million DA), 35% of products of various industries (20.87 million DA), 13.15% of agricultural products (84.47 million DA), 10% of services provided to enterprises (13.55 million DA) and 15.6% of services provided to households (7.93 million DA).

The agricultural products find their markets mainly in agribusiness and agriculture, but also in the transport sector. Let us say that, unlike other industrialized countries that integrate agricultural products into the industry, that biofuels and plastic chemistry, agricultural products are not or little used by the Algerian industrial branches other than agribusiness.

Transport and communications products rank third in intermediate consumption after the hydrocarbon branch and the transport itself. This intermediate consumption mainly concern the transport of crops, seeds, fertilizers and phytosanitary products, but also telephony, particularly mobile.

3- Methodology

3-1 Structure of the Model

This study is fanatical to estimate impacts (i.e. baseline estimation and simulation target) of Increasing the Production Efficiency Parameter in the Agriculture Sector on the Algerian Economy and quantifies the linkages between recession and economic instability**.** The Algerian computable general equilibrium model is presented in this section, which is a set of non-linear simultaneous equations followed by Lofgren, et al (2002), where the number of equation is equal to the number of endogenous variables. This section introduces the framework of the CGE model and algorithm for solving the objectives. The equations are classified in six different blocks, system constraints block as follows.

A-Price Block

The price system of the model is rich, primarily because of the assumed quality differences among commodities of different origins and destinations (exports, imports, and domestic outputs used domestically). The price block consists of equations in which endogenous model prices are linked to other prices (endogenous or exogenous) and to non-price model variables.

Import Price

$$PM_c = pwm_c(1 + tm_c) \cdot EXR \qquad (1)$$

Where PM_c is import price in LCU (local-currency units) including transaction costs, tm_c is the import tariff rate, pwm_c is the import price in FCU (foreign-currency units), EXR is the exchange rate (LCU per FCU).

The import price in LCU (local-currency units) is the price paid by domestic users for imported commodities (exclusive of the sales tax). Equation (1) states that it is a transformation of the world price of these imports, considering the exchange rate and

import tariffs plus transaction costs (the cost of trade inputs needed to move the commodity from the border to the demander) per unit of the import.

Export Price

$$PE_c = pwe_c(1 + te_c) \cdot EXR \qquad (2)$$

Where $PE_c$the export price (LCU) is, te_c is the export tax rate, pwe_c is the export price (FCU).The export price in LCU is the price received by domestic producers when they sell their output in export markets. This equation is similar in structure to the import price definition. The main difference is that the tax and the cost of trade inputs reduce the price received by the domestic producers of exports (instead of adding to the price paid by domestic demanders of imports).

Absorption

The absorption PQ_cQQ_c by the domestic demanders is the function of quantity supplied to the domestic market can be expressed as:

$$PQ_cQQ_c = [PD_cQD_c + PM_cQM_c](1 + tq_c) \qquad (3)$$

Where: PQ_c=composite commodity price, QQ_c = quantity supplied to domestic market, PD_c= domestic price of domestic output, QD_c= quantity of domestic output sold domestically and tq_c= sales tax rate.

Similarly the domestic output value, activity price and value added can be expressed as:

$$PX_c \cdot QX_c = PD_cQD_c + PE_cQE_c \qquad (4)$$

Activity price

$$PA_a = \sum_{c \in C} PX_{ac}\, \theta_{ac} \qquad (5)$$

Value added price

$$PVA_a = PA_a - \sum_{c \in C} PQ_c\, ica_{ca} \qquad (6)$$

Where: PX_c= producer price, QX_c= quantity of domestic output, PVA_a= value added price, PA_a= activity price, θ_{ac}= yield of commodity c per unit of activity a, and$c \in C$ where C is commodities.

