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A MULTI-OBJECTIVE APPROACH TO DEFINING EFFECTIVE POLICIES TO RELEASE THE STRUCTURAL CHANGE IN A COMPUTABLE GENERAL EQUILIBRIUM MODEL.

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ABSTRACT

The aim of this article is to suggest changes to the economic policies of Algeria in order to address the structural imbalance in its economy. The goal is to shift from an economy that relies heavily on oil prices to a more stable and balanced production structure that promotes economic development. Using the CGEM model applied to the Algerian economy through GAMS, this article conducted a simulation of economic policies. The results of the simulation showed improvements in the production group and the demand for factors across all sectors, particularly agriculture and industry. Positive changes estimated at between 10% and 60% were recorded in all sectors. Moreover, this package of policies had a positive impact on exports outside the oil sector. Exports in the industrial sector increased positively by 128%, while those in the agricultural sector increased by 29%. These findings indicate that Algeria has enormous potential and comparative advantages in these sectors. If protected in the current period, they could emerge as strong sectors and contribute significantly to the country's economic growth.

Keywords: Structural change, Optimal economic policies, CGEM, GAMS.

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INTRODUCTION

Macroeconomic policymakers are interested in various indicators such as growth, inflation, unemployment rates, and the size of the public deficit. However, policymaking can be challenging as multiple goals may conflict with each other. For example, implementing an aggressive anti-unemployment strategy may lead to inflation, and increasing domestic growth may negatively impact the trade balance. In such cases, multi-criteria decision-making (MCDM) techniques can help policymakers resolve conflicting goals. One such approach is Multi-objective Programming (MP), which aims to find Pareto-efficient solutions, meaning that no other option can improve some objectives without harming others. To operationalise the MCDM approach, policymakers need an analytical representation of the economy. A computable general equilibrium (CGE) model is commonly used for this purpose. These models have been used for evaluating public policy and conducting simulation exercises since the 1980s, both in industrialised and developing nations.

CGE modeling is a useful tool for policy makers to assess the impact of specific changes, such as policy implementations, on important economic variables like prices, production levels, tax receipts, and income distribution. This research proposes a new methodology that combines CGE modeling

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with MP, two analytical methods that have not been used together before, to create effective policies and evaluate existing or potential policies. The proposed methodology is both practical and theoretically sound, offering an innovative approach to policy formulation and assessment.

LITERATURE REVIEW

Computable General Equilibrium (CGE) models are a type of economic models that are designed to analyse the complex interactions of economic activities within an entire economy. These models are based on general equilibrium theory and simulate the behavior of various economic agents, sectors, and markets in order to predict the effects of policy changes, shocks or structural shifts (Mannheim & Konrad, 2001).

CGE models are designed to understand the intricate relationships between supply and demand in various sectors, including households, firms, and government entities. These models are powerful tools that can be used to predict the impact of different economic policies, such as tax reforms, trade liberalization, and environmental regulations (André & Cardenete, 2009).

According to renowned economists Hertel and Tsigas, CGE models facilitate “a systematic representation of economic structure, relationships, and behavioral responses in a computable framework”(Hertel, 1997). These models provide a quantitative framework for policymakers and researchers to understand how changes in one sector or policy might affect the entire economy. Within CGE models, various components are carefully constructed to emulate the complexity of the economy. Households are characterized by their consumption and savings behavior, while firms engage in production, factor markets, and investment decisions. Market mechanisms are simulated to reflect price determination and the equilibrium between supply and demand in different sectors (Garbaccio, 1995).

One notable contribution in this field is the Global Trade Analysis Project (GTAP), which has greatly influenced CGE modelling by providing a standardized database for international trade analysis(Narayanan, 2008). The GTAP database has become a crucial resource, enabling researchers to assess the impacts of global economic policies and trade agreements(Hertel, 1997).

Although CGE models are complex and require significant computational demands, they have undergone substantial development by incorporating advancements in data availability, computational power, and economic theory. Their capability to analyse the numerous impacts of policies on different economic agents and sectors remains invaluable to policymakers and researchers (Hu et al., 2021).

This recent publication delves into the integration of environmental considerations into CGE frameworks, exploring the effects of policies related to climate change, natural resources, and sustainability.M. S. Santos (2004) focuses on dynamic CGE models, emphasizing their application in macroeconomic analysis and policy evaluation over time, considering changing economic conditions and shocks.J. Santos (2020)investigates the implications of trade policies in a post-pandemic global economy using CGE models, considering shifts in international trade dynamics and their effects on various sectors. P. Chen (2008) reviews recent advancements in CGE modelling concerning structural change, examining how these models capture and analyse shifts in production, consumption patterns, and sectoral dynamics within economies.**:** This study investigates the interlinkages between sectors and the implications for structural change within economies using CGE models.L & P. R. Chen (2023)investigate the integration of abrupt technological disruptions into CGE models and their effects on economic structural change.Garcia (2022)explores the complex interdependencies between sectors and their role in driving structural changes within CGE frameworks.Nguyen (2023)analyses the impacts of climate policies on economic structural changes, using CGE models

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to assess sectoral shifts and resource reallocations. Li (2022) investigates the implications of incorporating heterogeneity among economic agents in CGE models for understanding structural changes and distributional effects.

THE PROPOSED METHODOLOGY APPLIED TO THE ALGERIAN ECONOMY

The economic model

There are three main phases of the study:

- Since we were using the 2020 input and output table,[1] we selected that year as our base year. The 19 sectors that make up the Algerian economy were divided into five fundamental sectors in accordance with the study's objectives, and the social accounts matrix was constructed using this information.[2]
- Determining the parameters and transactions as well as behavioural correlations within a macroeconomic framework.
- Solve the system of equations until we arrive at the ideal answer.

When the outcome matches base year data, we can say that the model has been calibrated. We use these data as a reference scenario to create scenarios for the evaluation of economic policies(Varga et al., 2022).

This static general equilibrium model consists of eight sets of non-linear equations. The equations include behavioral and technical equations, accounting equations, and equilibrium equations that are expressed as matches(N. Hosoe; K. Gasawa; H. Hashimoto, 2010)

We will be using the GAMS coding program to find a timely and accurate solution to the equation system in our model. Our first step is to define the initial entity in the model. To simplify the processing of data and formula equations, it would be useful to define a comprehensive set of economic sectors, economic unit classes or factors of production in the social accounting matrix, and then arrange them into subgroups based on the model requirementsof Richard Rosenthal (n.d.)

Economic Sectors block (production)

Production or products provided by us as (i) or (j), depending on where the data table in GAMS is changing. The symbol (i) for lines and (j) for columns is five sectors:
AGR: Agriculture.
IND: Industry.
HYD: gas and oil.
SER: Services.
BTP: Construction and public works.

