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Agricultural Taxation and Fiscal Sustainability in Emerging Economies: Evidence from a Recursive Dynamic CGE Model for Morocco

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Abstract: This paper investigates the economic, distributive, and fiscal implications of extending taxation to Morocco's still-exempt agricultural segment within the post-2014 agricultural tax reform framework. Covering the period 2025–2035, the study employs a recursive dynamic computable general equilibrium (CGE) model calibrated on a Social Accounting Matrix constructed from High Commission for Planning (HCP) 2024 data. The model incorporates agricultural dualism, fiscal recycling through the Agricultural Development Fund (FDA), capital accumulation, and climate-related productivity shocks. The results show that abrupt agricultural taxation reduces GDP, agricultural value added, productive investment, and rural welfare. Conversely, progressive and differentiated taxation limits these adverse effects while preserving macroeconomic stability. The findings indicate that the remaining exempt agricultural segment offers limited short-term revenue potential, making fiscal equity and tax-base broadening the main objectives of reform. The study concludes that sustainable agricultural taxation requires gradual implementation, effective FDA recycling, and climate-resilient agricultural investment.

Keywords: Agricultural taxation; Computable general equilibrium; Fiscal sustainability; Climate vulnerability; Morocco

JEL Classification: C68, H21, O13, Q18, Q54

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1. Introduction

Tax mobilization remains a major challenge for developing economies facing growing public expenditure needs, fiscal sustainability constraints, and increasing demands for tax equity (Tanzi & Zee, 2000; Besley & Persson, 2014). In this context, improving fiscal performance does not solely depend on increasing tax rates but also on broadening the tax base, reducing sectoral exemptions, and improving the allocation of the tax burden across economic activities (Bird & Zolt, 2008). These challenges are particularly significant in countries where large segments of the economy remain partially integrated into the formal tax system.

In Morocco, the agricultural sector occupies a strategic position within the national economy. Depending on climatic conditions, agriculture contributes between 12% and 15% of gross domestic product and accounts for nearly 30% to 40% of total employment, while its indirect effects on agro-industrial activities and rural demand further increase its macroeconomic importance (HCP, various years). Beyond its economic contribution, agriculture plays a critical social role through rural employment generation, food security, poverty reduction, and territorial stability. However, the sector also remains highly vulnerable to climatic shocks, particularly recurrent droughts and increasing water scarcity (World Bank, 2022; FAO, 2023).

Historically, Moroccan agriculture benefited from a highly favorable tax treatment. Agricultural incomes were largely exempted from corporate and personal income taxation for several decades in order to support rural incomes, stimulate investment, and preserve social stability in rural areas. This preferential regime was justified by the structural fragility of small-scale farming, the dependence of agricultural production on rainfall variability, and the strategic importance of the sector for national development. Nevertheless, the persistence of generalized tax exemptions gradually generated growing concerns regarding fiscal equity, tax neutrality, and public revenue mobilization.

A major institutional turning point occurred with the progressive agricultural tax reform introduced under the 2014 Finance Law. Since then, large agricultural farms exceeding specific turnover thresholds have gradually entered the formal tax system. Since 2020, only farms generating annual turnover below MAD 5 million remain exempt from direct taxation. Consequently, the current debate no longer concerns the taxation of a fully exempt agricultural sector, but rather the potential extension of taxation to the remaining exempt segment, composed mainly of small and medium-sized farms.

This institutional evolution substantially changes the analytical framework of agricultural taxation in Morocco. Estimates frequently discussed during the National Tax Conferences suggest that only 1% to 2% of agricultural farms are currently subject to direct taxation, while nearly 98% remain outside the tax base due to their low turnover levels. Although these farms individually exhibit limited taxable capacity, they collectively represent a substantial share of rural employment, agricultural activity, and territorial economic equilibrium. Therefore, extending taxation to this remaining exempt segment may generate important macroeconomic, distributive, and social effects.

