The Effect of External Oil price Shocks on the Algerian Economy in the Light of Trade Openness Simulation Using the Computable General Equilibrium Model

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Abstract:

This article aims to describe the effect of external oil price shocks on some variables of the Algerian economy such as local production, trade (import, export) by using the computable general equilibrium model.

The basic data of the model is the table of inputs and outputs of Algeria in 2013, which was identified by the social accounting matrix created by using national accounts data.

We have therefore tried to determine how the world price of oil affects the Algerian economy open to the shocks of trade liberalization, where we used a simulation of policy for the trade openness of the economy, which is the increase of 10% and the 30% drop in the price of oil.

The results of the study show that the tax revenues generated by the 10% increase in global oil prices were a reason to rely on the hydrocarbon sector and continued to depend on it instead of encouraging others sectors to be produced, such as the agricultural sector.

On the other hand, the tax revenues generated by the 30% fall in the price of oil led to a fall in the level of production and value-added in most sectors except in some sectors such as agriculture.

Keywords: Trade openness, Algeria, Oil price, Simulation, Computable general equilibrium model.

JEL classification codes: F14, C15.

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ملخص:

يهدف هذا المقال إلى وصف تأثير صدمات أسعار البترول الخارجية على بعض المتغيرات في الاقتصاد الجزائري مثل الإنتاج الوطني، التجارة (الاستيراد والتصدير)، باستخدام نموذج التوازن العام القابل للحساب.

البيانات الأساسية للنموذج هي جدول المدخلات والمخرجات للجزائر لسنة 2013، والذي تم تحديده باستخدام مصفوفة المحاسبة الاجتماعية التي تم إنشاؤها باستخدام بيانات المحاسبة الوطنية.

حاولنا تحديد الكيفية التي يؤثر بها السعر العالمي للبترول على الاقتصاد الجزائري المفتوح لصدمات تحرير التجارة، حيث استخدمنا محاكاة لسياسة الانفتاح التجاري للاقتصاد وهي الزيادة بـ 10٪والتخفيض بـ 30 ٪ في سعر البترول.

أظهرت نتائج الدراسة أن الإيرادات الضريبية الناتجة عن زيادة السعر العالمي للبترول بنسبة 10٪ كانت سببا في الاعتماد على قطاع المحروقات والاستمرارية في الارتكاز عليه بدلا من تشجيع القطاعات الأخرى مثل القطاع الزراعي. من ناحية أخرى، أدت الإيرادات الضريبية الناتجة عن التخفيض في السعر العالمي للبترول بنسبة 30٪ إلى انخفاض مستوى الإنتاج والقيمة المضافة في معظم القطاعات باستثناء البعض منها كالقطاع الفلاحي.

كلمات مفتاحية: الانفتاح التجاري، الجزائر، سعر البترول، المحاكاة، نموذج التوازن العام القابل للحساب.

1. INTRODUCTION:

The importance of trade openness for a country was mentioned by David Ricardo in (1817) in his theory of comparative advantages.

The author has shown that international exchange allows a differentiation of the relative costs of production, a reorientation of scarce resources towards the most efficient sectors and an improvement of the well-being of the population.

This theory was extended later by Heckscher and Olin (1933), these authors have confirmed these gains by adding those related to the remuneration of factors of production. (Alain, 1993)

When evaluating the effects of trade openness on an economy, computable general equilibrium models (CGEMs) are often used (lofgren, Harris, Robinson, 2001) because they remain the most appropriate for studying the economy. Impact on an economy of macro economic policies such as trade policies.

In particular, they make it possible to take into account the interactions between the different sectors of an economy, which is particularly useful for analyzing the impacts of trade openness on an economy. They are also more satisfactory than partial equilibrium analyses because they provide an overview of the channels through which policy implementation takes place.

It seems reasonable to expect the liberalization process to have a positive impact on some sectors or actors in the economy and negative for others. Most of the Computable General Equilibrium (CGEM) model used to assess the impacts of trade liberalization policies relies on neoclassical modeling as presented in Dervis and al. (1982), Lofgren and al. (2002) modeled on international food policy. Research Institute (IFPRI), or on the EXTER model of Decaluwe (2001).The Global Trade Analysis Project (GTAP) model is also widely used to analyze the impacts of trade liberalization policies, but still relatively low in the Caribbean and Pacific countries because of its multi-regional structure and the difficulty of having recent and reliable data for the countries of this region.

The growing importance of trade openness has generated considerable controversy among countries, particularly developing countries, as to their impact on economic activity. (Kim S.H, 2014)

This interest has increased in recent decades, coinciding with the emergence of the World Trade Organization which includes almost succeeding in imposing on them conditions which are centered on the inevitability of trade opening in order to adapt its policies with economic evolution in order to improve their economies.

The problem:

Since independence, the transformation of the Algerian economy has been characterized by a special situation resulting from the experience of central economic planning, which has dedicated the principle of "all-state", which has dominated for more than three years decades.

Algeria's development strategy was based on the model of manufacturing industries oriented by investment towards the production of intermediate consumer goods and equipment for the creation of industrial fabric this development strategy yielded important results over the period 1967-1984 with an average growth rate of more than 7%. (Benbitour, 1998)

When this growth did not benefit the national economy until it allowed the transfer of technology to the benefit of the industry, in particular the procedures adopted in the investment, which does not favor the transfer of technology, remains one of the weaknesses of the development of the Algerian economy.

The collapse of oil prices in 1986, combined with the depreciation of the dollar, has disastrously reduced the supply of machinery for the production of raw materials, leading to increased reliance on external debt, which ultimately affected the national economy.

