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THE IMPACT ASSESSMENT OF AN EVENTUAL OIL PRICE SHOCK WITH A COMPUTABLE GENERAL EQUILIBRIUM MODEL

ANALYSE D'IMPACT D'UN EVENTUEL CHOC PETROLIER AVEC UN MODELE D'EQUILIBRE GENERAL CALCULABLE

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Abstract

Energy issues are taking an increasingly important place in the various global agendas and there is no longer any doubt that the competition on energy will have repercussions all over the world. These repercussions could upset global balances and which can be economic, political and social. The purpose of this work is to assess the impact of the increase in petroleum products prices on the Moroccan economy. The proposed CGE model used for this study is based on the 2015 social accounting matrix. The results show that a gradual increase in the price of oil induces a deterioration of the main economic agents, household and government incomes and savings, an increase in the prices of products sold on the domestic market and a drop in exports

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felt at the level of oil-intensive products. These results also reveal the dependence and a great instability of the Moroccan economy with regards to changes in oil prices. In the event of a rise in oil prices, the country will be greatly destabilized, which will have repercussions on the budgetary balance and paving the way for economic and social difficulties.

Keywords: Energy, CGE model, scenario, increasing, oil price, economic agent.

Résumé

Les questions énergétiques prennent une place de plus en plus importante, dans les différents agendas mondiaux (conférence de juin 1992 de Rio de Janeiro, Copenhague 2009, protocole de Kyoto) et il ne fait désormais plus aucun doute, que la compétition sur l'énergie aura des répercussions partout dans le monde. Elle bouleversera les grands équilibres. Des répercussions qui peuvent être à la fois économiques, politiques et sociales. L'objet de ce travail et d'évaluer l'impact de l'augmentation des produits pétroliers sur l'économie marocaine. Le modèle EGC proposé pour cette étude est basé sur la matrice de comptabilité sociale de 2015. Les résultats montrent qu'une augmentation progressive du prix de pétrole induit à une détérioration des principaux agents économiques, des revenus et épargnes des ménages et ceux de l'état, une augmentation des prix de productions écoulées sur le marché intérieur, une baisse des exportations qui se révèle plus au niveau des produits à forte intensité de pétrole. L'analyse sectorielle révèle aussi que cette augmentation des prix affecte plus les branches à forte utilisation de pétrole. Ces résultats dévoilent également une dépendance et une fragilité de l'économie marocaine vis-à-vis des prix du pétrole. Dans le cas d'une hausse des prix, le pays sera fortement déstabilisé, ce qui va se répercuter sur l'équilibre budgétaire et ouvrant la voie à des difficultés économiques et sociales. De ce fait, et pour diminuer sa dépendance énergétique, le Maroc est appelé à renforcer ses politiques d'énergies renouvelables.

Mots clés : énergie, EGC, scénario, augmentation, prix de pétrole, agent économique.

1. Introduction

In a global economic context characterized by a constant increase in the prices of products related to fossil energy (gasoline, diesel, oil, etc,) and the costs related to its extraction, it becomes crucial for all countries to increase their sources of energy supply. In this context,

many initiatives and programs generally focusing on renewable energies have sprung up around the world, particularly in Europe (European directive on biofuels) and the United States (Banse et al., 2008), in order to respond to an ever growing demand.

Population growth, industrialization and technology development in developed countries have produced a sharp increase in the demand for oil. The increase in demand has been accompanied by a rise in oil prices, which has constituted a challenge for countries that import all of their oil needs.

The repercussions of the first oil shock, in 1979, on the oil-importing economies led economists to consider the variation in the price of oil as a major source of instability of economic activities, an instability that can result with an increasing of the budget deficit, a low economic growth, an increased unemployment and high inflation.

Morocco, as an oil importing country, is largely affected by the volatility of its prices. Its strong dependence on the world market to cover its basic needs, with its need for energy to guarantee economic growth and strengthen its industrial manufacture, accentuates its vulnerability to the external economy. A situation which weighs heavily on the balance of payments with an energy bill which raised up from 3.1% of GDP during the period 1995-1999 to 10.7% during 2008-2014 (Zouiri, 2016).