The literature on agricultural taxation highlights a complex trade-off between public revenue mobilization, economic efficiency, and social equity (Newbery, 1987; Burgess & Stern, 1993). While expanding agricultural taxation may improve fiscal fairness and reduce distortions associated with prolonged exemptions, excessive or poorly designed taxation may negatively affect rural incomes, agricultural investment, and food security, especially in economies characterized by strong structural heterogeneity and climatic vulnerability. These issues are particularly relevant in Morocco, where sharp disparities persist between irrigated commercial agriculture and rainfed smallholder farming systems.

Despite the growing policy relevance of agricultural taxation reforms in developing economies, the existing literature remains characterized by several important limitations.

First, most studies on agricultural taxation primarily rely on descriptive institutional analyses or partial equilibrium approaches, which do not adequately capture the economy-wide interactions between fiscal policy, sectoral production structures, household income distribution, and intersectoral linkages (Dervis et al., 1982; Shoven & Whalley, 1992). As a result, the broader macroeconomic and distributive effects of agricultural taxation reforms remain insufficiently explored.

Second, the empirical literature devoted to Morocco remains relatively scarce and largely predates the progressive agricultural tax reform introduced under the 2014 Finance Law. Earlier studies generally analyzed agricultural taxation within the context of a largely exempt agricultural sector and therefore do not account for the current institutional configuration in which large farms are already integrated into the tax system. Consequently, limited evidence exists regarding the taxation of the remaining exempt segment composed predominantly of small and medium-sized farms.

Third, previous studies rarely integrate climate vulnerability into the analysis of agricultural taxation reforms. This omission constitutes a major limitation in the Moroccan context, where agricultural production remains highly exposed to recurrent droughts, water scarcity, and climate-related productivity shocks (World Bank, 2022; FAO, 2023). Ignoring these structural vulnerabilities may lead to an underestimation of the distributive and macroeconomic consequences of fiscal reforms applied to agriculture.

Fourth, the role of fiscal recycling mechanisms and agricultural support policies remains insufficiently examined in the literature. Existing studies generally focus on the direct effects of taxation while paying limited attention to the potential stabilizing role of compensatory public investment mechanisms such as the Agricultural Development Fund (FDA). Yet, these mechanisms may significantly influence the magnitude and distribution of the adjustment costs associated with agricultural taxation reforms.

Accordingly, this paper contributes to the literature by developing a dynamic computable general equilibrium (CGE) model calibrated on a Moroccan social accounting matrix that explicitly incorporates sectoral heterogeneity, fiscal recycling mechanisms, capital accumulation dynamics, and climate-related productivity shocks. Unlike previous studies, the analysis focuses specifically on the macroeconomic and distributive implications of extending taxation to the still-exempt agricultural segment in post-reform Morocco.

More specifically, the paper makes three main contributions. First, it provides one of the first dynamic CGE analyses of agricultural taxation in Morocco under the post-2014 institutional framework. Second, it integrates fiscal policy, climate vulnerability, and agricultural heterogeneity within a unified macroeconomic modeling framework. Third, it evaluates the stabilizing role of fiscal recycling mechanisms and public agricultural investment in mitigating the adverse effects of taxation reforms on rural welfare, agricultural value added, and macroeconomic stability.

To address these issues, the study develops a recursive dynamic CGE model calibrated on a Moroccan social accounting matrix and simulates several agricultural taxation scenarios over the 2025–2035 period. The model explicitly incorporates sectoral heterogeneity between irrigated and non-irrigated agriculture, fiscal compensation mechanisms through the Agricultural Development Fund (FDA), capital accumulation dynamics, and climate-related productivity shocks. The

simulations evaluate progressive taxation schemes, differentiated taxation structures, and climate-sensitive fiscal reform scenarios.