- *Block equations*

The profit maximization function for sector (j) can be written as follows:(N. Hosoe; K. Gasawa; H. Hashimoto, 2010)

- In the first stage:

$$\underset{Y_j \;, F_{h,j}}{maximize}\, \pi_j^y = P_j^y Y_j - \sum_h P_h^f F_{h,j}$$

The equation (1) represents the production function of cobb-duglas, which illustrates factors of production, labour and capital.

[1] Source: Office National de Statistiques,IMF Staff Country Report.
[2] Appendix 1

$$Y_j = \mathbf{bj} \prod_h \mathbf{F}_{h,j}^{\beta_{h,j}} \; \forall j \ldots\ldots\ldots\ldots\ldots(1)$$

- In the second stage:

$$\underset{Z_j\;,,Y_j,X_{i,j}}{maximize} \pi_j^Z = P_j^z Z_j - \left(P_j^y Y_j + \sum_i P_i^q X_{i,j}\right).$$

$$Z_j = min\left(\frac{X_{AGR.j}}{ax_{AGR.j}}, \frac{X_{IND.j}}{ax_{IND.j}}, \frac{X_{HYD.j}}{ax_{HYD.j}}, \frac{X_{SER.j}}{ax_{SER.j}}, \frac{X_{BTP.j}}{ax_{BTP.j}}, \frac{Y_j}{ay_{.j}}\right).$$

$$F_h = \frac{\beta_{h,j} P_j^y}{P_h^f} Y_j \forall j, h \ldots\ldots\ldots\ldots\ldots(2).$$

$$.X_{i,j} = ax_{i,j} Z_j \forall i, j \ldots\ldots\ldots\ldots\ldots(3)$$

$$.Y_j = ay_j Z_j \forall j \ldots\ldots\ldots\ldots\ldots(4)$$

$$.P_j^Z = ay_j P_j^y + \sum_i ax_{i,j} P_i^q \; \forall j \ldots\ldots\ldots\ldots(5)$$

The table displays the variables and profiles of the economic sector cluster. The equations used the Generalized Leontief function and the input-output (Output-Input) approach, which lacks technicalsubstitution flexibility. This indicates that the value added of used factors of production and intermediate consumption from different products cannot be replaced, and that the intermediate consumption between them cannot be substituted. This is known as full integration between them, and production is the outcome of this integration between value added and intermediate consumption. The parameters are linked to the value added, total intermediate consumption of each sector, and intermediate consumption of various sectors of different products, and these parameters are less than one(Choi, 2015).

Government block

The CGEM is used in economic policy analysis by analyzing the results of changes in economic policies, especially tax rates, and in this section the explained equations of government behavior will be identified in the CGEM(Ashimov et al., 2020).

- *Block equations*

In this model, the Government collects taxes on consumer goods, imposes direct taxes on households and indirect taxes on production, and also collects import customs duties:

$$\mathbf{T^d} = \boldsymbol{\tau^d} \sum_h \mathbf{P_h^F FF_h} \ldots\ldots\ldots\ldots\ldots(6)$$

$$\mathbf{T_j^Z} = \boldsymbol{\tau_j^Z} \mathbf{P_j^Z Z_j} \forall \mathbf{j} \ldots\ldots\ldots\ldots\ldots(7).$$

$$\mathbf{T_i^m} = \boldsymbol{\tau_j^Z} \mathbf{P_j^Z Z_j} \forall \mathbf{i} \ldots\ldots\ldots\ldots\ldots(8).$$

$$\mathbf{X_i^g} = \frac{\mu_i}{\mathbf{P_i^q}} \left(\mathbf{T^d} + \sum_j \mathbf{T_j^Z} + \sum_j \mathbf{T_j^m} - \mathbf{S^g}\right) \forall \mathbf{j} \ldots\ldots\ldots(9)$$

Savings and Investment block

Equation (10) includes variables in parentheses that represent the sum of savings from families, government, and the external sector. In any economy, the total savings must be equal to the total investment. It is worth noting that foreign savings is an external variable. The following equations indicate the savings and investment rates in the economy.

$$\mathbf{X_i^v} = \frac{\lambda_i}{\mathbf{P_i^q}} \left(\mathbf{S^P} + \mathbf{S^g} + \boldsymbol{\varepsilon} \mathbf{S^f}\right) \forall \mathbf{i} \ldots\ldots\ldots\ldots(10)$$

$$.\mathbf{S^P} = \mathbf{SS^P} \sum_h \mathbf{P_h^f FF_h} \qquad \ldots\ldots\ldots(11)$$

$$.\mathbf{S^g} = \mathbf{SS^g}\left(\mathbf{T^d} + \sum_j \mathbf{T_j^Z} + \sum_j \mathbf{T_j^m}\right) \qquad \ldots\ldots\ldots(12)$$

Households block

The introduction of both government and investment and savings into the model requires an adjustment of the equation that explains the behavior of households, which is as follows:

$$\underset{X_i^p}{maximize}\ UU = \prod_i X_i^{p^{\alpha_i}}$$

Subject to:

$$\sum_i P_h^f FF_h - S^P - T^d.$$

$$X_i^p = \frac{\alpha_i}{P_i^q}\left(\sum_h P_h^f FF_h - S^p - T^d\right)\forall i \quad \text{..........(13)}$$

International Trade block

We can distinguish between two types of prices in international trade. The first is prices in domestic currency. The second is prices in foreign currency. The relationship between the two is through the equation (14) and (15). The equation (16) reflects the balance of payments, expressed through the prices of exports and imports in foreign currency(Jafari et al., 2021).

$$P_i^e = \varepsilon P_i^{W_e} \forall i \text{..........(14).}$$

$$P_i^m = \varepsilon P_i^{W_m} \forall i \text{..........(15)}$$

$$\sum_i P_i^{W_e} E_i + S^f = \sum_i P_i^{W_m} M_i \quad \text{..........(16)}$$

Substitution between imports and domestic goods (Armington composite)

To understand an open economy’s general applied balance model, it is crucial to consider the difference between domestic goods produced and consumed, and goods that are imported and exported. In this study, we assume that there is a partial substitution of goods, and we use the following equations to demonstrate this relationship.

The maximization problem of the Armington commodity is expressed through the following:

$$maximize\ \pi_i^q = P_i^q Q_i - \left[(1+\tau_i^m)p_i^m M_i + p_i^d D_i\right].$$

Subject to

$$Q_i = \gamma_i\left(\delta m_i M_i^{n_i} + \delta d_i D_i^{n_i}\right)^{\frac{1}{n_i}} \forall i \text{..........(17).}$$

$$M_i = \left[\frac{\gamma_i^{n_i}\delta m_i P_i^q}{(1+\tau_i^m)P_i^m}\right]^{\frac{1}{1-n_i}} Q_i \forall i \quad \text{..........(18)}$$

$$D_i = \left[\frac{\gamma_i^{n_i}\delta d_i P_i^q}{P_i^d}\right]^{\frac{1}{1-n_i}} Q_i \forall i \quad \text{..........(19)}$$

The equation (17)representsResources in the domestic market, consisting of imported and domestic products, are interchangeable. The constant parameter represents the level of the constant substitution elasticity function, and the parameter δm_i.is an import volume distribution marker and is limited between 0 and 1, and the constant substitution elasticity function (CES) has been used.

