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The Energy Efficiency Measures and Economic Performance: Empirical Evidence from Morocco Using a Computable General Equilibrium Model

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Abstract: In Morocco, energy efficiency offers an excellent opportunity to improve the country's economic competitiveness and increase purchasing capacity; energy efficiency also contributes to strengthening energy security and reducing the country's energy dependence. The importance of energy efficiency measures is also reflected in the country's determined national contribution and in achieving the Sustainable Development Goals. Energy consumption, on the other hand, continues to grow due to the socio-economic development of the country and the generalization of energy access to rural areas. Energy data alone is insufficient to assess the impact of energy efficiency measures in the country in detail. In fact, energy intensity, which represents the ratio of a country's energy consumption to its gross domestic product (GDP), is an important indicator for assessing energy efficiency. To examine the role of energy policies on economic growth, we developed a computable general equilibrium model (CGEM) in which the micro-macro relationship is carried out by macroeconomic data provided by the summary tables of the national accounts as well as production information from the database of the Haut Commissariat au Plan. Our model is based on changes in energy consumption patterns, as a result of energy efficiency measures, can affect the demand for goods and services in various sectors, which would in turn affect the production and prices of those goods and services The results of our study also support the fact that energy efficiency measures have an impact on overall economic performance and growth in most economic sectors.

1. Introduction

Sustainable development has emerged as a central framework for addressing global challenges, integrating economic, social, and ecological dimensions. These dimensions—encompassing innovation, competitiveness, and democracy—collectively contribute to environmental protection and the conservation of natural resources (United Nations, 2015). Energy, as a critical driver of these dimensions, plays a dual role: it facilitates economic growth. It improves well-being, while also generating externalities such as resource depletion and environmental degradation. Consequently, effective energy management is essential for achieving sustainable economic systems (IEA, 2021).

In Morocco, energy efficiency represents a strategic opportunity to enhance economic competitiveness and improve living standards. According to the Haut Commissariat au Plan (HCP), the country's energy bill exceeded 82 billion DH in 2018, underscoring the financial burden of fossil fuel imports (HCP, 2019). By prioritizing energy efficiency, Morocco can reduce this expenditure, thereby increasing disposable income and strengthening energy security. These efforts align with the nation's Nationally Determined Contributions (NDCs) under the Paris Agreement and support the achievement of the United Nations Sustainable Development Goals (SDGs) (Ministry of Energy, Morocco, 2020).

Morocco has positioned itself as a regional leader in renewable energy development. The national energy strategy aims to increase the share of renewable energy to 42% of total installed electrical capacity by 2020, as part of a broader effort to diversify energy sources and reduce dependency on imports (IRENA, 2020). Concurrently, energy efficiency has been identified as a key priority, with ambitious targets to reduce energy consumption by 12% by 2020 and 15% by 2030. To achieve these goals, the government has implemented sector-specific action plans in critical areas such as transport, industry, and construction (World Bank, 2021).

The country's commitment to an energy transition is evident in its pursuit of a decarbonized and efficient energy model. This transition is driven by the dual objectives of enhancing citizen well-being and ensuring long-term economic prosperity. Renewable energy and energy efficiency are at the core of this transformation, representing a paradigm shift in the energy sector (Burandt et al 2019). Technological advancements have further strengthened the synergy between these two components, making their integration into investment decisions and policy frameworks essential for sustainable development (REN21, 2022).

Despite significant progress, Morocco faces ongoing challenges in managing its energy consumption. The Haut Commissariat au Plan (HCP) reports that energy demand continues to rise, driven by socio-economic development and expanding energy access to rural areas (HCP, 2021). However, energy data alone is insufficient to evaluate the effectiveness of energy efficiency measures. A more robust indicator, such as energy intensity, the ratio of energy consumption to gross domestic product (GDP)—provides a clearer assessment of energy efficiency trends and their economic implications (IEA, 2023).

The central role of energy production in the economic circuit highlights the importance of studying energy policies and their impact on sustainable development. This study employs a computable general equilibrium (CGE) model to analyze the effects of energy policies on various economic aggregates in Morocco (Elame & Lionboui, 2021).

Calculable General Equilibrium Models have become a fundamental tool in evaluating the economic and environmental impacts of energy efficiency investments. These models capture the interdependencies between different economic sectors, allowing for a comprehensive assessment of how energy efficiency investments influence economic performance, energy consumption, and emissions (Fattahi et al., 2023; Qi et al., 2024).