This new situation is forcing the Algerian government to undertake economic reforms to stabilize the national economy with a new disengagement from the state and a move towards greater openness of the economy. With the liberalization of imports and the development of exports as pillars of the new economic development strategy.

Algeria, and like all other developing countries, is starting to feel the danger of globalization and its repercussions, which have led many

countries to economic integration to occupy competitive positions in order not to stay away from it all.

In this regard, it has been shown that a number of theoretical and applied studies determine the role of the policy of trade openness and in terms of the nature of data and methods of analysis, the positive role of openness in economic growth.

It is therefore possible to say that on the basis of the results obtained by some theoretical and applied studies in this respect on the one hand, as well as the openness of the Algerian economy, which is affected by the conditions of the world economy on the other hand and in general.

The principal focus of the study is to show the nature and extent of the incentives oil prices could provide on the way to further boost the economy of Algeria. It also tries to find out what the economic position would be, should the oil prices be decrease or increase.

In the light of study objectives, the major hypothesis will be as following:

- Algeria's economy is mainly supported by oil rents and dependent on the available crude oil deposits, the country has the capacity to sustain GDP growth, government expenditure and development growth. There exists a controversial empirical relationship between oil rents and economic growth in Algeria, and hence the need to initiate policy frameworks to sustain economic sustainability.
- The computable general equilibrium model is appropriate for measuring the effect of external shocks resulting from the application of the open trade policy to the Algerian economy.

To achieve this, it will be necessary to specify:

- Selection of the computable general equilibrium model proposed for the Algerian economy with reference to the social accounting matrix, which will serve the database to solve this model with the choice of the mathematical formula.
- The implementation of the model;
- The simulation of design and description;

- Finally draw the results of the model which done by using the program called General Algebraic Modeling System (GAMS).

To understand all aspects of the subject, we divided the research into two parts, a theoretical approach in which we moved to different theoretical concepts and a descriptive statistical analytical approach that focused on the collection and analysis of practical data used.

2. Literatures review:

Many researchers spent a great deal of their time looking into trade and trade related problems. It was only recently during the 1973 oil embargo by Arab countries that some researchers came to realize the effect of differences in oil exports in the light of activities of oil producing economies. The main aim of this paper is to review the related literatures essential to the theme chosen for this research work to this research.

The analysis of the macroeconomic effects of oil price shocks has received considerable attention in the literature (for recent surveys see Kilian (2008b) and Hamilton (2008)). Most of it focuses on industrialized countries, particularly on the US. This bias is even more noticeable in cross-country studies (Cologni and Manera (2008);Kilian (2008a); Peersman and Van Robays (2012)) with some notable exceptions such as Abeysinghe (2001), Cuñado and Pérez de Gracia (2005) and Cuñado et al. (2015) who have looked at the impacts of oil price shocks in the Asian region.

Some studies focus on the effects of oil prices under the framework of market structures. The effects of oil price increase on output and real wages have been shown by Rotemberg and Woodford (1996) in an imperfectly competitive market scenario. In their study, it has been shown that 1 percent oil price increase contributes to 0.25 percent output and 0.09 percent real wage decline. And these results have been supported by Finn (2000). Finn studies oil price and macroeconomic relationship under perfect competition. According to the author, the adverse effect of oil price increase on economic activity is indifferent to the market structure. Regardless of the

structure of the market, perfect or imperfect, oil price increase negatively affects economic activity.

Guo and Kliesen (2005) used a measure of realized volatility constructed from daily crude oil future prices traded on the Nymex, and find that, over the period 1984-2004, oil price volatility has a significant effect on various key US macroeconomic indicators, such as fixed investment, consumption, employment and the unemployment rate.

Jin (2008), in a comparative analysis, discovered that oil price increases exert a negative effect on economic growth in Japan and China and a positive effect on Russia. Specifically, a 10 per cent permanent increase in international oil prices is associated with a 5.16 per cent growth in Russian gdp and a 1.07 per cent decrease in Japanese gdp.

Elmi and Jahadi (2011) used var approach to analyze the effect of oil price shocks on economic growth fluctuations in selected opec and oecd countries for the period 1970-2008, and found that both opec and oecd countries are affected by oil price shock albeit at different degrees.

Berument et al. (2010) in a study on Middle East and North African countries found the asymmetric effects of world oil price shocks on the gdp of Algeria, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia, and UAE to be positive and statistically significant, while positive but insignificant results were reported for Bahrain, Egypt, Lebanon, Morocco and Yemen.

Farzanegan and Markwardt (2009) found a strong positive relationship between oil price changes and industrial output growth and real effective exchange rate for the Iranian economy. However, Lorde et al. (2009) found that unanticipated shock to oil price volatility brings about random swings in the macro economy of Trinidad and Tobago. However, only government revenue and the price level exhibit significant responses, while magnitude of oil price volatility responses tend to yield smaller macroeconomic impacts. Also, Granger-causality tests indicate causality from oil prices to output and oil prices to government revenue. Similarly, Bekhet and Yusop (2009) reveal evidence of a stable longrun relationship and substantial short

run interactions between the oil price and employment, economic growth and growth rate of energy consumption in Malaysia.

Chuku et al. (2011) studied the linear and asymmetric impacts of oil price shocks on the Nigerian economy for the period 1970Q1-2008Q4 using var model and Granger causality test approach; and found that oil price shocks are not a major determinant of macroeconomic activity in Nigeria in the linear model; while Granger causality results indicate that world oil prices do not influence macroeconomic activity and that non linear specification results show that the impact of world oil price shocks on the Nigerian economy are asymmetric.