Transfer between exports and domestic goods

The process of converting locally produced goods into exportable products is known as enterprise transformation. In this process, we assume that the goods meant for domestic consumption cannot be completely replaced by the exported goods. The transfer of goods between exports and domestic consumption can be illustrated through equations. The ultimate goal is to maximize the exchange of goods between GDP and exports.(Lofgren et al., 2002):

$$maximize\ \pi_i = \left(P_i^e E_i + P_i^d D_i\right) - \left(1+\tau_i^Z\right)P_i^e Z_i$$

Subject to

$$Z_i = \theta_i\left(\varepsilon e_i E_i^{\emptyset_i} + \varepsilon d_i D_i^{\emptyset_i}\right)^{\frac{1}{\emptyset_i}} \forall \text{ ....} \mathbf{(20)}$$

$$E_i = \left[\frac{\theta_i^{\emptyset_i}\varepsilon e_i\left(1+\tau_j^Z\right)P_i^Z}{P_i^e}\right]^{\frac{1}{1-\emptyset_i}} z_i \forall i \text{.........(21)}$$

$$.\boldsymbol{D}_{i} = \left[\frac{\theta_i^{\phi_i} \varepsilon d_i \left(1+\tau_j^{Z}\right) P_i^{Z}}{P_i^{d}}\right]^{\frac{1}{1-\phi_i}} z_i \forall i \text{……….(22)}$$

Equation (20) represents the distribution of products offered from sectors between the domestic market and the world market in the form of exports, while the constant parameter$\boldsymbol{\theta}_{\mathbf{i}}$ represents the level of the fixed conversion flexibility function.The constant elasticity of transformation function called CET has been used to contain the technical transformation parameter.

Equilibrium condition

In previous entries, we have described the behavior of all economic operators, including households, sectors, government, investment, savings, and the outside sector, through a system of equations. The final step of the modeling process is to establish a balance between supply and demand.

$$\boldsymbol{Q}_{\mathbf{i}} = \mathbf{X}_{\mathbf{i}}^{\mathbf{p}} + \mathbf{X}_{\mathbf{i}}^{\mathbf{g}} + \mathbf{X}_{\mathbf{i}}^{\mathbf{v}} + \sum_{\mathbf{j}} \mathbf{X}_{\mathbf{i,j}} \ \forall i \text{…………(23)}$$

$$\sum_{\mathbf{j}} \mathbf{F}_{\mathbf{h,j}} = \mathbf{FF}_{\mathbf{h}} \ \forall \mathbf{h} \text{…………………………(24)}$$

DATABASES AND CALIBRATION

In this part of our study, we consider the structure of the model that we use later to study macroeconomic policies on structural balance in the Algerian economy. The model form of the “EXTER” general equilibrium model (which was carried out by Bernard Decaluwé with other economists) has also been drawn upon. We will also adapt to the data available in the social accounting matrix for 2020(Fofana Ismail, 2007), which has been considered as a reference year for this model(Decaluwé Bernard et autres, 2001).

The CGEM is a mathematical model used to analyze the interactions of economic agents in a given economy. It consists of 24 endogenous variables and 24 real-time equations that describe the relationships between these variables. By utilizing the software GAMS (General Algebraic Modeling System), we can obtain a unique equilibrium solution that satisfies all the equations simultaneously. This solution provides valuable insights into the functioning of the economy and can be used to make informed decisions about policy changes or economic interventions.

Calibration of CGEM parameters

Calibration is a crucial step in achieving CGEM. It involves assigning numerical values to the different parameters of a predefined model, in a way that allows us to match the function of the model with the social accounting matrix data for the base year. This helps us determine the values of function parameters such as input and output assessment coefficients. The flexibility in assigning these values can come from econometric estimates from previous studies, or from expert knowledge, especially in developing countries where time series data is unavailable for parameter estimation (Go et al., 2016).

By assigning specific values to the parameters, we are able to calculate model variables that match their 2020 baseline values. When we solve the real-time equations of the model and achieve balance, the parameters and equations allow us to re-establish the baseline year(Taylor, 2016).

At the calibration stage, we make it impossible to estimate all the parameters of the model. We do this by concluding their values using the equations of the model they contain, and with the base year data. At the same time, we resolve the general application balance model. After performing the necessary mathematical steps, we derive relationships that provide numerical values to most of the parameters through model equations (N. Hosoe; K. Gasawa; H. Hashimoto, 2010):

Table 1 Mathematical formulae for parameters

Equations	Parameters
$.ax_{i,j} = \frac{X^0_{i,j}}{Z^0_j} \forall\, i,j$	**Liontif function coefficients**
$.ay_j = \frac{Y^0_j}{Z^0_j} \qquad \forall j.$	
$.\delta m_i = \frac{(1+\tau_i^m)P_i^{m0} M_i^{0(1-n_i)}}{(1+\tau_i^m)P_i^{m0} M_i^{0(1-n_i)} + P_i^{d0} D_i^{0(1-n_i)}} \forall\, i.$	**Function parameter of CES[3]**
$.\delta d_i = \frac{P_i^{d0} D_i^{0(1-n_i)}}{(1+\tau_i^m)P_i^{m0} M_i^{0(1-n_i)} P_i^{d0} D_i^{0(1-n_i)}} \quad \forall\, i.$	
$..\gamma_i = \frac{Q_i^0}{\left(\delta m_i M_i^{0n_i} + \delta d_i D_i^{0n_i}\right)^{\frac{1}{n_i}}} \qquad \forall\, i$	
$\varepsilon e_i = \frac{p_i^{e0} E_i^{0(1-\emptyset_i)}}{p_i^{e0} E_i^{0(1-\emptyset_i)} + p_i^{d0} D_i^{0(1-\emptyset_i)}} \qquad \forall i.$	**Function parameter of CET[4]**
$.\varepsilon d_i = \frac{p_i^{d0} D_i^{0(1-\emptyset_i)}}{p_i^{e0} E_i^{0(1-\emptyset_i)} + p_i^{d0} D_i^{0(1-\emptyset_i)}} \qquad \forall i.$	
$.\theta_i = \frac{Z_i^0}{\left(\varepsilon e_i E_i^{0\emptyset_i} + \varepsilon d_i D_i^{0\emptyset_i}\right)^{1/\emptyset_i}} \forall i.$	
$.SS^P = \frac{S^{P0}}{\sum_h P_h^{f0} FF_h}.$	**Estimated savings factors and direct tax rates** [5]
$.SS^g = \frac{S^{g0}}{T^{d0} + \sum_j T_j^{Z0} + \sum_j T_j^{m0}}.$	
$.\tau^d = \frac{T^{d0}}{\sum_h P_h^{f0} FF_h}.$	

Table 2 : Numerical values of exogenous variables in Algerian CGEM

Numerical value	symbols	Definition
1757510	$FF_h.$	**Income provided to households from labor h**
10317062	$FF_h.$	**Income provided to households from capital H**
2389394	$S^f.$	**Current account deficit - foreign savings -**
1.000	$P_i^{W_e}.$	**Prices of exports denominated in foreign currency**
1.000	$P_i^{W_m}.$	**Import prices denominated in foreign currency**

(3)- The armington production function contains four parameters and these coefficients appear in three equations 17-18-19. The initial equilibrium values of the internal variables reflected in these equations are determined through the social accounting matrix.