A key strand of literature focuses on the role of Computable General Equilibrium (CGE) models in assessing energy efficiency policies. Böhringer and Löschel highlight the advantages of CGE models in capturing both direct and indirect effects of energy efficiency improvements across various economic agents. They emphasize that these models provide a dynamic framework to evaluate the long-term effects of energy investments, including potential rebound effects, where increased efficiency may lead to higher overall energy consumption due to lower effective energy costs. (Böhringer *et al*, 2008).

By simulating different policy scenarios, the research aims to provide actionable insights into the interplay between energy policies, economic performance, and sustainability goals (Böhringer *et al*, 2008).

2. Methodology

Contrary to macroeconomic models which require long series of statistical data, computable general equilibrium modelling is based on data from a single period called the base year. Its data are structured and organized in an accounting framework which is the Social Accounting Matrix (SAM)

2.1 Social Accounting Matrix

A social accounting matrix represents the macro- and meso-economic accounts of a microeconomic system, which captures the transactions and transfers between all economic agents in that system (Pyatt *et al.*, 1985). It can also be defined as a generalization of Leontief "s "input-output" table, since on the one hand, it offers a coherent presentation of the transactions that take place in a given economy, whether it is a country, a region or a group of countries or regions, and on the other hand, it provides economic policy makers with the accounting basis of an analytical framework that can facilitate their choices.

To address our research problem, we constructed a Social Accounting Matrix (SAM) for the year 2019 based on data from the Moroccan national accounts published by the High Commission for Planning (HCP). This matrix comprises five key accounts: production factors, goods and services, production activities, capital accumulation, and institutional units. A disaggregated SAM provides a more detailed representation of the economy, enabling a nuanced analysis of sectoral heterogeneity, particularly in the context of energy transition policies. According to recent studies (Rohn T., 2022), disaggregated SAMs are essential for capturing the distributional effects of policy interventions across different sectors and households, thereby improving the accuracy of economic forecasting models.

The commodity account represents the sources of products sold in the local market, including imports and domestic production (column view), as well as their destinations, such as final consumption, intermediate consumption, and investment (row view). These products are categorized into domestic goods and exported goods, as defined by the aggregated nomenclature of the national accounting framework (Salhi *et al.* 2022). The factors of production account include labor and capital, which receive income from the sale of their services to productive sectors in the form of wages and capital rent. This income is then distributed to economic agents as remuneration for their endowments in labor and capital.

The institutional units account encompasses households, firms (both financial and non-financial), public administrations, and the rest of the world. For households, this account tracks all sources of income, including remuneration for their production factors, transfers from other economic agents, and final consumption expenditures, as well as taxes and social contributions paid. For firms, the account reflects their share of profits from productive activities, transfers from other agents, and payments such as dividends, rent, taxes, and social security contributions to shareholders and the state. The government account captures income generated through taxes and transfers from resident institutions and the rest of the world, which is allocated to public services, subsidies, and transfers to households, firms, and non-residents.

Finally, the rest of the world account records income generated by imports and transfers from the domestic economy, as well as expenditures on exports and transfers to resident institutional units.

This account reflects either a surplus balance (net investment by non-residents in the national economy) or a deficit balance (net investment by nationals abroad) (Thorbecke, 2021).

The production account: this account tracks the revenues and expenditures of production activities. Revenues are generated by the sale of the branches' output, while expenditures include the purchase of raw materials and intermediate products, the remuneration of factors (labor and capital) and the payment of taxes on production net of subsidies.

The capital accumulation account: in this account, a distinction is made between gross fixed capital formation and the change in stocks. This account collects the savings of resident and non-resident institutional units for investment in products. According to the nomenclature of the Moroccan system of national accounts (SCN), we distinguish between 20 branches of activity presented in the **Table 1** below:

A00	Agriculture and forestry
A05	Fishing and aquaculture
B01000100	Houille et lignite
B01000101	Petrol brut
B01000102	Gaz naturel
B03009	Extraction of other products of extractive industries
CA01	Food and Beverage Manufacturing
CB01	Manufacture of textiles, clothing, leather and leather products
CC00	Manufacture of wood and paper products; printing and reproduction of media
C19000001	Essence
C19000002	Gasoil
C19000003	Fuel oils
C19000005	Butane and propane
C19000009	Other petroleum products
CE00	Chemical manufacturing
CF00	Manufacture of basic pharmaceutical products and pharmaceutical preparations
CG0	Manufacture of rubber and plastic products, and other non-metallic mineral products non-metallic
CH0	Manufacture of basic metals and fabricated metal products, except machinery and equipment
CI0	Computer, Electronic and Optical Manufacturing
CJ0	Manufacturing of electrical equipment
CK0	Machinery and equipment manufacturing
CL0	Transportation equipment manufacturing
CM0	Other manufacturing (including furniture manufacturing), repair and installation