The importance of oil for the Moroccan economy, and the vulnerability of this economy to the oil prices shocks, justifies the interest of this study. Along the same lines, the purpose of this study is to establish a database and develop a tool to generate relevant information on the global economy of the country at a much more precise level of detail, in order to be able to simulate the impact of any external chocks or development policies before their implementations. The developed model will also help to empower policymakers to strengthen their knowledge on the macroeconomic aggregates. It can also enable policymakers in several sectors to design more effective policies to target vulnerable groups and to anticipate international prices fluctuation.

2. Literature revue

2.1 Oil price volatility

Energy is essential to most development outcomes. It is an essential input for production system. It turns out to be more important that there is no a substitute good in short-term. In addition, other important elements may influence the energy market such as demand, supply and technological development. The rise of several economies including China, Brazil and India implies that the demand for energy is continuously increasing. On the supply side, the increase

in crude oil production capacity is often held back by the high cost of new investments so that for some countries the maximum production capacity remains unchanged for more than a decade.

Historically, the oil market has been characterized by high volatility of oil prices. This volatility is mainly due to supply and demand which vary according to the needs of the global economy, and also to political, economic or climatic events.

At the beginning of the 21st century, the oil market experienced high volatility, and exceptional price increases. During this period (2000 - 2016), we can distinguish three main periods:

The 2000-2003 period: marked by a relative price stability. The 2004-2008 period: oil prices rise to 92 dollars per barrel *($ / baril)* which is due to high demand for oil. The 2008-2014 period: this period was marked by high volatility, because of the 2008 crisis; prices recorded an increase of 78.28% in 2008 compared to 2005 and a fall of -36.61% in 2009 compared to 2008. Between 2010 and 2011, these prices recorded a significant increase from an annual average of 71 dollars / barrel in 2010 to an annual average of 87 *($ / baril)* in 2011. In 2013, strong fluctuations were recorded during the year when the price of oil reached its maximum with a price of 91 *($ / baril)* and then decreased to 40 *($ / baril)* in 2015. During the last 4 years, a downward trend in the price of oil has been observed, the price of oil has stabilized between 40 and 60 dollars per barrel, which corresponds to the target of the OPEC (Organization of the petroleum Exporting Countries). Similarly, we see that the price of a barrel has fallen again to 36 *($ / baril)* in November 2020.

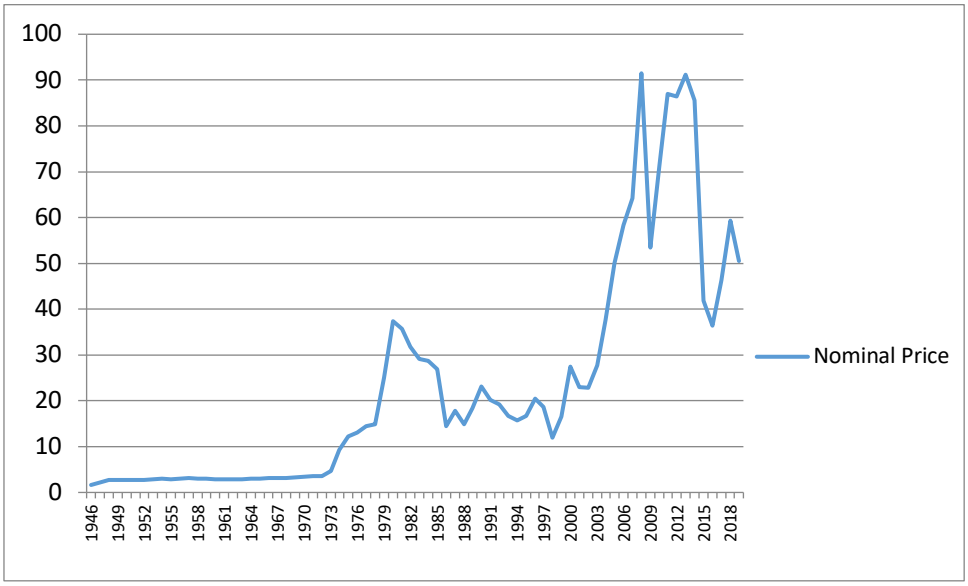

Figure 1 : Annual Average Crude Oil Prices ($ / baril)

(*https://inflationdata.com/articles/inflation-adjusted-prices/historical-crude-oil-prices-table)*

The structure of the Moroccan economy shows a real dependence on oil. According to the 2007 input-output table, it appears that the oil-intensive sectors are Fisheries and aquaculture, with an intermediate consumption of 35.75% of petroleum products, transport (32.79%), the extraction industry (30.59%), Production and distribution of electricity and water (23.51%) and the other manufacturing Industries except oil refining activity (18.22), Trade And Repair (16.08%).

therefore, the consequences of oil price shock on these sectors can be severe given the level of their intermediate consumption of petroleum products, however, and with the interdependence that exists between the different sectors, the shock can affect all the others low oil-intensive sectors, and as a result, a slowdown of the hole economic of the country.