Lescaroux and Mignon (2008) considered the effect of oil price changes on gdp, cpi, unemployment rate and bond price in opec member countries and some oil importing countries. In two cases, Iran and Saudi Arabia, causality is birectional. For Brazil and Oman causality runs from gdp to oil price. For other cases, oil price change causes gdp change.

Farzanegan and Markwardt (2008) analyzed the impact of oil price shocks on Iran's economy. The study estimated a VAR to analyze the dynamic relationship between oil price shocks and major macroeconomic variables. The study also pointed out the asymmetric effects of oil price shocks. The quarterly data included measures of industrial GDP per capita, government expenditures, inflation, imports, and exchange rate over the period Q2, 1975 to Q4, 2006. The results revealed that positive and negative oil price shocks significantly affect the inflation and the real exchange rate, but have a marginal impact on government expenditures. The results also suggested that positive oil price shocks increase industrial output by decreasing the price of imported inputs and negative oil price shocks reduce industrial output due to the higher price of imported inputs.

Aye et al. (2014) examined the effect of oil price shocks on the manufacturing production of South Africa by utilizing monthly data on oil prices and manufacturing production over the period February 1974 to December 2012. For this purpose, a modified bivariate VAR, GARCH-in-Mean VAR, and maximum likelihood tests were applied. The results

indicated that oil prices negatively affected South African manufacturing production and the response of manufacturing production towards the positive and negative oil price shocks were asymmetric.

Hamdi and Sbia (2013) study the dynamics among oil revenues, government spending, and growth in Bahrain. The authors find that oil revenues remain the principal source for growth and the main channel through which government spending is financed. Dizaji (2014) examines the effects of oil shocks on government expenditures and government revenues in Iran. The author finds that causality runs from oil revenues to government total expenditures. Their results also reveal that the contribution of oil revenue shocks in explaining the government expenditures is stronger than the contribution of oil price shocks. Akanbi and Sbia (2017) find empirical evidence of the effects of fiscal policy on the current accounts of oil exporting countries. Medina (2016) study the impacts of commodity price shocks on fiscal policy indicators in Latin American and find that fiscal aggregates rise in response to positive shocks to commodity prices. (Medina.L, 2016)

3. Social Accounting Matrix:

The social accounting matrix is a complete accounting system to represent a particular economy in a given period.

It is an analytical tool in national accounting to measure, present, analyze and interpret the benefits and costs in the economy of a given society, in order to evaluate its performance and determine its contribution to the well-being of society.

As stated in the United Nations System of National Accounts the matrix covers six main types of accounts: factors of production, economic units, economic sectors, products, capital accumulation and the outside world. (Nations, 1993)

It is presented in the form of a table or square matrix, which gives a complete and numerical picture of the most important macroeconomic aspects of a given economy over a given period of time. (Ismael, 2007)

The social accounting matrix belongs to the family of economic tables, such as the table of entries and exits, the general economic table. On the one hand, it provides a clear overview of the various transactions and exchanges that take place in a particular economy, On the other hand, decision-makers have an accounting framework for the analysis of economic policy and the easy choice of policy. (autres, 2001)

Matrix data come from national income accounts, various economic tables such as the table of inputs and outputs, census data, household surveys, public finances and foreign trade, such as the balance of payments. The United Nations System of National Accounts includes guidelines for the development of the social accounting matrix.

It is not easy to give a specific concept to the social accounting matrix, but it is a very important accounting framework, because they allow the development of all economic accounts by clarifying the production flows for all industries, factors of production as well as the calculations of incomes and expenditures for different economic units .

This is represented by a dual entry system each row in the matrix is represented by row and column, where the row represents the income and the column represents the expenses, the total flows in the row must be equal to the total flows in the column.

Although the matrix has a common form and structure, it can be disaggregated and subdivided into sub-accounts or by adding new accounts, depending on the nature of the economy studied and the problem identified, as well as the availability of data and information.

The social accounting matrix was first designed in the 1960s, a Cambridge University research team completed an English economic matrix whose data was used to solve the early growth models and used for purposes academic.

The first practical applications of the social accounting matrix date back to the mid-1970s, when a research team from the International Labor Office created a matrix for the Sri Lankan economy under the supervision of economists Richard Stone and GeeryPyatt.

4. The theoretical structure of the social accounting matrix:

The social accounting matrix is a square table with two entries for a given year, the different accounting flows are recorded from the income and expenditure of the economy studied. Revenues are given in lines indicated by i, expenses in columns are indicated by j.

The internal compatibility of the accounting nature of the social accounting matrix is guaranteed for each account , general revenues are the same as overhead.

$$\sum_{j} t_{ij} = \sum_{i} t_{ki}$$

Total Revenue = Total Expenses

4.1 The account of the factors of production:

The production factor account includes labor and capital and can be divided into sub-accounts. For example, the workforce can be divided into skilled and unskilled labor, depending on the needs of the study and the availability of data.

4.2 The account of economic units (economic agents):

This account includes activities for families, institutions, government and the outside world.

4. 3 The activity account:

The activity account includes income from the sale of goods and services in domestic and foreign markets. These revenues are spent on the purchase of intermediate goods, raw materials and factors of production, as well as for the payment of taxes.

4.4 Account of (goods and services):

The product account represents a department store that buys goods and services from local and foreign production activities and sells them to families, government, institutions and the outside world.

4. 5 Capital accumulation account (investment / savings):

The capital account includes the savings of families, corporations, the state and the outside world; expenditures are capital expenditures by gross capital accumulation, changes in inventories and funds transferred abroad.