D35	Electricity, gas, steam and air conditioning production and distribution
E00	Water production and distribution, sanitation, waste management and depollution
F00	Construction
G00	Wholesale and retail trade; repair of motor vehicles and motorcycles
H00	Transport and storage
I00	Accommodation and catering activities
J00	Information and communication
K00	Financial and insurance activities
L68	Real estate activities
MN0	Research and development and business services
O84	Public administration and mandatory social security
PQ8	Education, human health and social work activities
RS0	Other services

Table 1. Social Accounting Matrix's accounts

For a more accurate model, we have chosen the RAS method of calibration of our model, this method is a technique used in Social Accounting Matrix (SAM) calibration, which involves adjusting the values in a matrix to ensure that they accurately reflect the economic conditions being modeled. The RAS method involves adjusting the values in a matrix in a way that preserves the original row and column totals while achieving some other desired properties. The name "RAS" comes from the three steps involved in the method: Ratio adjustment, Proportional adjustment, and Scaling.

• Ratio adjustment: In this step, the ratios between the rows and columns are adjusted to achieve some desired properties. For example, if the matrix is not balanced, meaning that the row and column totals are not equal, the ratios may be adjusted to achieve balance. This is done by dividing each row total by the corresponding column total and computing the average ratio, which is then used to adjust the values in the matrix.

• Proportional adjustment: In this step, the values in the matrix are adjusted proportionally to achieve the desired ratios. For example, if the average ratio computed in step 1 is less than 1, the values in the matrix are multiplied by the average ratio to increase them. If the average ratio is greater than 1, the values are divided by the average ratio to decrease them.

• Scaling: In this step, the values in the matrix are scaled to ensure that the row and column totals are equal to their original values. This is done by computing scaling factors for the rows and columns and multiplying the values in the matrix by these factors.

The method is commonly used in SAM calibration to ensure that the matrix accurately reflects the economic conditions being modeled.

2.2 Simulations of energetic efficiency

In the context of energy transition in Morocco, a social accounting matrix (SAM) could be a useful tool to study the impacts of various energy scenarios on the economy. SAM is a table that represents the inter-sectoral transactions in an economy, and it can be used to study the impacts of changes in one sector on other sectors of the economy. To stimulate the energy transition in Morocco, we use the software GAMS to run the model and ensure ethe equilibrium, we have considered the following scenario:

- Energy efficiency measures: This scenario could involve implementing measures to reduce energy consumption and improve energy efficiency in various sectors of the economy. The impact of such measures on the economy could be studied by modeling changes in energy consumption patterns and the growth of the energy efficiency sector.

To explain the interaction between economic aggregates and energy transition in a general equilibrium model, it is necessary to consider the interconnections between different sectors of the economy, as well as the interactions between the energy sector and other sectors of the economy. Changes in energy consumption patterns, as a result of energy efficiency measures, can affect the demand for goods and services in various sectors, which would in turn affect the production and prices of those goods and services.

In our model, the interactions between different sectors of the economy are modeled using equations that represent the supply and demand relationships between different markets. These equations are then solved simultaneously to obtain the market-clearing prices and quantities for each market. The solution to the CGE model represents the new equilibrium of the economy, which takes into account the impacts of energetic efficiency on different sectors.

The interaction between economic aggregates and energy efficiency in our model is explained through the following equilibrium equations:

- Market clearance: This equation represents the balance between supply and demand in a market. In the context of energy, it represents the balance between the supply of and demand for energy.

- Factor market clearance: This equation represents the balance between the supply and demand for factors of production particularly labor and capital. In the context of energy transition, it represents the balance between the supply of and demand for the factors needed to produce renewable energy, energy efficiency measures, and low-carbon fuels.

$$\sum(W_i * L_i) = \sum(R_i * K_i)$$

where W_i represents the wage rate paid to labor by firm i, L_i represents the quantity of labor employed by firm i, R_i represents the rental rate paid to capital by firm i, and K_i represents the quantity of capital employed by firm i.

Goods market clearance: This equation represents the balance between the supply and demand for goods and services. In the context of energy transition, it represents the balance between the supply of and demand for goods and services produced using renewable energy, energy efficiency measures, and low-carbon fuels:

$$\sum(x_{ij}) = \sum(X_j)$$

where x_{ij} represents the quantity of good j consumed by consumer i and X_{ij} represents the total quantity of good j produced.