2.2. Energy assessment with CGE modeling

Many studies has addressed the question of the relationship between oil price volatility and economic activities. Following the energy crisis in the early 1970s, interest in energy supply and energy policy was on the rise (Perrihann et al. 2017). Energy studies that focused on the energy sector were mainly of the partial equilibrium type. They used exogenously determined demand for energy to endogenously determine the cost minimizing levels of resource extraction, conversion, and distribution (Bergman 1988). CGE models have become a much used tool to analyze energy policy and its impact on the rest of the economy. Economists use CGE models to analyze the socioeconomic impacts of energy taxation (Solaymani and Kari, 2014) and energy market regulation (Vandyck and Regemorter, 2014). Energy-focused CGE models also have been used to study the sensitivity of the economy to oil price changes (Sanchez, 2011). These models rely on a macro and micro economic framework that represents the whole economy (sectors, factors of production and taxation and subsidy systems), as well as economic actors (producers, households, government, and the rest of the world).

The interest on energy assessment is increasing due to prices variability and the increasing demand on this limited resource. According to Schmidhuber and Tobiello (2007), prices for petroleum products remain high, the dependence between food and energy markets will be very important.

Using a computable general equilibrium model, Fan et al. (2007) analyze the impact of rising crude oil prices on China's economy. The results of these simulations show that the increase in

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the price of oil has a direct impact on the Chinese economy with a real reduction in GDP, investment and an increase in production costs.

Bentour (2015) analyzes the effect of the removal of oil price subsidies on the Moroccan economy using an input-output analysis for the period 1998-2013. The author simulated three scenarios of an increase in the price of oil. The results of these simulations show a high effect on petroleum intensive sectors such as transport, electricity and water sectors.

Recent studies were interested to other source of energy such as biofuel energy assessment and its effects on the food security of many countries. Some authors concluded that investing in renewable energies increases economic growth and contributes to the reduction of poverty (Arndt et Benfica, 2009; Banse et al., (2008). They evaluate the implications of the implementation of the EU biofuels directive by integrating a demand function for land, and come to the conclusion that these directives have an impact on agricultural markets at the global level and within European market,

3. Methods

3.1 Computable general equilibrium model

Computable general equilibrium modelling (CGEM) is defined as a representation of the economy, describing all interactions between economic agents (households, businesses, government, rest of the world), between economic sectors and between the economy as a whole and the outside world. It is a complex program of equations, called functional forms, which reflect different economic behaviors (Annabi et al, 2003).

Many authors have focused on the choice of functional forms and the determination of parameters in different models, presenting multiple markets and Models (Janvry and Sadoulet, 1995). We can mention here the linear expenditure system of Stone (1954) (LES); the almost ideal demand system of Deaton and Muellbauer (AIDS) (1980), and the combination of these two systems (GAIDS) (Bollino, 1990). Other models exist, less used, such as the translog model of Christensen et al, (1975) and the Leontief type function, which implies zero elasticities.

The bibliography distinguishes between tow type of models, mono-regional models and multiregional models. A mono-regional MEGC is composed of a single region, the region, belonging to a country, can take several forms: state, province, large economic region, municipality or village. Its structure is based on the national MEGC (Rodriguez, 2007; Lemlin 2008), Two elements distinguish the mono-regional CGEMs from the national CGEMs (Rodriguez 2007). The rest of the world represents the outside world in a national model and for a mono-regional model represents the rest of the country and the other countries, In addition,

it is difficult to simulate economic policy scenarios specific to the region in a national model without a very detailed desegregation. However, the mono-regional models suffer from several shortcomings that limit their ability to deal with issues of regional inequality. Lemelin (2008), Lofgren and Robinson (2002), and Haddad (2009) criticize the CGEMs to a single region with a focus on the problem of lack of interregional connections and the lack of feedback effects from the region to the nation which can underestimate the fallout of growth. Indeed, these models do not take into account the region's competitiveness gains from interregional trade flows (Rodriguez 2007). Finally, this modeling requires the availability of several regional data that are generally rare or even unavailable.