B-Production and trade block

The production and trade block covers four categories: domestic production and input use; the allocation of domestic output to home consumption, the domestic market, and exports; the aggregation of supply to the domestic market (from imports and domestic output sold domestically); and the definition of the demand for trade inputs that is generated by the distribution process. Production is carried out by activities that are assumed to maximize profits subject to their technology, taking prices (for their outputs, intermediate inputs, and factors) as given. In other words, it acts in a perfectly competitive setting. This block defines production technology and demand for factors as well as CET (constant elasticity of transformation) functions combining exports and domestic sales, export supply functions and import demand and CES (constant elasticity of substitution) aggregation functions. This block contains several functions and equations for the production side of the economy as follows:

Activity production function

$$QA_c = ad_a \prod_{f \in F} QF_{fa}^{\alpha_{fa}} \quad (7)$$

Factor demand

$$\mathrm{WF_f WFDIST_{fa}} = \frac{\mathrm{a_{fa} PVA_a QA_a}}{\mathrm{QF_{fa}}} \quad (8)$$

Intermediate demand

$$\mathrm{QINT_{ca}} = \mathrm{ica_a QA_a} \quad (9)$$

Output function

$$\mathrm{QX_c} = \sum_{\mathrm{a \epsilon A}} \theta_{\mathrm{ac}}\, \mathrm{QA_a} \quad (10)$$

Composite supply (Armington) functions

$$\mathrm{QQ_c} = \mathrm{aq_c}\left(\delta_{\mathrm{c}}^{\mathrm{q}} \mathrm{QM_c^{-p_c^q}} + \left(1-\delta_{\mathrm{c}}^{\mathrm{q}}\right)\mathrm{QD_c^{-p_c^q}}\right)^{\frac{-1}{\mathrm{p_c^q}}} \quad (11)$$

Import-domestic demand ratio

$$\frac{\mathrm{QM_c}}{\mathrm{QD_c}} = \left(\frac{\mathrm{PD_c}}{\mathrm{PM_c}} \frac{\delta_{\mathrm{c}}^{\mathrm{q}}}{\left(1-\delta_{\mathrm{c}}^{\mathrm{q}}\right)}\right)^{\frac{1}{1+\mathrm{p_c^q}}} \quad -1 < \mathrm{p_c^q} < \infty \quad (12)$$

Composite supply for non-imported commodities

$$\mathrm{QQ_c} = \mathrm{QD_c} \quad (13)$$

Output transformation function

$$QX_c = at_c\left(\delta_c^t QE_c^{p_c^t} + (1-\delta_c^t) QD_c^{p_c^t}\right)^{\frac{1}{p_c^t}} \quad (14)$$

Export-domestic demand ratio

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PD_c}\frac{(1-\delta_c^t)}{\delta_c^t}\right)^{\frac{1}{p_c^t-1}} \quad -1 < p_c^t < \infty \quad (15)$$

Output transformation for non-exported commodities

$$QX_c = QD_c \quad (16)$$

Where: QA_c= activity level, $QF_{fa}^{\alpha_{fa}}$= quantity demanded of factor f by activity a, $WFDIST_{fa}$= wage distortion factor for f in a, $QINT_c$= quantity of c used in activity a, WF_f= average wage (rental rate) of factor f, ad_a= production function efficiency parameter, ica_a= *quantity of c as intermediate input per unit of activity a,* qg_c = *government commodity demand,* δ_c^q= *share parameter for composite supply (Armington)function,* δ_c^t= *share parameter for output transformation (CET) function,* p_c^q= *exponent for composite supply (Armington)function,* at_c= *shift parameter for output transformation (CET) function,* , p_c^t=*exponent for output transformation (CET) function* and$f \in F$ is the fictional from where F is factors with f being labor or capital.

C-Institution block

This block consists of equations that map the flow of income from value added to institutions and ultimately to households. These equations fill out the inter-institutional entries in the SAM (Social Accounting Matrix of Algeria. This block contains several functions and equations for the institution side of the economy as follows:

Factor income

$$YF_{hf} = shry_{hf} \sum_{a \in A} WF_f WFDIST_{fa} QF_{fa} \qquad (17)$$

Non-government domestic institution

$$YH_h = \sum_{f \in F} YF_{hf} + tr_{h,gov} + EXR \cdot tr_{h,row} \qquad (18)$$

Household consumption demand

$$QH_{ch} = \frac{\beta_{ch}(1 - mps_h)(1 - ty_h)YH_h}{PQ_c} \qquad (19)$$

Investment demand

$$QINV_c = qinv_c \cdot IADJ \qquad (20)$$

Government revenue

$$YG = \sum_{h \in H} ty_h \cdot YH_h + EXR \cdot tr_{gov,row} + \sum_{c \in C} tq_c \left(PD_c QD_c + PM_c QM_c\right) + \sum_{c \in CM} tm_c EXR \cdot pwmc_c \cdot QM_c + \sum_{c \in CE} te_c\, EXR \cdot pwe_c \cdot QE_c + ygi \qquad (21)$$