4. 6 Account of the outside world:

Its income includes income from the goods and services account (imports) and transfers by economic units, expenditures include exports and transfers to various economic units.

Thus, the social accounting matrix is an analysis of all the accounting processes that take place during a given period and usually a year.

The information provided by the analysis makes it possible to analyze the impact of economic policies and to facilitate the choice of policies by decision-makers.

5. Close the social accounting matrix:

Different statistical approaches used in the creation of branch accounts, institutional sectors result in a difference between the balances of the different accounts.

The preparation of the various accounts is accompanied by a systematic review of the overall coherence of the system.

It is about balancing the supply and use of accounts by balancing the product accounts to reach the final overall balance of the social accounting matrix.

6. Reconciliation and balancing of the social accounting matrix:

The next step in developing or building of social accounting matrix is to balance all the matrix inputs generated by the expenditure and revenue calculations, that is, to balance all the total values of columns and rows.

However, before constructing the exact social accounting matrix that can be considered the appropriate data set for the computable general equilibrium model; some adjustments need to be made.

In order to align the matrix with the computable general equilibrium model, the aggregate social accounting matrix of an economy is considered an important element before preparing the ground for the discussion of the equations of the basic computable general equilibrium model.

7. The importance of the social accounting matrix in defining activity multiples:

7.1 The Leontief multiplier:

Multipliers measure the impact of additional demand tests and Leontief multiples that take into account tribal and distant productive links, which are required exclusively for intermediate consumption, it is recognized that each sectoral production requires fixed rate intermediate consumption noted aij. If we have:

$$X_{ij} = a_{ij} + X_j$$

Where X_{ij} represents the production in sector i sold in sector j as intermediate consumption and Xj the total production in sector j.

In this case, we assume that the economy is closed and that final and intermediate demand is satisfied by their local production needs. The balance between supply and demand in each sector is written as follows:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j F_i$$

Or F is the beam of demand:

$$X = AX + F$$
$$(I - A) X = F$$
$$X = (I - A)^{-1} F$$

Or: $(I - A)^{-1}$is a multiplier matrix of Leontief

8. The social accounting matrix of the Algerian economy for 2013:

In this section, we will present the social accounting matrix for the Algerian economy in 2013, the selection of this year as a reference year is explained on the basis of the available data of input and output tables published by the national statistics office for the year 2013.

8.1 Data sources used:

The sources used to construct the social accounting matrix are first an input-output table for the year 2013 which is originally a table representing a balance of resources for the use of goods and services and various data on intermediate consumption and value-added analysis to compensate for wages.

This table includes 19 activity sectors according to the functional classification established by the system of Algerian economic accounts as well as a table for the production account and the accounts (operation of the insurance companies - operation of the banks - real estate - public administration).

The second data source used is the 2013 General Economic Table, this table includes four accounts: the production account, the operating account, the income and expenditure account and the investment account according to the Algerian economic calculation system. The general economic picture for 2013 includes five clients: companies and similar companies, households and individual institutions, public administrations, financial institutions and the other world.

In addition to these two important sources of data in the creation of the social accounting matrix in general, we have also used other publications of the National Statistical Office as well as reports on the economic situation published by the Economic Council and social national.

8.2 Accounts of the social accounting matrix for the year 2013:

The matrix we constructed includes fourteen sectoral activities from the 19 activity groups of the 2013 Input-Output Table: Agriculture, Forestry, Fisheries (01), Petroleum Sector (03) and the Petroleum Services and public works (04).

The industrial sector is composed of a group of industrial branches for the input-output table for the year 2013 designates the industries of steel, mechanical, metallurgical and electrical (06), Industry of building materials (07), Chemistry Industrial, Plastic and Rubber (09), Food Industry (10), Textile Industry, Apparel and Socks (11), Leather and Footwear Industry

(12), Wood, Paper and Cork Manufacturing (13), Miscellaneous Industries (14), Mines and quarries (05).

The service sector includes transportation and communications (15), commerce (16), hotels, cafes, restaurants (17), institutional services (18), family services (19), the last section the Directorate of Water Power (02), Buildings, Public Works (08).

We explain the selection of this group to the nature of the problem studied and the nature of the model used, which requires at least ten sectors as well as the nature of the characteristics of the national economy.

The rest of the accounts belong to two accounts: the VAT account, the customs duties on the imports, the calculation of the income tax and the remaining accounts for the agents of production: hand, money and capital, and finally a special savings-investment account.

9 .Computable general equilibrium models applied to international trade:

The general equilibrium model is a complex system of mathematical equations illustrating and visualizing the nature and functioning of an economy based on the neoclassical economic theory of general equilibrium, a detailed description of production techniques, behavior and consumer preferences. Describe the optimal behavior of economic decision-making units or economic units (usually families, businesses, governments and the outside world).

The numerical solution of the model is obtained by using data from the social accounting matrix, an accounting table based on the double input system known in the national accounts for the representation of an economy in a given period of time.

This makes the model computable, and the model system is solved from simultaneous equations in real time using software with clear and easy-to-use language. The computable general equilibrium model is therefore applied to the theory of general equilibrium on the data of the social accounting matrix. (B.Ravikumar, 2016)

Among these models, the Johansen Leif model in 1960 for the study of economic growth in Norway and the Harberger model in 1962 to study the impact of tax policy on corporate profits in the United States, this approach is used as an analytical tool to study the effects of the implementation of long-term economic policies such as the liberalization of foreign trade, the introduction of a new type of taxation in the tax system and other policies economic.