Budget constraint: This equation represents the balance between a household's income and its spending on goods and services. In the energy transition context, it represents the balance between the income generated by renewable energy, energy efficiency measures, and low-carbon fuels, and the spending on these products.

$$Y_i = \sum p_j * x_{ij}$$

where p_i represents the price of good j and x_{ij} represents the quantity of good j consumed by consumer i.

Production function: This equation represents the relationship between the inputs used in production and the outputs produced. In the context of energy transition, it represents the relationship between the inputs needed to produce renewable energy, energy efficiency measures, and low-carbon fuels, and the outputs produced

2.3 Model Structure

In our model, demand is formed by consumption (intermediate and final), investment and exports, while supply is generated by imports and domestic production. The level of production can determine the quantity of inputs used by agents, more precisely enterprises, and therefore their intermediate consumption and their investments, which are two elements that make up demand. It also determines the level of employment and therefore the final consumption of households through their income. Another effect of employment on demand is through the setting of wages via the unemployment rate (**Figure 1**). This dynamic between wages, costs and prices influences demand in various ways. Wages impact on household consumption as they constitute a large share of household income. Prices and costs influence profits and consequently household consumption; dividends and investments affect the level of indebtedness of sectors. Price developments are the driving force behind the model's substitution mechanisms. This evolution of prices between imported and domestic goods sets the share of imports in the supply of each product.

The equilibrium of each market is achieved by regulating prices. Wages represent the equilibrium variables in the labor market; the savings-investment equilibrium is constrained. Real investment is fixed and is financed by the savings of households, firms, the government (public surplus) and the rest of the world (current account). Equilibrium is achieved by an endogenous fluctuation in corporate savings. This equilibrium is achieved through Walras Law which is a fundamental concept in general equilibrium theory that states that the value of excess demand in one market is equal to the sum of the excess demands in all other markets. In other words, if there is a shortage of a good in one market, there must be a surplus of some other good in another market, since the total value of all goods produced and consumed in an economy must balance.