(4)- Calibration procedures for CET are the same as for CES. There are four unknown coefficients in only three equations 20-21-22.

(5)- There are three unknown female teachers: the average tendency to save families, the average tendency to save the government, and the direct tax rate, derived from the savings function, 11-12. The direct tax rate is derived from the direct tax income and the income of the families that are supposed to be the base of the taxes.

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1.000	τ^{d}.	**Direct tax rate**
1.0000	τ_j^{Z}.	**Rate of production taxes on sector j commodity**

Table 3: Numerical values of leontief function coefficients

value	symbols	definition	value	symbols	definition
0.086	$.ax_{hyd,ser}$	**Leontief fonction coefficients**	**0.030**	$ax_{agr,agr}\cdot$	**Leontief fonction coefficients**
0.052	$.ax_{hyd,btp}$		**0.243**	$ax_{agr,ind}\cdot$	
0.025	$.ax_{ser,agr}$		/	$.ax_{agr,hyd}$	
0.037	$ax_{ser,ind}\cdot$		**0.060**	$ax_{agr,ser}\cdot$	
0.016	$ax_{ser,hyd}\cdot$		**0.002**	$.ax_{agr,btp}$	
0.127	$.ax_{ser,ser}$		**0.105**	$.ax_{ind,agr}$	
0.009	$.ax_{ser,btp}$		**0.255**	$.ax_{ind,ind}$	
/	$.ax_{btp,agr}$		/	$.ax_{ind,hyd}$	
0.025	$.ax_{btp,ind}$		**0.271**	$.ax_{ind,ser}$	
0.008	$.ax_{btp,hyd}$		**0.483**	$.ax_{ind,btp}$	
0.015	$.ax_{btp,ser}$		**0.183**	$.ax_{hyd,agr}$	
0.060	$.ax_{btp,btp}$		**0.057**	$.ax_{hyd,ind}$	
0.656	$.ay_{agr}$		**0.147**	$.ax_{hyd,hyd}$	
0.440	$.ay_{ser}$		**0.383**	$.ay_{ind}$	
0.395	$.ay_{btp}$		**0.830**	$.ay_{hyd}$	

Table 4: numerical values of CET function coefficients

Table 5: numerical values of CES function coefficients

0.311	εe_{agr}.	
0.599	.εe_{ind}	**CET coefficient function** [6]
0.637	.εe_{hyd}	
0.360	.εe_{ser}	
0.339	.εe_{btp}	
0.689	.εd_{agr}	
0.401	.εd_{ind}	
0.363	.εd_{hyd}	
0.640	.εd_{ser}	
0.661	.εd_{btp}	
1.508	.θ_{agr}	
2.002	.θ_{ind}	
4.087	.θ_{hyd}	
1.933	.θ_{ser}.	
1.872	.θ_{btp}	

0.311	.δm_{agr}	
0.599	.δm_{ind}	**CES coefficient function** [7]
0.637	.δm_{hyd}	
0.360	.δm_{ser}	
0.339	.δm_{btp}	
0.689	.δd_{agr}	
0.401	.δd_{ind}.	
0.363	.δd_{hyd}.	
0.640	.δd_{ser}.	
0.661	.δd_{btp}.	
1.508	γ_{agr}.	
2.002	γ_{ind}.	
4.087	γ_{hyd}.	
1.933	γ_{ser}.	
1.872	γ_{btp}.	

Table 6: numerical values of savings and direct tax rates

ss^P.	ss^P.	
ss^g.	ss^g.	**Estimated savings and direct tax rates**
τ^d.	τ^d.	

a- CGEM closure

The CGEM is a model used in the Algerian economy, which comprises of 24 equations that correspond to 24 internal variables. The model is square and allows for a single solution. In order to achieve a single solution, all external variables must be clearly defined when the model is closed. The model is used as a tool to predict expected economic shocks and the impact of various policies on other variables within the model. The closure mix for this model includes the following:

Table 7: The macroeconomic policies instruments In Algerian CGEM

Transfers to households h	.FF_h
Current account deficit - foreign savings	S^f.
Prices of exports denominated in foreign currency	$P_i^{W_e}$.
Import prices denominated in foreign currency	.$P_i^{W_m}$
Direct tax rate	.τ^d
Rate of production taxes on sector j commodity	.τ_j^Z
Tariff rate for sector j goods	τ_i^m.

(6)- Calibration procedures for CET are the same as for CES. There are four unknown coefficients in only three equations 20-21-22.

(7)- The production function armington contains four parameters and these coefficients appear in three equations 17-18-19. The initial equilibrium values of the internal variables reflected in these equations are determined through the social accounting matrix.

The reason for selecting these specific variables is that they have the potential to be used as an effective tool for analyzing policies and determining the effects of various changes or shocks. Their value is not determined by the model equations that have been allocated. The world prices of exports are among the external variables in this closure since the premise of the small open economy has been relied upon to emphasize that Algeria, the country to which this study applies, is unable to control or be affected by these prices. Once the closure is complete, the model's quality will be tested by solving its equations to ensure its accuracy for future scenarios:Cliquez ou appuyez ici pour entrer du texte.

- ***Historical simulation***

To ensure that the model accurately represents reality, the study leaders compare the calculated values of internal variables with observed values. The closer they are, the better the model. Before any impact occurs, the value of the variable (Q_i) must be zero. This ensures that aggregate supply and aggregate demand in the market are equal, according to the law of the head. The matrix used in the study is balanced in terms of income and expenditure per account.

- ***Static simulation***

This refers to a set of separate projections made for a specific time frame, followed by conducting policy analysis tests on a particular phenomenon. The idea is to alter the direction of one of the variables in the interpretation of the phenomenon while observing the variable Q_i. During these shocks, the value of Q_i should be close to zero.