Since the early 1980s, much work has been done using this modeling technique using advanced computer programs such as the Comprehensive Modeling System and the General Algebraic Modeling Process (GAMS).
Even the small type of general equilibrium models can be calculated, it can also be solved in a framework-based spreadsheet, such as Microsoft Excel.
Generally, in terms of international trade, there are two approaches to building computable general equilibrium models:

The construction of a multistate model in which each member of the integration structure is modeled in detail and interconnected by trade flows, for example the Bayat and Raownd models in 1984 for Malaysia and the construction of the famous model by Hicks 1988 in Australia. Kimble and Harrison in 1984 and Morgan in 1989 used multiregional models to analyze tax effects.

Jonas and Halley (1989) also presented a computable general equilibrium model for Canadian provinces that focuses on assessing the impact of government policies.

Derradov and Starn (1981) also developed a business valuation model, the best-known model for analyzing the trade liberalization problems of 34 industrialized and other developing countries, it has been used to assess the effects of reducing tariff barriers and non-tariff barriers.

Finally, we mention the Mirage model, built in 2002 to evaluate the European Union's trade policy with its environment.

Mirage is a multisectoral and multi-regional balancing model that includes elements of incomplete competition, product differentiation and foreign direct investment.

It is about building a model for the state where only the most involved partner is modeled, this model can only know the effects of integration by measuring the trade policy of this country with its partners to include it in the model.

In this section of the models includes the model of Boadway and Tridenic (1978) for Canada. and the famous model of Devris, Milo and Robinson (1982) from Turkey.

10. The structure of the computable general equilibrium model:

The computable general equilibrium model comprises four economic units: families, firms, governments (the state) and the outside world. (mourad, Manuel de comptabilité nationale, 1987) .

Economic units are defined as a group of economic agents who follow identical or similar economic behavior in the exercise of their economic functions.

10. 1 families: The family is the cornerstone of this sector and consists of a group of people living in a single dwelling: Individual establishments are included in this sector, such as small traders, craftsmen, doctors, lawyers, its main function is the consumption and production of goods and services. (mourad, Cours de comptabilité nationale, 1979)

Families seek to maximize their utility, which is a growing function of consumption: the more we consume, the more we benefit, but at higher levels of consumption.

The value of income is determined by the value of the work provided by these families, the interest rate.

A typical family is considered to express the rest of all families, or a group of them is taken when they are distinguished in terms of categories in terms of level of education, level of income, nature of work and other standards. (Anne, 1997)

10.2 companies:

Companies are defined as units whose main activity is the production of goods and services (the distinction is made between companies and similar financial and non-financial corporations in accounting systems).

The goal of companies is to maximize their profits, as in the global standard models: the production functions are used to express the techniques used and to relate the inputs of the production process to the factors of production limited to most labor and capital models.

In some models, land, raw materials and other factors are added, when the model is created, these factors are selected according to the desired uses and according to the nature of the economy studied.

10.3 Public Administration (Government or State):

Public administrations represent the state or the government, their main role is to provide non-commercial, free or semi-free services and redistribute income through taxes, fees and assistance.

In calculable general equilibrium models as in global econometric models, the role of the state is considered outside the model, which does not mean that the state plays no role in the economy, but that he has a role of government expenditure.

10. 4 The other world:

The other world includes a group of non-resident economic units with relationships with resident units: families, businesses, governments, and other organizations.

Most of the computable general equilibrium models are based on Paul Armington's theory of 1969, and he found that the goods produced by the country and the imported goods were replaceable.

Consumers prefer to choose between domestic and imported products based on relative prices, with exports being imported from other countries and affected by the competitiveness of exported products.

In the case of the assumption that capital circulates freely, the interest rate is determined in the world economy, it is considered externally in the

model, which distinguishes the model from its theoretical framework since one of the prices of the economy studied is determined externally.

11. Using the social accounting matrix in the computable general equilibrium model:

The numerical solution of the model is obtained by using matrix data of social accounting, an accounting table based on the double entry system known in the national accounts for the representation of an economy in a certain period of time. (Kehoe.T.J, 1996)

This makes the model computable, and the model system is solved from simultaneous equations in real time using software with clear and user-friendly language, thus, the computable general equilibrium model is applied numerically to the theory of equation general equilibrium of social accounting matrix data.

Most of the equations in the model are derived from partial economic theory, in particular from the neoclassical general equilibrium theory, which determines how the quantities of goods and services offered are affected by price changes in all the problematic markets of the world.

On the other hand, the analysis of the behavior of economic units is part of the macroeconomic analysis, and thus the general equilibrium model derives from the means of analysis and from the basis of microeconomic theory to analyze phenomena and macroeconomic variables.

The general equilibrium model is often designed to study a specific subject according to the nature of the subject, the type, the form and the degree of detail of the model. (DufforJ.M, 1998)

The one-sector model and the multisectoral model, and between the single-economy model and the multi-economy model.

Since the general equilibrium models can be computed according to Walrasian equilibrium theory, it is possible to make changes in the models according to the specificity of the studied economy, develop assumptions about the behavior of economic units or productive activities in the economy and the impact of changes resulting from economic policies,

crises and shocks on the economy studied through the results obtained from the model.

12. The computable general equilibrium model proposed for the Algerian economy:

12. 1 Choice of the model:

We have proposed a calculable general equilibrium model of the Algerian economy, which is a set of nonlinear real-time equations submitted by Lofgren and All 2002 which like most other computable general equilibrium models belong to classical models general equilibrium centered on trade liberalization. Or commercial openness in developing countries, described by Dervis de Melo and Robinson in 1982.