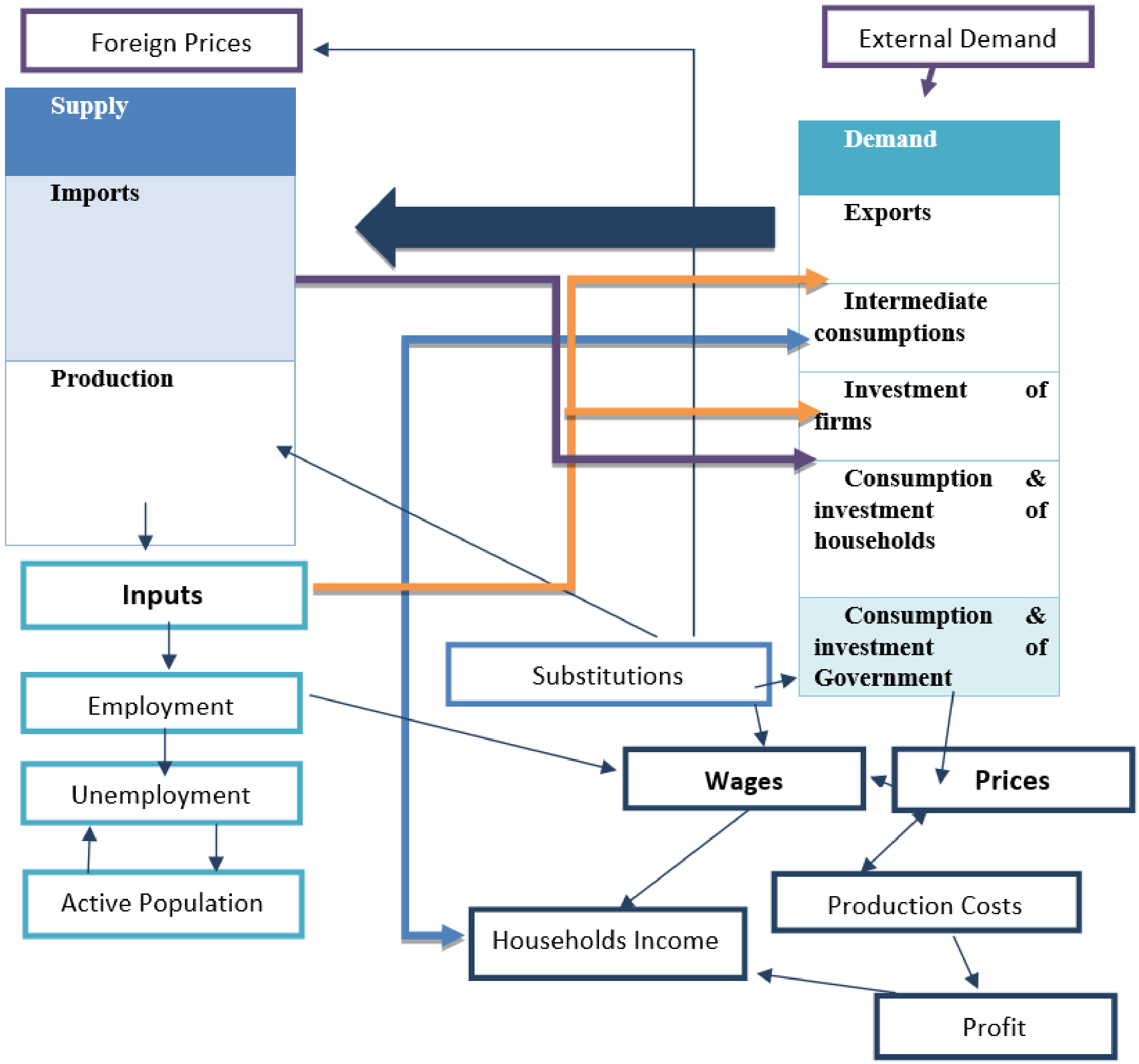

Figure 1. Model structure

The Walras' Law is an important concept in general equilibrium theory. It states that in a general equilibrium, the sum of the excess demands across all markets must be zero. Mathematically, it can be represented as:

$$\sum p_j * D_{ij} = 0$$

where p_i represents the price of good j, D_{ii} represents the excess demand for good j by consumer i, and the summation is taken over all goods j and consumers i.

The excess demand for a good j by consumer i, D_{ii}, can be calculated as:

$$D_{ij} = x_{ij} - X_j$$

where x_{ii} represents the quantity of good j consumed by consumer i, and X_i represents the total quantity of good j produced.

The importance of Walras' Law for demand and supply in general equilibrium models lies in its ability to ensure that all markets in an economy are simultaneously in equilibrium. In a general equilibrium model, the supply and demand in each market are interdependent, meaning that the quantity of a good supplied in one market is determined by the demand for that good in all other markets. Walras' Law ensures that the general equilibrium model is internally consistent, and that the allocation of resources is efficient. This is because excess demand or supply in one market will lead to changes in relative prices that encourage the adjustment of production and consumption across all markets, until all markets are in equilibrium.

3. Results and Discussion

An analysis was conducted using a simulation to explore the potential effects of implementing energy efficiency measures. The focus of the simulation was on increasing the demand addressed to Morocco, which means there was a simulated rise in the demand for goods and services within the country. The purpose of this simulation was to understand the economic implications that could arise from implementing energy efficiency measures and the subsequent increase in demand. By studying the simulation results, researchers or analysts can gain insights into the possible impacts of such measures on the overall economy.

The simulation yielded significant economic outcomes, although the specific details are not provided in this context. These outcomes may refer to notable changes in various economic indicators or variables. For a comprehensive understanding, more detailed information is likely available that provides an in-depth explanation and analysis of the simulation results. This additional information could include quantitative data, such as changes in GDP, employment rates, inflation, energy consumption patterns, or other relevant economic indicators. The analysis utilized a simulation to assess the potential effects of energy efficiency measures in Morocco. The simulation outcomes were substantial and likely offer valuable insights, which can be further explored in the following **Figure 2**.

Figure 2 presented above illustrates that the majority of economic aggregates have experienced positive changes, with exports, investment, household income, imports, and GDP showing the most significant improvements. In contrast, the other aggregates have displayed less variation, and therefore have not experienced changes to the same extent. Notably, exports have demonstrated the largest variation of all economic aggregates, increasing by 0.72%. It is worth mentioning that while investment, exports, imports and GDP have all demonstrated positive variations, other economic aggregates have displayed only minor changes. Although most economic aggregates have displayed positive variations, a few have shown slight changes during the analyzed period.