The multi-regional model is a reliable alternative to regional models. It provides a methodological structure reflecting interactions between several regions, In this case, production factors, especially labor and households are more mobile due to inter-regional migration, Multiregional modeling involves the introduction of distance which requires the modeling of transport costs and interregional trade flows (Giesecke and Madden, 2013). The ORANI and MONASH-RES models are the two best-known examples that have used this approach.

The ORANI model was originally designed as a national MEGC for the case of Australia. Then, these results were regionalized at the level of six states. This model was adapted later for some applications in other countries (Horridge et al., 1995) for the case of South Africa; (Haddad and Azzoni,2001) and (Haddad and Domingues, 2002) in the case of Brazil. MONASH-RES is also a multi-regional MEGC that adopts the top-down structure. It was developed by Parmenter and Welsh (2000). It was developed for the case of Australia by Dixon et al, (2000) and has led to several regional forecast studies.

The resolution of a MEGC is done in two stages. The model is solved at the national level and then the results are disintegrated across regions. This last step can be repeated several times depending on the level of regional disaggregation (Rodriguez, 2007). These behavioral equations require the calculation of some parameters; this is called calibration. According to Annabi et al, (2003), the calibration consists in choosing numerical values of the various parameters of the functional forms, such as they are compatible with the initial social accounting matrix (SAM). The Social Accounting Matrix (SAM) is a static table in which, for a given year, the flows of exchanges between the various economic agents are recorded. The SAM is based on the principle of balancing outgoings or uses and resources. This accounting equality is verified not only at the global level, but also for each agent, firms and households (themselves divided into sectors or social categories), government and the rest of the world. It

is therefore a generalization of input-output matrices describing inter-sectors exchanges (Pyatt et ronde, 1985; decaluwé, 2001) (figure 2).

The SAM used in this study summarizes the Moroccan economic for the year 2015. It presents five accounts: The factor of production account: labor and capital; the account of institutional units: representative household, businesses, government and the rest of the world; the goods and services account: aggregated into 20 products; the accumulation account: investment and savings; the account of the production activities aggregated into 20 activities.

The model is globally composed of several blocks of equations: the block of production equations; the block of the income and savings equations of economic agents; the block of tax equations (direct and indirect); the block of foreign trade equations; the block of demand equations; the block of price equations; the block of equilibrium equations.

The CGE model is a simultaneous equation system. This requires that the number of equations equal the number of variables for the model to have a unique solution. For this purpose, some variables will be kept fixed in relation with the type of macroeconomic closure retained for the model, such as the exchange rate, international prices, capital and labor. The variables chosen must reflect the existing economic reality and can be used to carry out economic policy simulations.

		1	2	3	4	5	6	7	8	9	10
		Activities	Commodities	Factors of production	Enterprises	Households	Government	Taxes	Savings or Investment	Rest of the world	Total
1	Activities		Domestic supply								Activity income
2	Commodities	Intermediate demand				Consumption spending (C)	Recurrent spending (G)		Investment demand (I)	Exports (E)	Total demand
3	Factors of production	Value added								Factor income from abroad	Total factor income
4	Enterprises			Capital income to enterprises							Enterprises income
5	Households			Factor payments			Transfers			Worker's remittances	Income of households and other domestic institutions
6	Government				Transfers from enterprises to government			Net indirect & income taxes, custom duties		Foreign grants & loans	Total government revenue
7	Taxes		Net Indirect taxes and custom duties		Income taxes on the enterprises	Personal income tax					Total net tax revenue
8	Savings or Investment				Savings of the enterprises	Private savings	Fiscal balance			Current account balance	Total savings
9	Rest of the world (ROW)		Imports (M)	Factor income to the rest of the world	Transfers from enterprises towards the ROW	Transfer payment from household sector	Transfers from government				Foreign exchange outflow
10	Total	Gross output	Total supply	Total factor spending	Total spending of enterprises	Total other sector spending	Total government spending	Total net tax	Total investment spending	Foreign exchange inflow	

Figure 2 : A Social Accounting Matrix table

(source : Breisinger, Thomas and Thurlow 2009)

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The main advantage of the model is that it gives indications of the expected effects at not only the level of macroeconomic variables, the activities, but also, and especially agents, through price and aggregate consumption, aggregate income of the country, wages, etc.