It is a modular static model, which allows the implementation of a set of policy simulations to modify policies and other external conditions, and measure the impact of these changes.

The computable general equilibrium model was used to analyze the state of the Algerian economy in the direction of greater liberalization of the trading system and its interaction with various external shocks, the basic data for the model was the table of entries and exits for the year 2013.

12. 2 Mathematical formula of the model:

The computable general equilibrium model for the case of Algeria presented in this section is mathematically a set of nonlinear real-time equations, used by Lofgren and Al 2002.

For convenience, the equations are classified into four blocks or groups: price, output, goods, institutions, and system constraints that are:

12.2.1 Price block: This block contains price equations with internal variables that describe the demand and supply of the model.

12.2.2 Block of production and trade: The block of production and trade comprises four categories: national production and input use, distribution of domestic product for domestic consumption, domestic market, exports, compilation of supply on the local market (imports and local production sold locally) and defining the demand for the commercial inputs created by the distribution process.

12.2.3 Foundation block: This group consists of equations that determine the value-added flow of businesses, and finally households, these equations fill the inputs between institutions in Algeria's social accounting matrix, and this cluster contains several functions and equations for the aspect of the institution of the economy.

12.2 .4 Block the restriction of the system: it consists of:

- Factor markets;
- Markets for composite raw materials;
- Current account balance of the rest of the world in foreign currencies;
- Saving and investment;
- Price adjustment.

The basic model of this study comprises 14 sectoral activities, four institutional agents, two main factors of production, savings-investment, value-added tax, and customs duties. The 14 sectors of the table of entries and exits of Algeria for the year 2013 were regrouped as follows:

Agriculture Sector (01), Water Sector - Energy and Buildings, Public Works (02), Fuels Sector (03), Petroleum Services and Industry Sector (04) and Mining and Quarrying Sector (05), Iron and steel industry, Metallurgy and electricity (06), Construction materials industry (07), Chemical industries, Plastics and rubber (08), Food industry (09), Textiles, clothing and stockings (10), Leather and footwear (11) Wood, Paper and Cork Industry (12), Miscellaneous Industries (13), Services Sector (14).

The quantitative model representing the basic economy was constructed using the social accounting matrix of the year 2013.

13. Model execution and consistency test:

This model is solved in the General Program of the Linear Modeling System (GAMS). The consistency of the model is tested simultaneously. By solving this model, the program (GAMS) is used to find a range of prices, wages and exchange rates that respond to the complex set of non-linear equations (Lofgren et al 2002).

14. Simulation design and description:

In this section, we will present the different policy simulations that we would like to implement using a computable general equilibrium model.

The simulations that will be conducted mainly according to the realistic state of the economy have been tested to match the direction of the economy, the simulation applied in this study is shock of oil prices in the international market. (Sbia.R, 2017)

14.1 The rise and fall of world oil prices:

It is a simulation that aims to test the effect on the local economy, so that the rise and fall of the price of oil is one of the main tools of trade policy, is often used to correct the deficit and also to maintain the international reserve. (Dizaji.S.F, 2014)

Two types of price shocks will be presented, namely the increase in world oil prices by 10%, the 30% drop in world oil prices and the combination of these two scenarios with total trade liberalization. (Sbia.R H. a., 2013)

14.1 .1 The effect of the 10% increase in the price of oil:

14.1 .1 .1 Effects of a 10% increase in the price of oil on Local production: At the production level, we saw an increase in the product offering in most sectors, but the impact was negative in other sectors.

Table 1. Effects of a 10% increase in the price of oil on local production

- Unit (%) -

Local Production	Scen a3	Scen a3+c1
Total	2.303244	3.598917
SEC1-C	2.086231	2.878351
SEC2-C	10.93602	12.39823
SEC3-C	-0.06436	1.04395
SEC4-C	8.300689	10.27274
SEC5-C	-3.08704	-1.9078
SEC6-C	5.021705	6.987857
SEC7-C	6.296853	7.769271
SEC8-C	1.094529	2.866837

SEC9-C	5.212185	6.194788
SEC10-C	6.056439	5.759293
SEC11-C	1.139828	0.166455
SEC12-C	-0.92957	1.891457
SEC13-C	1.18311	2.176744
SEC14-C	1.142882	2.036673

Source: Among author's calculations using simulation results from GAMS software.

Table N° 01 shows that the volume of production in the water and energy, construction and public works sector has increased by 10.93602 per cent, in the petroleum services and public works sector of 8.300689 per cent, and the building materials sector of 6.296853 per cent.

All because of the correlation between production in these sectors and the revenue generated by the activity of the hydrocarbons sector.

Oil collection is one of the most important sources that the state uses in its budget to finance its expenditures, with investment in the construction and public works sector being considered one of the largest expenditures.

While rising oil prices have had a negative impact on production, especially in mines, quarries, woodworking, paper and cork, with a decrease of -3,08704% and -0,92957% respectively.

In the case of total trade liberalization, we note that production increased in all sectors, except for extractive industries, the increase in total output was estimated at 3.598917 percent.

Because of the increase in income of economic units, demand increases, so that imports increase to meet the needs of the local market, while exports decline, leading to a trade imbalance. this is what he proved Berument et al. (2010) in a study on Middle East and North African countries found the asymmetric effects of world oil price shocks on the gdp of Algeria, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia, and UAE to be positive and statistically significant, while positive but insignificant results were reported for Bahrain, Egypt, Lebanon, Morocco and Yemen.