A critical aspect of economic growth and sustainability, particularly in the Moroccan context, is the role of household consumption in improving energy efficiency (Kettani & Sanin, 2023; El Hafdaoui *et al.* 2024). Addressing energy efficiency at the household level can have significant economic and environmental benefits, contributing to both sustainable development and long-term cost savings. One of the key mechanisms for achieving this is increasing public awareness and education on energy conservation. By implementing targeted public campaigns and educational programs, households can develop a deeper understanding of their consumption patterns and the advantages of adopting energy-efficient practices. Informed consumers are more likely to take proactive steps in reducing energy waste, which in turn supports broader national energy efficiency goals.

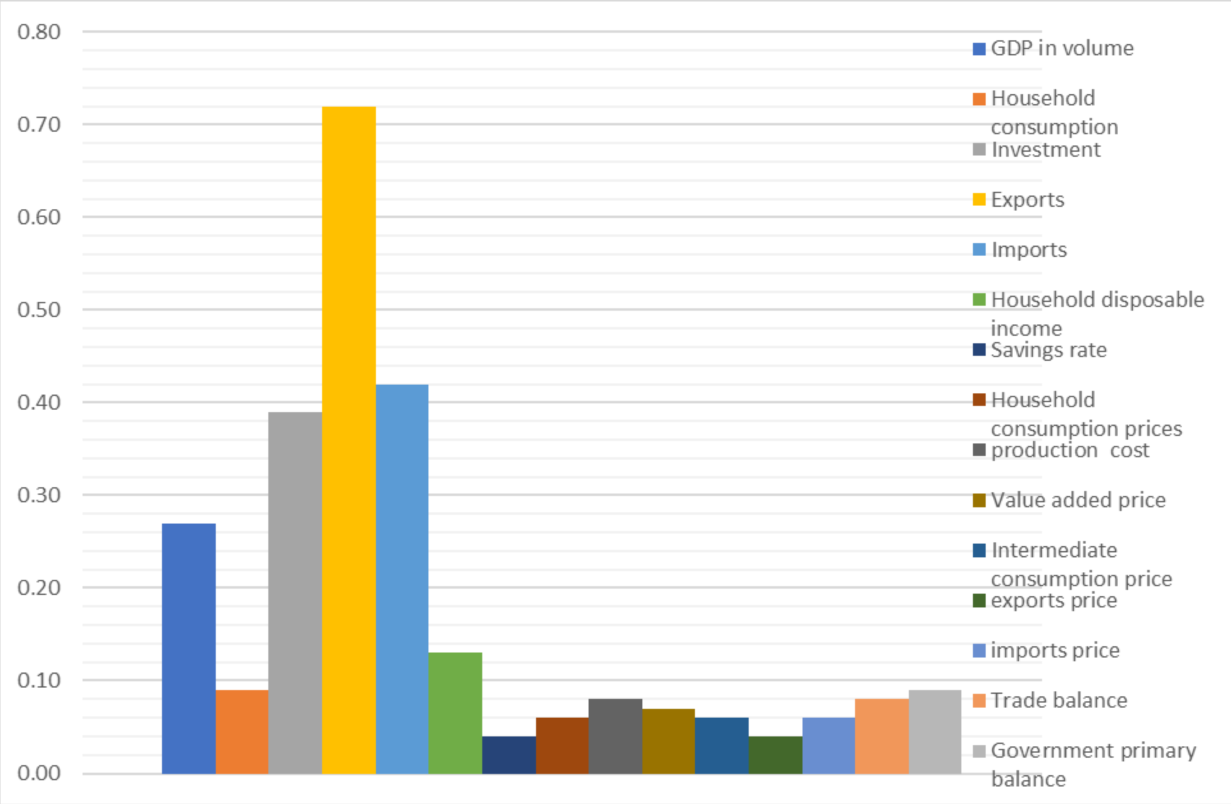

Figure 2. Result of simulations

Nevertheless, the positive trends observed in the previously mentioned economic aggregates have counterbalanced the negative variations observed in these variables. Despite some economic aggregates experiencing slight changes, the overall trend suggests that this simulation will lead to improved economic performance. We believe that household consumption can contribute to achieving better energy efficiency in the Moroccan context and this can be achieved through the following measures:

Awareness and Education: One of the crucial steps to promote energy efficiency at the household level is to raise awareness and educate citizens about the importance of energy conservation. Conducting public campaigns and providing educational materials can help households understand their energy consumption patterns and the potential benefits of adopting energy-efficient practices. This knowledge empowers individuals to make informed decisions about their energy use.