EFFICIENT POLICIES SCENARIOS, MODEL RESULTS AND INSIGHT

After conducting an initial simulation exercise to assess the quality of the economic model and its potential for addressing economic shocks, the study now focuses on analyzing the proposed economic policy scenario. The primary objective of the study is to propose economic policies that can rectify the structural imbalances in the Algerian economy. To achieve this, the exogenous variables mentioned earlier will be employed to create shocks and determine their impact on the endogenous variables using GAMS. The proposed economic policy scenario is presented in the table below.

Figure 1: Proposed economic policy scenario and simulation specification

Simulation description	Scenario symbol	
• The price of oil has risen by 50%. • The increase in the direct tax rate is 40%. • reduction in tax rates on production80 per cent • increase in the rate of customs duties 70 per cent • reduction in the trade deficit 80 per cent • Increase the allocation of production factorfor households by 30 per cent.	Scen4	**Scenario**

This study outlines the optimal economic policy package for Algeria to eliminate dependence on the oil sector and correct structural disequilibrium. The objective of the study was to increase the productive capacity of sectors outside the oil sector. The study was carried out through numerous tests using the General Algebraic Modeling System (GAMS) which caused shocks to the model's exogenous variables and noted sectoral changes in the endogenous variables of the model.

A shock was created by reducing production taxes by 80%, which had a negative impact on State revenues represented in variable Tz. To take the fiscal constraint into account, direct taxes were increased by 40%. However, increasing direct taxes would reduce the purchasing power of households. This would lead to an increase in the allocation of production agents to households, which would encourage demand for national production and avoid leakages in the form of imports.

On the one hand, domestic production would be encouraged by a 70% increase in customs tariffs and a reduction of the trade deficit by 80%, in addition to the application of trade policies to raise import prices. This package of macroeconomic policies has allowed us to achieve positive results in all sets of the CGEM in the Algerian economy, reflecting the desired structural change in the contributions of sectors to the various variables that reflect economic equilibrium.

THE RESULTS OF THE SIMULATION IN THE PRODUCTION BLOCK

Based on Figure3.4, we note that the change in the production of all sectors has registered a significant increase, with agriculture rising by 10.40 per cent while industry production has risen by over 40 per cent. Services, construction and public works sectors have risen by between 31 and 30 per cent, as the production of the fuel sector continues to rise by 60 per cent. Even if oil prices fall by 50 per cent, other sectors will continue to register positive changes, confirming the effectiveness of this policy package.[8]

Figure 2: **The results of the simulation in production of h product**

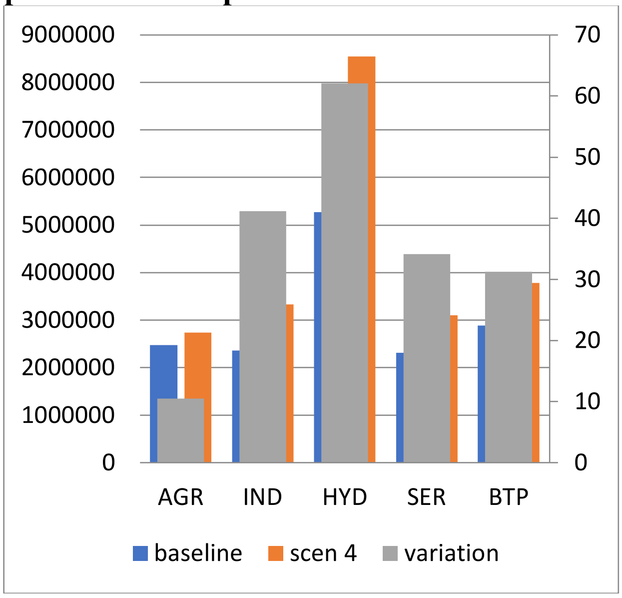
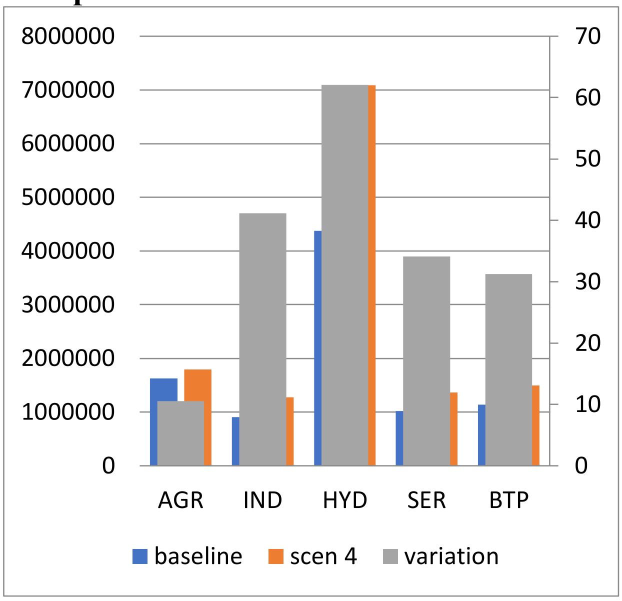


Figure 3: **The results of the simulation in composite factor**



Demand across all sectors, without any exceptions. Consumption demand in the agricultural sector has gone up by 35%, and in the industry, it has improved by 98%. Similarly, in the services, construction, and public works sectors, it has risen by 83% to 78%. This indicates that the policy package has contributed significantly to an increase in consumer demand. The increase in production revenue allocations to families has boosted their purchasing power, leading to an increase in demand.

[8]The impact of a 50 per cent decline in oil prices has been tested, and it has been shown that this decline, in addition to the economic policy package, is leading to positive changes in the production of sectors Z, ranging from 23 per cent in the agricultural sector to 70 per cent in the industrial sector. The only sector that has achieved a negative rate of change is the construction and public works sector, which explains the significant correlation between construction and public works and changes in oil prices.

We have also observed a positive change in investment demand. In the agricultural sector, investment demand has risen by 7%, and in the industry, it has gone up by 55%. In the construction and public works sector, the increase has ranged from 41% to 45%. This shows that the implementation of the economic policy package has led to an improvement in the productive activity of the economic sectors, resulting in an increase in investment demand. The reduction of production taxes and the imposition of customs duties has encouraged the domestic product in the industrial fields, which has inevitably led to an increase in investment demand, particularly in the industrial sector. This confirms Algeria's ownership of the industrial potential to correct the structural imbalance.