Government expenditures

$$EG = \sum_{h \in H} tr_{h,gov} + \sum_{c \in CE} PQ_c \cdot qg_c \qquad (22)$$

Where : YF_{hf}= transfer of income to h from f, WF_f= average wage (rental rate) of factor f,، $WFDIST_{fa}$= wage distortion factor for f in a, QF_{fa}= quantity demanded of factor f by activity a, YH_h= income of h, $tr_{h,gov}$= government transfer from household, QH_{ch} = quantity of consumption of commodity c by h, $QINV_c$= quantity of investment demand, $IADJ$= investment adjustment factor, YG= government revenue, $shry_{hf}$= share of the income from factor f in h, mps_h= share of disposable income to savings, ty_h= rate of income tax for h, $qinv_c$= base-year investment demand, $tr_{gov,row}$= government transfer to rest of the world and qg_c= government commodity demand.

D-System constraints block

This block defines the constraints that are must be satisfied by the economy as a whole. The model's micro constraints apply to individual factor and commodity markets. The system constrains in an economy as follows:

Factor markets

$$\sum_{\propto \in A} QF_{fa} = QFS_f \qquad (23)$$

Composite commodity markets

$$QQ_c = \sum_{\propto \in A} QINT_{ca} + \sum_{h \in H} QH_{ch} + qg_c + QINV_c \qquad (24)$$

Current account balance for ROW

$$\sum_{c \in CE} pwe_c \cdot QE_c + \sum_{i \in I} tr_{i.row} + TASV = \sum_{c \in CM} pwm_c \cdot QM_c + irepat \ + yfrepat_f \qquad (25)$$

Savings-Investment balance

$$\sum_{h \in H} mps_h \cdot (1 - ty_h) YH_h + (YG - EG) + EXR \cdot FSAV = ygi + EXR \cdot irepat + \sum_{c \in C} PQ_c \cdot QINV_c + WALRAS \qquad (26)$$

Price normalization

$$\sum_{c \in C} PQ_c \cdot cwts_c = cpi \qquad (27)$$

Where: QFS_f= supply of factor f, $QINT_{ca}$= quantity of c used in activity a, $FSAV$= foreign savings, $irepat$= investment surplus to ROW, $yfrepat_f$= factor income to ROW, EG= government expenditure,walras= dummy variable, $tr_{i.row}$= transfer to institution to ROW, cpi= consumer price index,$cwts_c$ = commodity weight in CPI.

The basic model of my study consists of 14 sectors, four institutional agents, two primary factors production, and the rest of the world (ROW). The 14 sectors where aggregated from the 2013 Algerian Input-Output table that is initially comprised of 22 sectors. The benchmark model representing the baseline economy is constructed using the social accounting matrix of Algeria 2013 as shown in annex. For the sectors, each sector is assumed to produce a single composite commodity for the domestic market and for ROW. There are four domestic final demand sectors. They are household, enterprise, government and an agent that allocate saving over investment demand from all production sectors. These institutions obtain products from both domestic production sectors and ROW (imports).

All producers are assumed to maximize profits and each faces a two-level nested Leontief and Cobb-Douglas production function (Lofgren, et al, 2002). Each commodity is produced by Leontief technology using intermediate input from various production sectors and primary inputs (labour and capital). The primary inputs are determined by Cobb-Douglas production function. To capture features of intra-industry trade for a particular sector, domestic products and products from ROW within the sector are assumed to be imperfect substitutes and their allocations are determined according to Armington CES (constant elasticity of substitution) function. On the supply side, output allocation between the domestic market and ROW are according to constant elasticity of transformation (CEF) function. On the demand side, a single household is assumed. The household is assumed to maximize utility according to Cobb-Douglas utility function subject to income constraint. Consumption demand for a sector's product is also a CES function of the domestically produced and imported

product. Government expenditure is specified as exogenously determined. Sectoral capital investments are assumed to be allocated in fixed proportions among various sectors. In terms of macroeconomic closure, investment is saving-driven and capital is assumed mobile across activities and fully employed. Labor is also fully mobile at fixed wage. Both factors are available in fixed supplies. Factor incomes are distributed to household and enterprise on the basis of fixed shares (derived from base-year data). Outputs are demanded by the final demand agents at market-cleaning prices and exchange rate is assumed flexible.