The results suggest that abrupt agricultural taxation without compensatory mechanisms could generate significant negative effects on GDP, agricultural value added, and rural welfare. Conversely, gradual taxation combined with targeted fiscal recycling and climate adaptation investment appears to reduce macroeconomic distortions while improving fiscal sustainability and tax equity. The findings therefore highlight the importance of sequencing, targeting, and institutional design in agricultural tax reforms implemented in structurally vulnerable economies.

The remainder of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature on agricultural taxation and fiscal reforms in developing economies. Section 3 presents the dynamic CGE model, calibration strategy, and simulation scenarios. Section 4 discusses the simulation results and analyzes the macroeconomic, sectoral, and distributive effects of agricultural taxation reforms. Section 5 discusses the main policy implications arising from the simulation results. Finally, Section 6 concludes by summarizing the main findings and highlighting their implications for sustainable agricultural taxation reform.

2. Literature Review

2.1. Agricultural Taxation and Fiscal Capacity in Developing Economies

The mobilization of domestic fiscal resources remains one of the central challenges facing developing economies. Increasing public expenditure needs, infrastructure financing requirements, rising social demands, and fiscal sustainability constraints have intensified the need to broaden tax bases and improve tax capacity (Tanzi & Zee, 2000; Besley & Persson, 2014). In many developing countries, however, tax systems remain characterized by narrow fiscal bases, widespread exemptions, high levels of informality, and unequal distribution of the tax burden across economic sectors (Bird & Zolt, 2008).

Within this broader context, agricultural taxation occupies a particularly sensitive and complex position. Agriculture simultaneously fulfills economic, social, territorial, and food-security functions while remaining highly exposed to climatic uncertainty and structural vulnerability. Historically, many developing countries adopted preferential fiscal regimes for agriculture in order to protect rural incomes,

preserve food security, and support structural transformation processes (Newbery, 1987). Agricultural tax exemptions were often justified by low productivity levels, fragmented land structures, weak administrative capacity, and the political sensitivity of taxing vulnerable rural populations.

However, prolonged tax exemptions may generate important distortions and fiscal inequities. Burgess and Stern (1993) argue that maintaining broad agricultural exemptions over extended periods may reduce fiscal neutrality, distort resource allocation, and weaken public revenue mobilization. Similarly, Bird and Zolt (2008) emphasize that unequal tax treatment between sectors may undermine both horizontal equity and fiscal legitimacy, particularly when highly profitable agricultural activities remain partially outside the formal tax system.

The theoretical foundations of agricultural taxation are closely linked to the broader literature on optimal taxation. Ramsey (1927), Mirrlees (1971), and Diamond and Mirrlees (1971) demonstrate that efficient tax systems should minimize distortions while ensuring sufficient revenue mobilization and preserving distributive equity. Applied to agriculture, these principles imply that fiscal reforms must account not only for revenue objectives but also for productive efficiency, income volatility, rural welfare, and heterogeneous productive capacities.

In developing economies, this trade-off becomes particularly complex because agriculture often combines modern export-oriented activities with low-productivity subsistence farming systems. Consequently, agricultural taxation cannot be analyzed solely from the perspective of fiscal yield; it must also incorporate issues related to social cohesion, rural poverty, structural transformation, and economic resilience.

2.2. Structural Heterogeneity and Agricultural Dualism

A major theme in the literature concerns the strong structural heterogeneity characterizing agricultural sectors in developing countries. Agricultural systems frequently exhibit a dual structure combining highly productive, market-integrated commercial farms alongside smallholder and subsistence-oriented agriculture with limited productive capacity (Johnston & Mellor, 1961; Timmer, 2009).

This dualism has important implications for tax policy design. Large commercial farms generally benefit from better access to irrigation, credit, technology, export markets, and institutional support, allowing them to sustain higher productivity and stronger taxable capacity. By contrast, smallholder farms often operate under severe

financial constraints, unstable incomes, weak market integration, and high exposure to climatic shocks.