Figure 4: **The results of the simulation in investment demand**

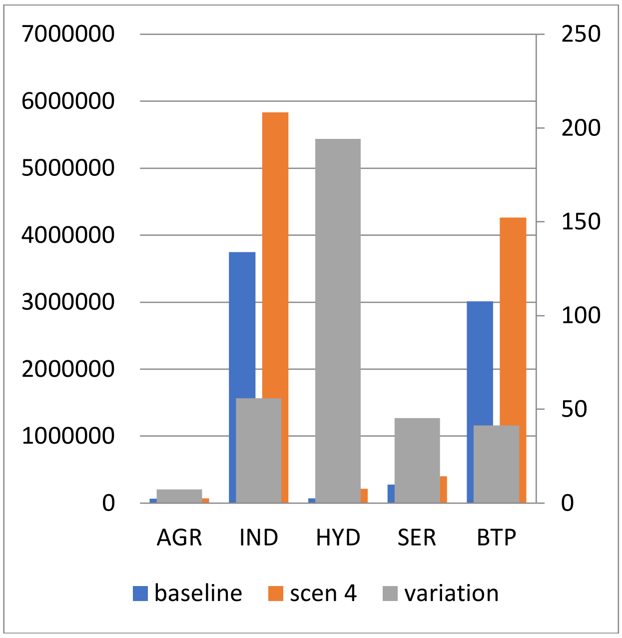
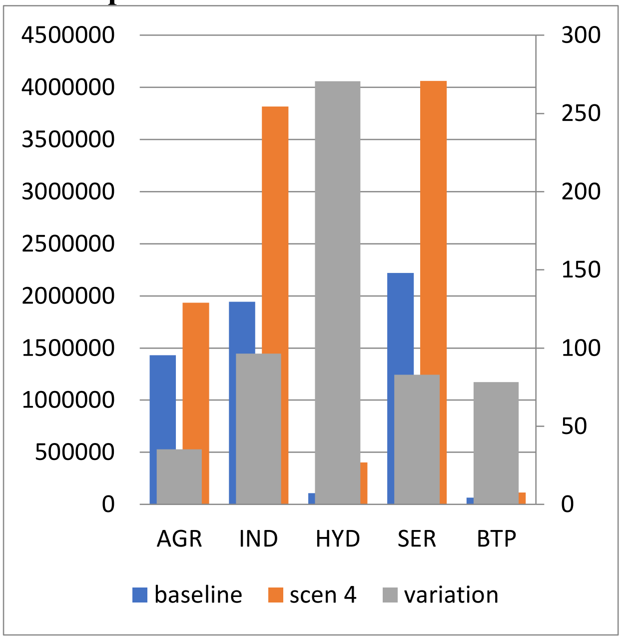


Figure 5: **The results of the simulation in consumption demand**



THE RESULTS OF THE SIMULATION IN THE INTERNATIONAL TRADE BLOCK

Figure 7 shows the results of the simulation in Armington's composite. Figure 8 and Figure 9 show the simulation results in import and export, respectively.The economic policy package implemented in the Algerian economy has led to an increase in the supply of domestic goods in all sectors. Agriculture and industry have both seen a growth of 10% and 34%, respectively. The service sector has grown by 34% and construction and public works have seen a growth of 26%. From Figures 10-11, it is evident that tax revenue from production has decreased in all sectors. The industrial sector has witnessed the largest decline.

Figure 6: **The results of the simulation in domestic product**

Figure 7 **: The results of the simulation in Armington' composite**

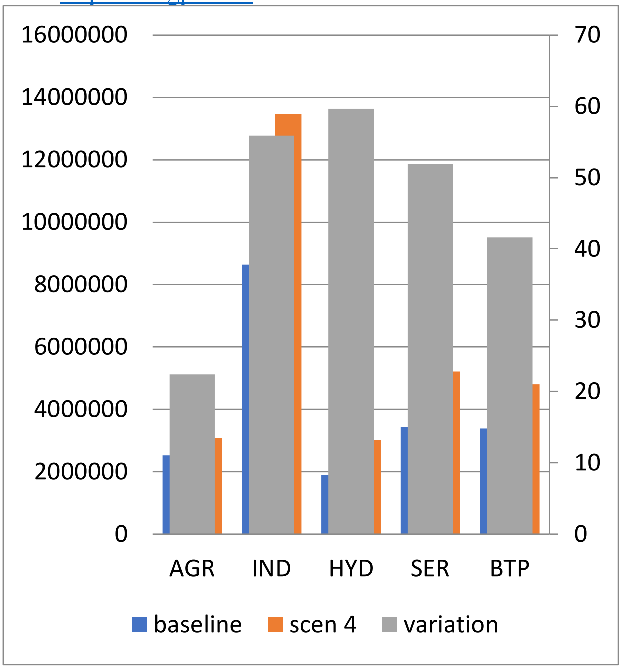


Figure 8: ***The results of the simulation in import***

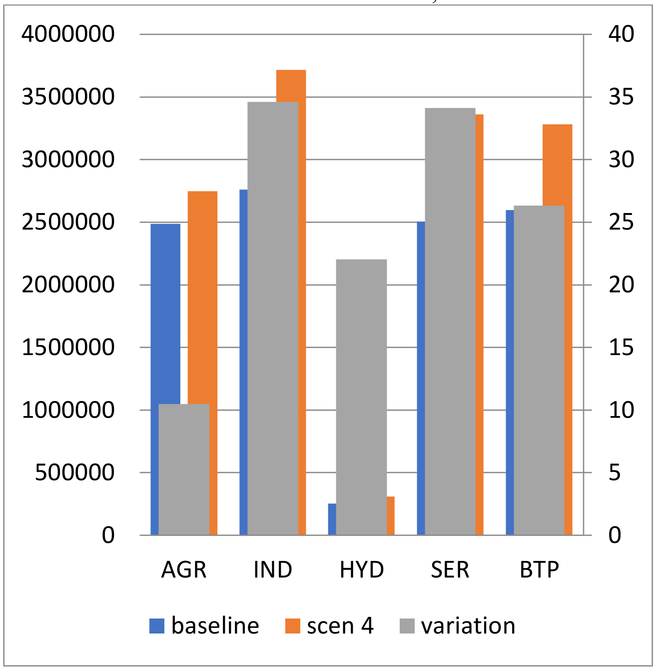
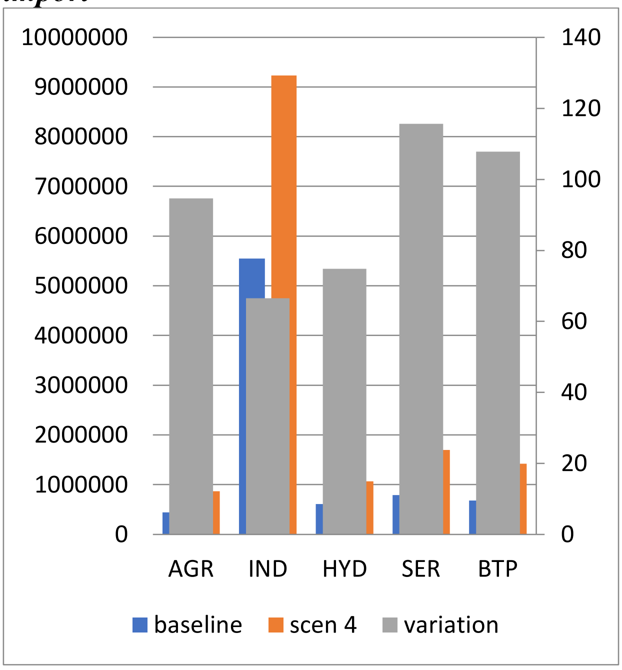
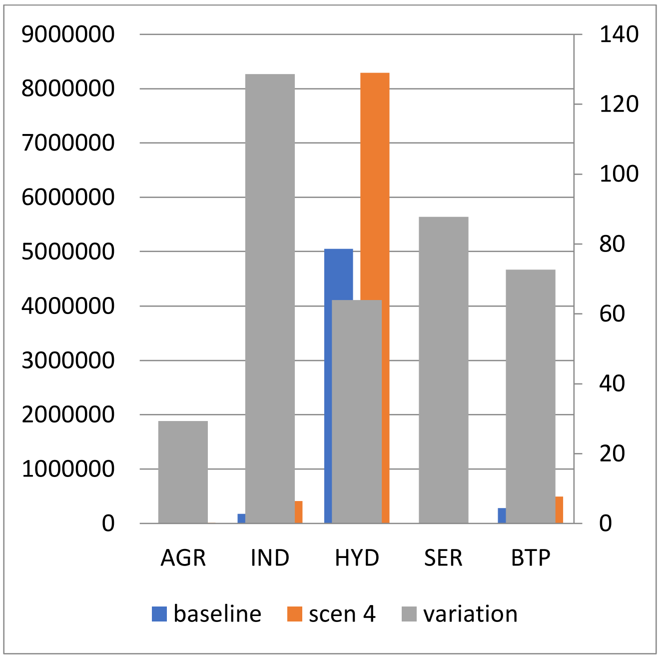