3-2 Simulation design

Description of the simulation

This section presents the results obtained from different policy simulations carried out using the CGE model developed for this study purpose. The simulations carried out are mostly based on the realistic situation of the economy and tried to fit with the trend of the economy.

In scenario 1, the impact of technological change in the agricultural sector is carried out by changing the efficiency parameter in the value-added function for the agriculture sector. In scenario 2, the efficiency simultaneously increases by 10 percent and elimination of the tariff in all importing sectors. The principal objective of this simulation is to examine the linkages of agricultural productivity growth on non-agricultural sectors. Simulation experiments are listed in Table 1 and the corresponding simulation results are presented sequentially.

Table 1: scenario codes and definition of the simulation

Scenario codes	Simulation specifications
Scenario 1	Increasing the production efficiency parameter in the agriculture sector by 10 percent to test the Impacts on the other sectors of the economy.
Scenario 2	Simultaneously increasing the efficiency by 10 percent and elimination the tariff in all importing sectors.

4- Model results and discussion

A CGE model is used to analyse Algerian's economic situation if the country moves further to improve the agriculture sector and find ways how the economy could change with this improvement. The principal database for the model is the input output table of Algeria for 2013, from which 38x38 social accounting matrix is construction using other data.
Model results indicate that:

Effects on macroeconomic variables:

The technological change simulated in the CGE model is assumed to be neutral and technological change is considered by increasing the scale parameter of the value added function exogenously in each of the agricultural sectors. The positive effect of the agriculture productivity growth can be seen in the increase in both the household and government income. Household's and government's incomes increase by 4.13 and 5.67 percent respectively (Table 1). GDP at factor cost (total value added) also increases by 4.64 percent. This agricultural productivity growth scenario is combined with trade liberalisation scenario by eliminating tariff in all the importing sectors, the combined

scenario shows a further improvement in the household consumption to 5.58 percent. GDP increases further and agricultural productivity increase causes a transfer of resources from agriculture to non-agricultural production.

Table2: Effect of 10 percent increase in shift parameter on macroeconomic variables

	Scen1	Scen2
Household income	4.13	5.58
GDP	4.646635	6.627248
Government income	5.672607	-3.62542
Government saving	14.3768	-19.2789
Private Consumption	4.0721	7.067186
Real balance of trade	-1.2487	-3.20725
Total investment	8.423322	-4.37504

Source: The authors' calculation by using GAMS simulation results

In the combined scenario, the change in the terms of trade shows an increase in both the exports and imports. But the increase in imports is higher than the increase in exports, causing a deterioration of the real balance of trade (Table1).

Effects on domestic output and trade:

The productivity increase in agriculture causes an increase in total output and GDP at factors costs by 5.65 and 2.81 percent respectively. The increase is further boosted by tariff removal, but interestingly the increase in productivity in agriculture pushes the output in almost all sectors in the economy up, explaining a strong relationship between agriculture and non-agriculture. In scenario 2, aggregate agricultural output increases by 3.21 percent and the same in the aggregate industry and aggregate services. In the combined scenario, the growth in industrial output is higher than the agricultural output. This is because the industrial sector uses more imported inputs than the agriculture and the elimination of tariff further boosts industrial output. But interestingly, the increase in the value added in agriculture is much higher than that of in industry in both scenarios. Boutista and Robinson (1996) got similar findings for the CGE model of the Philippines, where the productivity growth in the crop sectors, simulated by changing the shift parameter in the value added function, causes increase in both the agriculture and non-agricultural sectors.

Table3: Effects of 10 percent increase in the shift parameter on output and value added

	Output		**Value added**	
Sectors	Scen1	Scen2	Scen1	Scen2
Total	5.652563	9.647533	2.814289	3.214289
SEC1-C	7.824446	9.815543	4.653804	5.653804
SEC2-C	6.543348	10.50143	2.622378	3.622378
SEC3-C	3.848465	5.870997	2.715655	3.715655
SEC4-C	6.84176	9.810529	1.823708	2.823708
SEC5-C	7.000231	10.97316	2.051282	2.951282
SEC6-C	7.155248	11.11441	3.076923	3.976923
SEC7-C	6.00524	9.973523	1.27186	2.07186
SEC8-C	7.065289	12.03126	1.608579	2.308579
SEC9-C	5.410123	7.390387	0.983607	1.183607
SEC10-C	3.218122	5.221748	3.680982	4.280982
SEC11-C	0.342774	3.375486	1.826484	2.226484
SEC12-C	5.155282	9.136904	3.837953	4.737953
SEC13-C	4.21881	6.211586	1.79704	2.59704
SEC14-C	3.621648	7.614583	2.423469	3.523469