Incentives and Rebates: To encourage households to invest in energy-efficient appliances and technologies, the government or energy providers can offer financial incentives and rebates. This might include reduced prices or tax credits for purchasing energy-efficient appliances, insulation, or renewable energy systems. By making these options more financially accessible, more households will be motivated to upgrade their energy infrastructure.

Energy Audits and Home Upgrades: Conducting energy audits for households can identify areas of energy waste and inefficiency. Energy auditors can provide tailored recommendations for home upgrades and improvements, such as installing LED lighting, improving insulation, or upgrading to energy-efficient heating and cooling systems. Governments can support these initiatives by offering subsidies for energy audits or providing low-interest loans for energy-efficient home improvements.

Smart Energy Management: Promoting smart energy management systems can help households monitor and optimize their energy consumption. Smart meters, programmable thermostats, and home energy management apps can enable users to track their energy usage in real-time and adjust their consumption habits accordingly. This level of control encourages more responsible energy use and can lead to significant energy savings.

Community Engagement: Fostering a sense of community engagement and collective responsibility for energy efficiency can be beneficial. Local initiatives, such as neighborhood energy-saving challenges or community workshops on energy conservation, can motivate households to adopt sustainable practices. Encouraging energy-saving behavior as a community effort can create a positive social influence and reinforce energy-efficient habits.

Renewable Energy Adoption: Encouraging households to generate renewable energy on-site, such as through solar panels, can contribute to the national goal of achieving energy efficiency and sustainability. Net metering policies that allow households to sell excess energy back to the grid incentivize renewable energy adoption and can offset household electricity costs.

Conclusion

Based on the simulation results and their relevance to the Moroccan context, it is evident that implementing energy efficiency measures and increasing the demand addressed to Morocco can have significant positive impacts on the country's economy. The majority of economic aggregates, including exports, investment, household income, imports, and GDP, have demonstrated improvements, indicating the potential benefits of such measures in the Moroccan context

The substantial increase in exports, by 0.72%, is particularly noteworthy for Morocco, as it can enhance the country's competitiveness in international markets and contribute to a more balanced trade balance. This improvement aligns with Morocco's ongoing efforts to diversify its economy and reduce dependence on specific sectors.

Furthermore, the positive variations in investment, household income, and GDP indicate that energy efficiency measures can stimulate economic growth and improve the overall standard of living for Moroccan citizens. Increased investment in energy-efficient technologies and infrastructure can create job opportunities and contribute to sustainable economic development.

To achieve even better energy efficiency, particular attention should be given to household consumption patterns. Households are significant consumers of energy, and promoting energy-efficient practices at the household level can lead to substantial energy savings. Implementing awareness campaigns, offering incentives for adopting energy-efficient appliances, and encouraging responsible energy consumption behaviors can all play a crucial role in achieving better energy efficiency.

Moreover, investing in renewable energy sources can reduce the country's reliance on fossil fuels and promote cleaner and more sustainable energy production. Incentives for adopting renewable energy technologies, such as solar panels for residential use, can empower households to become active participants in the national energy efficiency drive.

In conclusion, the simulation results indicate that implementing energy efficiency measures and increasing the demand addressed to Morocco can have a positive impact on the country's economy. To achieve even greater energy efficiency, focusing on household consumption and promoting the adoption of renewable energy sources will be essential. By doing so, Morocco can make significant strides towards a more sustainable and prosperous energy future, and as discussed above by focusing on household consumption and implementing these strategies, Morocco can make substantial progress in achieving better energy efficiency. Energy-efficient households not only contribute to environmental sustainability but also support economic growth, energy security, and improved living standards for its citizens. A comprehensive and coordinated effort involving government, energy providers, and citizens is essential to ensure a successful transition towards a more energy-efficient and sustainable future

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References

Boeters S, Savard L., Chapter 26 - The Labor Market in Computable General Equilibrium Models, Handbook of Computable General Equilibrium Modeling, Elsevier, Volume 1, 2013, Pages 1645–1718, ISSN 2211–6885, ISBN 9780444595683, https://doi.org/10.1016/B978-0-444-59568-3.00026-2.

Böhringer, C., & Rutherford, T. F. (2008). Combining bottom-up and top-down. *Energy Economics*, 30(2), 574-596. https://doi.org/10.1016/j.eneco.2007.03.004

Burandt, T., Pahle, M., Flachsland, C., & Edenhofer, O. (2019). Equity and distributional implications of renewable energy transition in the European Union: A model-based assessment. *Climatic Change*, 153(3-4), 477-491.

Chen, C., & Jakob, M. (2017). Instrument choice and stranded assets in the transition to clean capital. *Ecological Economics*, 135, 269-277.