Figure 9: ***The results of the simulation in export***





The economic policy package that has been implemented has resulted in a significant increase in the supply of domestic goods across all sectors of the Algerian economy. The agriculture and industry sectors have seen a growth of 10% and 34% respectively, while the services sector has seen a rise of 34%, and construction and public works have grown by 26%.

THE RESULTS OF THE SIMULATION IN THE GOVERNMENT BLOCK

Based on Figures 10-11, it seems that revenue generated by taxes on production has decreased across all sectors. The industrial sector has seen the biggest decline, with a nearly 80% decrease. The fuel sector has also experienced a decline of nearly 80% in services. This is to be expected, as there has been a reduction in production tax rates as proposed in the 80% economic policy package.

To make up for the decline in state revenue, the package proposed an estimated 40% increase in direct taxes, which has resulted in an estimated 74% increase in direct tax revenues. Meanwhile, customs revenue has increased between 60% and 100% in all sectors, which is a natural consequence of the increased rate of customs duties.

Figure 10: **The results of the simulation in customs tariffs**

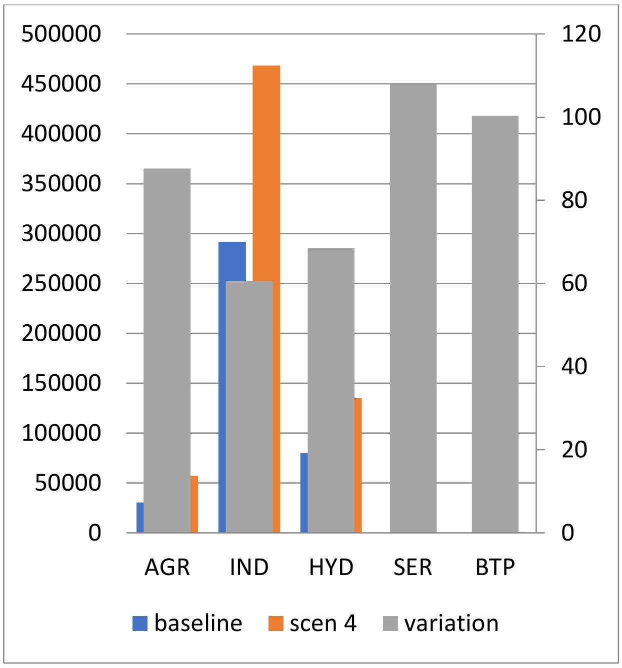


Figure 11: **The results of the simulation in production taxes**

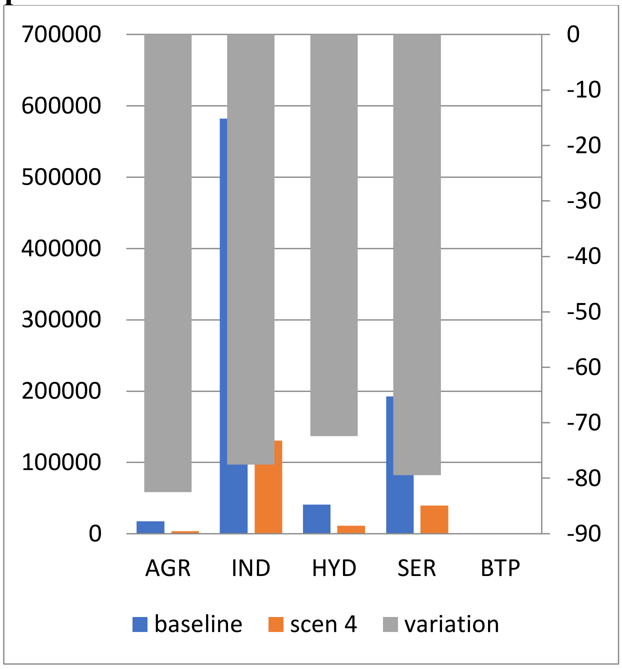


Table 8: The results of the simulation in the global variables

Simulation **50 per cent increase in the price of oil, 40 per cent increase in the rate of direct taxes, 80 per cent reduction in the rate of taxes on production, 70 per cent increase in the rate of customs duties, 80 per cent reduction in the trade deficit, 30 per cent increase in the allocation of components of production**		**Baseline scenario**	**Global variables**	
Variation	Amount	Amount	symbols	**Definition**
I. Production block				
43.74	13016500	9055074	Y	**composite factor**
40.49	21489100	15295338	Z	**Global production**
47.08	10733430	7297564	CAP	**Capital demand**
30.00	2284770	1757510	LAB	**Labor demand**
II. Global demand block				
79.17	10331710	5766299	Xp	**Households consumption**
50.33	10776046,9	7168183	Xv	**Investment demand**
III. International trade block				
66.49	9205274,27	5528757	E	**Export**
76.96	14285900	8072766	M	**Import**
48.86	29580400	19870342	Q	**Armington's good**
26.49	13408760	10600148	D	**Domestic goods**
IV. Government block				
74.07	0011541	662997	Td	**Direct taxes**
-77.85	184584,917	833567	Tz	**Production taxes**
64.19	660611,371	402338	Tm	**Customs tariffs**
V. Other variables				
5.29	0025736	2444260	Sg	**Government saving**
24.33	0070193	5645275	Sp	**Private saving**
	0.567		Epsilon	**Exchange rate**

CONCLUSION

This article discusses the use of macroeconomic policies in the Algerian economy using the CGE model. The article aims to address the question of finding the optimal mix of macroeconomic policies to resolve structural disequilibrium. The general applied balance model is designed to study economic balances, analyze the impact of economic shocks and policies on economic variables, and evaluate the balance in the economy. This model relies on the matrix of social accounts that reflects the balance in the economy. The article explains the conceptual framework of this matrix and how it was built and used in the general applied balance model. The third part of the study focuses on building the applied balance model for the Algerian economy by following the theoretical steps.