Source: The authors' calculation by using GAMS simulation results

Robinson et al. (1998) have also conducted simulations for both the positive and negative productivity growths in the agricultural sectors in Indonesia using a CGE model. They have considered positive productivity growth as a proxy of adopting new technologies. The results showed an increase in production and value added in both agricultural and non-agricultural sectors, showing a strong relationship between agriculture with other economic sectors.

In scenario 1, exports and imports increase in almost all the sectors except in the textile, clothing and socks sector, where imports decrease. In scenario 1, total import increase by 13.6 percent with a consequent increase in agriculture by 9.86 percent. The corresponding increase in total export is 10.89 percent and in agriculture by 7.07 percent and Steel, mechanical, metallurgical and electrical industries sectors by 16.36 percent. In the combined scenario, both the exports and imports increase very sharply.

Table4: Effects of 10 percent increase in the shift parameter on exports and imports

	Imports		**Exports**	
Sectors	Scen1	Scen2	Scen1	Scen2
Total	13.60658	16.68963	10.89628	13.87149
SEC1-C	9.86466	12.85574	7.074825	9.065935
SEC2-C	30.41778	33.37165	13.51971	17.4788
SEC3-C	13.23504	16.25875	0	0
SEC4-C	0	0	0	0
SEC5-C	31.38345	35.35389	15.0201	17.99403
SEC6-C	28.45639	32.41228	16.36639	19.32645
SEC7-C	31.01819	30.98356	12.10556	16.07456
SEC8-C	23.62324	27.58724	13.46381	17.43046
SEC9-C	17.10388	16.08374	9.494743	12.4751
SEC10-C	17.83387	16.83786	3.914089	5.917613
SEC11-C	8.000815	8.036184	-1.22364	-2.1918
SEC12-C	30.12525	29.10509	10.97414	13.95622
SEC13-C	11.33106	10.32131	5.697018	8.689785
SEC14-C	23.92525	21.91757	3.890654	5.883755

Source: The authors' calculation by using GAMS simulation results

Conclusion

The impact of the change in productivity in agriculture influences the model economy positively at both sectorial and macro level. A shift in the scale parameter by 10 percent in the value added function is considered as a productivity improvement in the agriculture sector. This pushes total output, exports, imports and consumption up. Increase in output and employment in the non-agriculture sector is also significant. The effects are more positive when tariff is removed.

Economic performance in Algeria is still highly dependent on hydrocarbure production and productivity growth in agriculture has a highly positive impact on the whole of the economy. This way, the policies which increase investment in agriculture are particularly recommended.

Appropriate policy measures should be taken to reap the maximum benefit of the change in productivity in agriculture as the farming community responds positively with it. Under various types of institutional difficulties, market imperfections, lack of infrastructural facilities, without active policy support and careful participation of the government in the system, maximum benefit of the policy reform could not be reached to the farming community.

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Annex:

Table: Sectoral Aggregation of Algerian Social Accounting Matrix (SAM) for year 2013(DZD thousand)

	A	C	L	C	H	E
Activities		13759741				
Commodities	4403061				3922963	
Labor	8273639					
Capital						
Household				5286439	7052	29228
Enterprises				2986615		5277
Government	1083040				797552	
Saving-Investment					1514413	1601408
Income tax					205540	1779176
Sales tax		542063				
Tariff		169055				
ROW		3690885	585		2943	133029
Total	13759741	18161745		8273640	6450466	3548120

G	S-I	Ytax	Tva	Tariff	ROW	Total
						13759741
1862704	4545845				3427170	18161745
						8273640
1102359					25387	6450466
542227					14000	3548120
701887		1984716	542063	169055	598871	5877188
1430023						4545845
						1984716
						542063
						169055
237986						4065430
5877188	4545845	1984716	542063	169055	4065430	

Source: Authors calculation