The Moroccan agricultural sector illustrates this structural duality particularly clearly. Irrigated agriculture generally displays higher productivity levels, stronger market integration, and greater access to public support mechanisms. Rainfed agriculture, by contrast, remains heavily dependent on precipitation variability and exhibits lower productivity, weaker resilience capacity, and stronger vulnerability to drought episodes.

The persistence of this dual structure substantially complicates the implementation of uniform agricultural taxation policies. According to Atkinson and Stiglitz (1980), tax systems should account for heterogeneous welfare effects and differentiated productive capacities across economic agents. Similarly, Stiglitz (1982) emphasizes that optimal taxation requires consideration of both efficiency and distributive objectives, especially when income disparities are significant.

In this context, uniform agricultural taxation may generate asymmetric distributive effects by disproportionately affecting vulnerable rural households with limited savings capacity and high dependence on current agricultural income. Several studies suggest that excessive or poorly calibrated agricultural taxation may reduce investment incentives, constrain productive modernization, and increase rural inequality (Newbery, 1987; Bird & Zolt, 2008).

Consequently, progressive taxation schemes targeting highly productive and commercially integrated farms appear more consistent with the principles of tax equity and economic efficiency than generalized taxation approaches. This issue is particularly relevant in Morocco, where agricultural incomes and productive capacities remain highly unevenly distributed across farms and regions.

2.3. Agricultural Tax Reforms in Morocco: From Generalized Exemption to Selective Taxation

For several decades, Moroccan agriculture benefited from a quasi-generalized tax exemption regime. Agricultural revenues were exempt from both personal income tax and corporate income taxation as part of a broader development strategy aimed at supporting rural incomes, agricultural modernization, and social stability. This preferential treatment was justified by the structural fragility of small farms, the

dependence of agricultural activity on climatic conditions, and the strategic importance of agriculture for employment and food security.

However, the structural transformation of Moroccan agriculture progressively altered the terms of the fiscal debate. Since the early 2000s, the expansion of irrigated agriculture, export-oriented production, and high-value agricultural chains has increased productivity and income disparities within the agricultural sector. The emergence of large, modern, and highly capitalized agricultural enterprises raised increasing concerns regarding fiscal fairness and the unequal distribution of the tax burden across economic sectors.

A major institutional turning point occurred with the progressive agricultural tax reform introduced under the 2014 Finance Law. This reform established a gradual integration of agricultural activities into the formal tax system based on turnover thresholds. Since 2020, only farms generating annual turnover below MAD 5 million remain exempt from direct taxation.

This reform fundamentally transformed the nature of the agricultural taxation debate in Morocco. The issue no longer concerns the taxation of a fully exempt sector, but rather the potential extension of taxation to the remaining exempt agricultural segment composed primarily of small and medium-sized farms.

This institutional evolution creates a particularly important research context. Estimates frequently discussed during National Tax Conferences suggest that nearly 98% of agricultural farms remain outside direct taxation due to low turnover levels, despite their substantial aggregate role in rural employment and domestic agricultural production.

Despite the growing importance of these reforms, empirical evidence on their macroeconomic and distributive implications remains relatively limited. Existing studies on Moroccan agricultural taxation are generally descriptive or static in nature and largely predate the implementation of the post-2014 institutional framework.

2.4. Climate Vulnerability and Fiscal Sustainability

The interaction between climate vulnerability and agricultural taxation remains relatively underexplored in the literature despite its increasing importance in developing economies exposed to environmental stress. Agricultural production systems in many emerging economies remain highly dependent on rainfall conditions,

water availability, and climate-sensitive productivity dynamics (FAO, 2023; IPCC, 2023).

In Morocco, climate vulnerability constitutes one of the major structural constraints affecting agricultural productivity, rural welfare, and macroeconomic stability. Recurrent drought episodes continue to significantly affect GDP growth, agricultural value added, and rural incomes due to the central role of agriculture within the national economy. The World Bank (2022) identifies water scarcity and climate-related productivity shocks among the most important long-term risks facing Moroccan agriculture.