14.1 .1 .2 Effects of a 10% increase in the price of oil on trade:

Table N° 02 shows that exports have declined in all exporting sectors because of the lower production in some of the mind increasing the supply of local products in the local market.

Table 2. Effects of a 10% increase in the price of oil on trade Unit (%)

	Imports		Exports	
The sectors	**Scen a3**	**Scen a3+c1**	**Scen a3**	**Scen a3+c1**
Total	13.4003	14.37724	-2.7281	-1.7081
SEC1-C	14.84772	15.33879	-23.198	-21.202
SEC2-C	20.8301	21.78889	-21.148	-19.174
SEC3-C	0	0	-1.0854	-0.0640
SEC4-C	0	0	0	0
SEC5-C	11.25409	12.62302	-22.662	-20.476
SEC6-C	13.05651	14.52002	-17.452	-15.478
SEC7-C	17.73857	19.07962	-24.846	-22.864
SEC8-C	11.39778	12.93672	-20.342	-18.363
SEC9-C	16.7028	17.68342	-25.251	-22.262
SEC10-C	12.4275	13.73049	-15.838	-14.036
SEC11-C	11.02451	12.55369	-20.791	-18.771
SEC12-C	9.175703	10.01594	-23.446	-20.257
SEC13-C	13.7295	14.97223	-26.596	-23.967
SEC14-C	13.55581	13.95487	-27.870	-24.260

Source: Among author's calculations using simulation results from GAMS software.

The decline in total exports was estimated at -2.7281% below the base level, but with total trade liberalization, this figure is estimated at -1.7081%. In the case of imports, there was a significant increase in all sectors in both cases, however, the rate of increase of the scenario Scenario 3 + c1, after the total liberalization (openness) of the exchanges, was greater than in the first scenario, this is due to the increase in revenue on the one hand and the decrease in prices due to the elimination of tariffs on the other hand, with an increase of 14.3774%.

14.1 .1 .3 Effects of a 10% increase in the price of oil on macroeconomic variables:

Table N° 03 shows the effect of the 10% increase in oil prices on the Algerian economy at the macro level as follows:

Table 3. Effects of a 10% increase in the price of oil on economic variables - Unit (%) -

	Scen a3	Scen a3+c1
Household income	6.720858	3.716228
Gross domestic product	6.57053	8.553603
Government income	4.729908	1.689185
Government savings	15.97374	3.831
Private consumption	5.720858	8.716228
The actual trade balance	-13.7305	-15.7461
Total employment request	2.12	1.35
Total investment	12.05548	5.013625

Source: Among author's calculations using simulation results from GAMS software.

Rising oil prices have led to increased hydrocarbon revenues, which has led to higher oil revenues, one of the most important sources of state revenue, the country's total income grew by 4.729908% and its savings increased by 15.97374%.

We also note that private consumption rose 5.720858% as household income rose 6.720858%.

Increasing savings will encourage investment in all sectors, as the model illustrates by increasing the total investment by 12.05548 percent.

We also note that total labor demand has increased by 2.12%, as has the gross national product, which has also increased by 6.57053%.

However, with total trade liberalization, we note that the majority of economic variables have been compared to the situation of high oil prices.

With the exception of private consumption and gross domestic production, which rose by 8.716228 and 8.553603 per cent respectively compared to the reference situation. This is what he proved Hamdi and Sbia (2013) also Dizaji (2014).

14. 1.2 The effects of the 30% drop in oil prices:

14. 1 .2 . 1 The effects of the 30% drop in oil prices on local production :

At the production level, we saw an increase in production in some sectors, but the impact was negative in most other sectors.

Table 4. The effects of a 30% drop in oil prices on Local production

- Unit (%) -

Local Production	Scen b3	Scen b3+c1
Total	-5.74304	-2.74675
SEC1-C	0.636102	1.527275
SEC2-C	-6.80838	-2.43215
SEC3-C	-2.09406	-0.07034
SEC4-C	-8.58672	-6.61268
SEC5-C	12.81398	13.75143
SEC6-C	-9.07637	-7.11906
SEC7-C	-12.3235	-10.3534
SEC8-C	13.68851	14.94448
SEC9-C	-9.8327	-7.85122
SEC10-C	-7.00885	-5.20593
SEC11-C	6.593298	4.631965
SEC12-C	8.39467	9.374702
SEC13-C	5.847239	6.23985
SEC14-C	7.38766	8.080726

Source: Among author's calculations using simulation results from GAMS software.

Table N ° 04 shows that the volume of production has decreased in some sectors, particularly those of water, energy, construction and public works of -6.80838%.Petroleum services and public works sector -8.58672% and building materials sector -12.3235% because of the link between these sectors and revenues from the hydrocarbons sector.

We also saw a drop in production in the fuel sector-2,09406%,steel, mechanics, metallurgy and electricity -9.07637%,food, tobacco and sulfur, textiles, clothing and socks respectively -9.8327% and -7.0885%.

We note that these negative ratios reflect the response of these sectors to the impact of the decline in world oil prices, which has had a positive impact on production in other sectors.

In the case of total liberalization of trade, there is a clear improvement in production in sectors that have experienced a decline in the previous situation, so the decline from baseline was lower than the oil price. This is what he proved Peersman, G., Van Robays, I., 2012

The decline in total output in the case of total trade liberalization was estimated at -2.4675 per cent.

14.1 .2 .2 The effects of the 30% drop in oil prices on trade:

The lack of income of economic units in turn leads to a reduction in the final demand of families, a reduction in imports and an increase in exports due to the lack of requirements in the domestic market.