In addition, a number of other arguments also support the use of GEMs. For Beaumais et al, (1999), who justifies the use of CGEMs for the development of specific environmental issues or related areas such as biofuels, In fact, computable general equilibrium models could integrate the environment by establishing links that are explicitly adapted to environmental issues assessment. CGEMs have also been used to measure the impact of future changes such as Economic Partnership Agreements. According to Decaluwé (2001), general equilibrium modeling is a powerful tool for assessing the impact of economic policies,

In this context, this study aims to develop a series of social accounting matrix database for computable general equilibrium analysis and to simulate the impact of external chocks related to prices volatility. This modeling tool is also very useful for sustainable development policies assessment.

3. Results and discussion

The results of this paper simulate three scenarios of an increasing of the petroleum prices by 20%, 30% and 40%. The analysis of the results of this simulation indicates that an increase in the price of petroleum products leads to a drop in the main indicators and economic agents given that this sector represents the driving force of the Moroccan economy. Indeed, the economic agents, the household income and savings recorded a decline which increases with the intensity of the shock mainly due to the deterioration in income coming from the labor remuneration due to the fall in wage rates, Household income has fallen by 1.60%, 3.16% and 4.62% respectively, Savings decreased significantly by 9.56%, 19.15% and 28.16% (figure 3). The government account also recorded a respective decrease in its income of 1.21%, 2.44% and 3.62%, This decrease is due to the reduction of income coming from tax payments, which caused a fall in government savings (-3.10%, -6.49% and -9.99%). This partly explains the drop in investment for some sectors of the economy. It should be noted that the sectors of agriculture, fishing, agribusiness and textiles, being labor intensive, would influence the increase in the unemployment rate.

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As for the rest of the world, and with savings that remain fixed, imposed by the closure of the model, its income has registered a slight increase due to the gain in imports generated by the increase in oil prices.

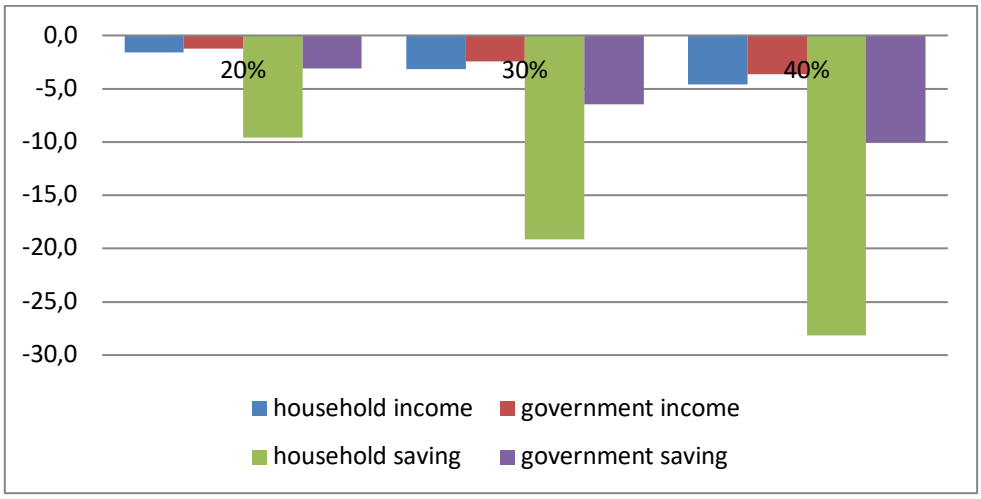

Figure 3: Evolution of economic agents saving and income according to the three price shocks

Imports of petroleum products fell by 2.5%, 4.3% and 5.9% respectively for the three shocks (figure 4). This significant decrease has a direct impact on the exports of the main sectors of the economy. Indeed, we are observing a progressive decrease in the exports of all agents and sectors that use petroleum products. The agricultural sector showed a decrease in exports of 13.2% for the last shock (30%), exports of the fisheries sector decreased by 5.84%, exports of the agri-food and tobacco industry sector decreased by 20.8% (Table 1).