This involves designing the model equations, calibrating the parameters, and identifying external variables that can be used in simulations to effect changes in economic policies. The objective is to find the optimal mix of economic policies to address the structural imbalance in the Algerian economy. After conducting several tests, the study finds the optimal mix of policies that can improve the internal sectoral variables in the Algerian economy.

7. REFERENCES

[1] Narayanan, B. G., & Walmsley, T. L. (2008). **Global trade, assistance, and production: the GTAP 7 data base**. Center for global trade analysis, Purdue University, 134.

[2] Hosoe, N., Gasawa, K., & Hashimoto, H. (2010). ***Textbook of computable general equilibrium modeling: programming and simulations*.** Springer.

[3] André, F. J., & Cardenete, M. A. (2009**). Defining efficient policies in a general equilibrium model: a multi-objective approach.***Socio-Economic Planning Sciences*, *43*(3), 192–200. https://doi.org/10.1016/j.seps.2008.11.001

[4] Ashimov, A. A., Borovskiy, Y. V., Novikov, D. A., Sultanov, B. T., &Onalbekov, M. A. (2020). **Macroeconomic Analysis and Parametric Control Based on Global Multi-country Dynamic Computable General Equilibrium Model (Model 1). In *Macroeconomic Analysis and Parametric Control of a Regional*** *Economic Union* (pp. 73–201). Springer International Publishing. https://doi.org/10.1007/978-3-030-32205-2_2

[5] Richard Rosenthal, T. E. (2007). ***GAMS-A User's Guide***.GAMSDevelopmentCorporation,WashingtonDC,USA.

[6] Chen, L. ,& P. R. (2023). **Dynamic Modeling of Technological Disruptions in CGE Frameworks**. *Economic Modelling*, *45*(02), 301–308.

[7] Chen, P. (2008). **Equilibrium Illusion, Economic Complexity and Evolutionary Foundation in Economic Analysis**. *Evolutionary and Institutional Economics Review*, *5*(1), 81–127. https://doi.org/10.14441/eier.5.81

[8] Choi, S. C. T. (2015). **A Complementarity Approach to Solving Computable General Equilibrium Models**. *Computational Economics*, *46*(2), 305–323. https://doi.org/10.1007/s10614-014-9462-7

[9] Decaluwé Bernard et autres. (2001). **la politique économique du développement et les modèlesd'équilibregénéral calculable** (les presses de l'université de Montréal, Ed.).

[10] fofana Ismail. (2007).**Elaborerune Matrice de ComptabilitéSocialePour l'Analysed'Impacts des Chocs et Politiques Macroéconomiques.**Réseau de Recherche Sur Les Politiques Economiques de Réduction de La Pauvreté (PEP).

[11] Garbaccio, R. F. (1995). **Price reform and structural change in the Chinese economy: policy simulations using a CGE model.** China Economic Review, 6(1), 1-34.

[12] Garcia, A. , et al. (2022). **Sectoral Interactions and Structural Change Dynamics**. Journal of Economic Dynamics and Control, 38(04), 511–529.

[13] Ginsburgh, V., & Keyzer, M. (2002). **The structure of applied general equilibrium models**. MIt Press.

[14] Go, D. S., Lofgren, H., Ramos, F. M., & Robinson, S. (2016). **Estimating parameters and structural change in CGE models using a Bayesian cross-entropy estimation approach**. *Economic Modelling*, *52*, 790–811. https://doi.org/10.1016/j.econmod.2015.10.017

[15] Hertel, T. W. ,& T. M. E. (1997). **Global Trade Analysis: Modeling and Applications**. *Cambridge University Press.*, 5–94.

[16] Hu, H., Dong, W., & Zhou, Q. (2021). **A comparative study on the environmental and economic effects of a resource tax and carbon tax in China: Analysis based on the computable general equilibrium model**. *Energy Policy*, *156*. https://doi.org/10.1016/j.enpol.2021.112460

[17] Jafari, Y., Britz, W., Guimbard, H., & Beckman, J. (2021). **Properly capturing tariff rate quotas for trade policy analysis in computable general equilibrium models**. *Economic Modelling*, *104*. https://doi.org/10.1016/j.econmod.2021.105620

[18] Li, K. ,& W. H. (2022). **Incorporating Heterogeneity in CGE Models: Implications for Structural Change**. Review of Economics and Statistics, 20(1), 125–143.

[19] Lofgren, H. (Economist), Harris, R. L., & Robinson, Sherman. (2002). **A standard computable general equilibrium (CGE) model in GAMS**. International Food Policy Research Institute.

[20] Conrad, K. (2001). **Computable general equilibrium models in environmental and resource economics.** Discussion Papers/Institut für Volkswirtschaftslehre und Statistik, 601.

[21] Nguyen, T. ,& S. J. (2023). **Climate Policy and Economic Structural Transformation**. *Economic Policy*, *28*(3), 401–420.

[22] Santos, J. (2020). **Using input-output analysis to model the impact of pandemic mitigation and suppression measures on the workforce**. In *Sustainable Production and Consumption* (Vol. 23, pp. 249–255). Elsevier B.V. https://doi.org/10.1016/j.spc.2020.06.001

[23] Santos, M. S. (2004). **Simulation-based estimation of dynamic models with continuous equilibrium solutions.** Journal of Mathematical Economics, 40(3–4), 465–491. https://doi.org/10.1016/j.jmateco.2003.12.003

[24] Taylor, L. (2016). **CGE applications in development economics**. Journal of Policy Modeling, 38(3), 495–514. https://doi.org/10.1016/j.jpolmod.2016.02.010

[25] Varga, J., Roeger, W., & in 't Veld, J. (2022). E-QUEST: **A multisector dynamic general equilibrium model with energy and a model-based assessment to reach the EU climate targets**. Economic Modelling, 114. https://doi.org/10.1016/j.econmod.2022.105911