Table 5. The effects of the 30% drop in oil prices on trade

- Unit (%) -

	Imports		Exports	
The sectors	**Scen b3**	**Scen b3+c1**	**Scen b3**	**Scen b3+c1**
Total	-31.839	-30.458	2.12846	3.5068
SEC1-C	-35.197	-34.203	22.11033	23.06471
SEC2-C	-45.6208	-43.646	39.30623	40.39384
SEC3-C	0	0	2.37204	3.24695
SEC4-C	0	0	0	0
SEC5-C	-34.6833	-32.070	35.00908	36.7896
SEC6-C	-31.5065	-28.5387	22.20033	24.09706
SEC7-C	-40.7858	-38.8061	27.26623	28.94071
SEC8-C	-23.9682	-21.9956	24.21926	26.10372
SEC9-C	-38.815	-37.8277	30.54067	32.04614
SEC10-C	-23.131	-22.8129	16.43615	15.84281
SEC11-C	-13.3257	-11.3814	26.97327	25.07587
SEC12-C	-18.2582	-17.2734	20.52685	21.47243

SEC13-C	-29.7165	-29.0214	35.46563	36.12662
SEC14-C	-34.3005	-33.3047	33.90433	34.2876

Source: Among author's calculations using simulation results from GAMS software.

According to Table N° 05 It is clear to us that exports have increased in all export sectors due to the decline in the supply of local products on the local market and their export. The total increase in exports was estimated at 2.1284%, which again increased in the case of total trade liberalization to 3.5068 percent.

As we observe from Table N ° 05 that the rate of change of imports has decreased in all importing sectors, due to the reduction of demand on the domestic market, this resulted in a lack of absorption of various import and local products, with a rate of decline of 31.839%. This is what he proved Medina (2016).

14.1 .2 .3 The effects of the 30% fall in oil prices on macroeconomic variables:

Table N ° 06 shows the effect of the 10% fall in oil prices on the Algerian economy at the macro level as follows:

Table 6. Effects of a 30% drop in oil prices on economic variables - Unit (%)

	Scen b3	**Scen b3+c1**
Household income	-13.7763	-15.7803
Gross domestic product	-7.73162	-1.75025
Government income	-5.1499	-7.19665
Government savings	-26.725	-68.531
Private consumption	-10.7763	-1.78028
Total employment request	-1.9	-0.14
Total investment	-18.0125	-22.0599

Source: Among author's calculations using simulation results from GAMS software.

Household income decreased by 13.7763 per cent which in turn affected private consumption, which in turn decreased by 10.7763 per cent, mainly due to the low wage rate due to the decrease in total demand for electricity. employment of 1.9%.

We also note that government revenues decreased by 5.1499%,while savings fell by 26.725% due to lack of fuel revenues due to lower world oil prices. This has had a negative impact on investments, which decreased by -18.0125 percent.

This negative impact on all economic variables increases more strongly in the case of total trade liberalization, thus increasing the decline of all variables. With the exception of private consumption and gross domestic production, which are characterized by a marked improvement over the decline in oil prices.

Finally, we conclude that the fall in the price of oil negatively affects most of the sensitive economic sectors such as the fuel sector and the construction and public works sector, in addition to deteriorating indicators reflecting the standard of living of individual incomes and high unemployment and that Cuñado, J., Jo, and S., Pérez de Gracia. F reached on 2015.

Several factors influence the results of the percentages found in the variation of the value of the variables, because of the shortcomings that characterize the model and the most important ones such as: the model is static it must be developed in a dynamic model, so that we can enter the temporal dimension on the variables.

It is not possible to know the dynamic changes in the values of the variables over time, such as the change in economic growth in gross domestic output and other variables in the time dimension.

15. Conclusion:

With regard to the oil price shock scenario on the world market:

In the first simulation, we found that the tax revenues generated by the 10% increase in world oil prices were a reason to rely on the hydrocarbon sector and continued to depend on it instead of encouraging other sectors to produce like the agricultural sector.

The decline in the unemployment rate and rising incomes and savings of economic units has caused an increase in demand for private consumption and investment, Imports and rising exports have fallen in all

kinds of products, leading to higher prices, and so the results of these simulations reflect the reality of fluctuations in the world price of oil in the Algerian economy.

The second simulation using the model was the 30% decline in oil prices, as we saw a decline in the level of production and value-added in most sectors except in certain sectors such as agriculture, mining, Rubber.

We also saw a drop in private consumption and a decline in the level of investment, which led to lower prices and a lack of imports, because of low income and savings for all economic units with an increase in the unemployment rate and the number of unemployed.

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17. Appendices:

Appendice 1. Scenario codes and simulation definition

Scenario code	Simulation specifications
Scen a3	The 10% increase in the price of oil in the global market
Scen b3	The 30% drop in the price of oil in the global market
Scen a3+c1	The 10% increase in the price of oil in the world market with the elimination of tariffs in all import sectors
Scen b3+c1	The 30% drop in the price of oil in the world market with the elimination of tariffs in all import sectors

Appendice 2. Equations and variables of the model

Model equation:

Price block:

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

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

$$PQ_c QQ_c = [PD_c QD_c + PM_c QM_c](1 + tq_c) \quad (3)$$

$$PX_c \cdot QX_c = PD_c QD_c + PE_c QE_c \quad (4)$$

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

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

Block of production and trade:

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

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

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

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

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

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

$$QQ_c = QD_c (13)$$

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

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

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

Foundation block:

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

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

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

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

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

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

Block of equilibrium system:

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

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

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

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

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