Elame F., Lionboui H. (2021), The impact assessment of an eventual oil price shock with a computable general equilibrium model, *REMSES*, 6(2), 200-214, https://revues.imist.ma/index.php/REMSES/article/view/26704

El Hafdaoui H., Khallaayoun A., Ouazzani K. (2024), Long-term low carbon strategy of Morocco: A review of future scenarios and energy measures, *Results in Engineering*, 21, 101724, ISSN 2590-1230, https://doi.org/10.1016/j.rineng.2023.101724

Fattahi A., Reynès F., van der Zwaan B., Jos Sijm, Faaij A. (2023), Soft-linking a national computable general equilibrium model (ThreeME) with a detailed energy system model (IESA-Opt), *Energy Economics*, 123, 106750, ISSN 0140-9883, https://doi.org/10.1016/j.eneco.2023.106750

Forsell, N., Korosuo, A., Lauri, P., Gusti, M., & Valsta, L. (2017). Exploring the implications of possible EU bioenergy targets on land use and forestry markets. *Global Change Biology*, 23(12), 4986-5002

Jakob, M., & Chen, C. (2017). Instrument choice and stranded assets in the transition to clean capital. *Ecological Economics*, *135*, 269-277.

Hamza E.B., Abdellali F., Redouane M., Ismail M. (2024). Investing in Education: What Effect on Inequality in Morocco? A Simulation Study Using a Computable General Equilibrium Model. In: El Bhiri B., Saidi R., Essaaidi M., Kaabouch N. (eds) *Smart Mobility and Industrial Technologies. ICATH 2022. Advances in Science, Technology & Innovation. Springer, Cham*. https://doi.org/10.1007/978-3-031-46849-0_21

High Commission for Planning (HCP). (2019). National Accounts of Morocco. https://www.hcp.ma

Kettani M., Sanin M. E. (2024), Energy consumption and energy poverty in Morocco, *Energy Policy*, 185, 2024, 113948, ISSN 0301-4215, https://doi.org/10.1016/j.enpol.2023.113948

Krey, V., Luderer, G., Clarke, L., Kriegler, E., & Riahi, K. (2014). Making or breaking climate targets: The AMPERE study on staged accession scenarios for climate policy. *Technological Forecasting and Social Change*, 90, 24-44

Pahle, M., Burandt, T., Flachsland, C., & Edenhofer, O. (2019). Equity and distributional implications of renewable energy transition in the European Union: A model-based assessment. *Climatic Change*, 153(3-4), 477-491

Qi, L., Zhao, L., Zhang, Y. *et al.* (2024). Computable general equilibrium analysis of neutral carbon trading scheme and revenue recycling impacts on income distribution in China. *Humanit Soc Sci Commun* 11, 131, https://doi.org/10.1057/s41599-024-02627-z

REN21. (2022). Renewables 2022 Global Status Report. Paris: REN21 Secretariat. https://www.ren21.net/gsr-2022/

Rohne T., E. (2022). Methodology. In: Agriculture for Economic Development in Africa. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-07901-6_6

Ruiz-Fuensanta, M. J., Gutiérrez-Pedrero, M.-J., Tarancón, M.-Á. (2019). The Role of Regional Determinants in the Deployment of Renewable Energy in Farms. The Case of Spain. *Sustainability*, 11(21), 5937. https://doi.org/10.3390/su11215937

Salhi J., Benammou S., A Tunisian social accounting matrix for impact analysis of macroeconomic policies and shocks, 06 October 2022, *Research Square* https://doi.org/10.21203/rs.3.rs-2117673/v1.

Tarancon, M. A., Lechon, Y., & Saez, R. (2019). Insights into the long-term economic evaluation of an energy efficiency retrofit program for residential buildings. *Energy and Buildings*, 196, 50-64

Thorbecke, E. (2021). The Role of Social Accounting Matrices in Economic Development Planning. *Journal of Development Economics,* 148, 102567. https://doi.org/10.1016/j.jdeveco.2020.102567

World Bank (2016), Morocco - Clean and Efficient Energy Project: Maroc - Projet d'énergie propre et efficace (French). Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/329541468187755520

Zhang, Y., Wang, G., Worrell, E., Crijns-Graus, W., & Faaij, A. (2016). Energy consumption and GHG emissions of six biofuel pathways by LCA in (the) People's Republic of China. *Applied Energy*, 184, 1185-1194

(2025) ; http://www.jmaterenvironsci.com