Household consumption demand has not undergone a significant change even though its income has declined. A more in-depth analysis of the demand for each good reveals that the decline is mainly due to the fall in demand for transport (which decreased by 2.71%) and to the increase in the prices of the production sold on the local market for several sectors of the economy following the increase in energy prices.

The increase in the price of oil pushed up the cost of production activities, which resulted in a drop in factor wages of 0.5%. This fall in wages leads to a deterioration in the purchasing power and savings of households that reduce their demand for final consumption for several commodities. The public sector demand has not changed as the model's closure rules impose constant public consumption.

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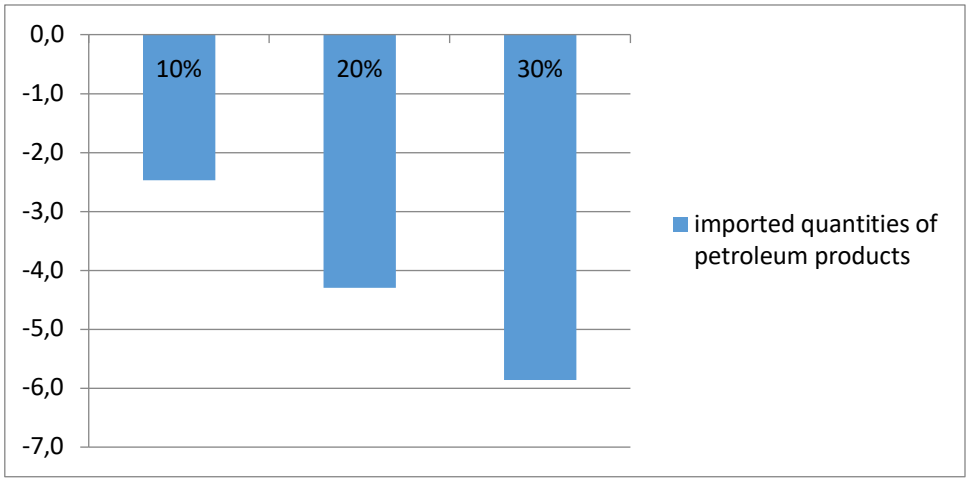

Figure 4: evolution of imported quantities of petroleum products

Table 1: Exports by sector of the economy

	Exports		
	20%	30%	40%
Agriculture, forestry and related services	-4,37	-8,84	-13,20
Fisheries, aquaculture	-9,64	-8,04	-5,84
Extraction industry	4,53	9,98	15,80
Food and tobacco industries	-7,87	-14,76	-20,82
Textile and leather industries	0,19	0,44	0,78
Chemical and parachemical industry	-1,10	-2,32	-3,52
Mechanical, metallurgical and electrical industry	0,22	0,53	0,93
Other manufacturing industries, excluding petroleum refining	-6,15	-12,03	-17,41
Electricity and water	-3,56	-6,29	-8,95
Construction and public works	0,00	0,00	0,00
Trade	0,00	0,00	0,00
Hotels and restaurants	-2,70	-5,08	-7,47
Post and telecommunications	-3,35	-6,71	-10,20
Financial activities and insurance	1,27	2,28	2,86
Real estate, rental and services rendered to businesses	6,67	14,33	22,03
Public administration and social security	0,00	0,00	0,00
Education, health and social action	0,00	0,00	0,00
Other non-financial services	0,78	1,26	1,34

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Conclusion

Oil being the main source of energy in the world, is considered essential to the functioning of world economies. The increase in world demand for oil, driven by the development of economies and certain geopolitical events, has led to disruptions in the oil market. The overall objective of this paper was to highlight the vulnerability of oil-dependent economies to oil price shocks. In this context, we have simulated the impact of the progressive increase in the prices of petroleum products by 20, 30 and 40% on the Moroccan economy. The model developed in this paper is a general equilibrium model. The advantage of this type of model is that it allows to visualize the impact of the shock on all variables of the real economy as well as to quantify this impact. This model is based on a social accounting matrix of 2015. The results of this simulations show that a gradual increase in the price of oil induces a deterioration of the main economic agents, the incomes and savings of households and the government, an increase in the prices of products sold on the domestic market, a drop in exports which is more evident in oil-intensive products such as fisheries, the agro-food industry, electricity and water.

In this context and to achieve the objectives assigned by the new energy strategy of the government focusing on the reduction of energy dependence regarding the international market, the Moroccan government should diversify its energy sources and invest more in renewable energy.

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