This climate dimension substantially complicates the design of agricultural taxation reforms. Taxation may reduce disposable income and productive investment precisely when agricultural producers face increasing climate adaptation costs and declining hydric availability. Consequently, the macroeconomic and distributive effects of agricultural taxation are likely to depend strongly on the interaction between fiscal reforms, productivity shocks, and climate resilience policies.

Nevertheless, most empirical studies on agricultural taxation continue to neglect climate-sensitive dynamics. Existing approaches frequently assume stable productivity conditions and therefore underestimate the amplification effects associated with droughts and hydric stress. This omission appears particularly problematic in the Moroccan context, where climate variability directly affects both agricultural output and fiscal sustainability.

2.5. Fiscal Recycling Mechanisms and Agricultural Support Policies

The literature on fiscal reforms increasingly emphasizes the importance of compensatory mechanisms and fiscal recycling policies in reducing the adjustment costs associated with taxation reforms. In CGE and Social Accounting Matrix (SAM)-based approaches, the macroeconomic effects of taxation depend not only on the initial fiscal burden but also on the allocation of the additional revenues generated by the reform (Dervis et al., 1982; Decaluwé et al., 2001).

Public investment programs targeting agricultural modernization, irrigation infrastructure, technological upgrading, and rural connectivity may partially offset the contractionary effects associated with agricultural taxation. Through multiplier effects, productivity gains, and capital accumulation dynamics, compensatory mechanisms can support agricultural output, rural incomes, and long-term growth trajectories.

In Morocco, the Agricultural Development Fund (FDA) constitutes one of the main public instruments supporting agricultural modernization and productive investment. Since the launch of the Green Morocco Plan and subsequently the Generation Green 2020–2030 strategy, the FDA has played a central role in financing irrigation systems, agricultural equipment, hydraulic infrastructure, and modernization projects.

These public investments generated important positive externalities through productivity improvements, market integration, export development, and technological diffusion. However, several studies also emphasize that public agricultural support may disproportionately benefit larger and more capitalized farms due to unequal access to finance, administrative capabilities, and institutional networks.

As a result, the effectiveness of fiscal recycling mechanisms depends strongly on governance quality, targeting efficiency, and distributive design. Poorly targeted support mechanisms may reinforce existing inequalities and generate long-term dependency effects, whereas well-designed compensatory policies may improve both economic efficiency and social sustainability.

2.6. Computable General Equilibrium Approaches and Agricultural Taxation

Computable general equilibrium (CGE) models have become one of the principal analytical tools used to evaluate fiscal, commercial, and sectoral reforms in developing economies. Unlike partial equilibrium approaches, CGE models explicitly incorporate intersectoral linkages, factor markets, institutional interactions, price adjustments, and macroeconomic constraints (Shoven & Whalley, 1984, 1992; Robinson, 1989).

Dynamic recursive CGE models are particularly appropriate for analyzing agricultural taxation reforms because they allow the integration of capital accumulation, investment dynamics, public expenditure effects, and intertemporal adjustment mechanisms. These models are therefore capable of capturing both direct and indirect effects transmitted through production structures, household income distribution, consumption patterns, and public finance channels.

In the Moroccan context, however, applications of CGE models to agricultural taxation remain relatively limited. Existing studies generally focused on generalized agricultural taxation before the implementation of the progressive post-2014 tax reform framework. Karim and Mansouri (2015), for example, show that agricultural

taxation may generate short-term contractionary effects on rural welfare while improving public revenues.

Nevertheless, previous empirical contributions present several limitations. First, most studies do not explicitly account for the current institutional configuration in which large farms are already integrated into the tax system and only the still-exempt agricultural segment remains outside the fiscal base. Second, existing approaches rarely integrate climate vulnerability, fiscal recycling mechanisms, and agricultural heterogeneity simultaneously within a unified macroeconomic framework. Third, many studies rely on static approaches that fail to capture dynamic adjustment mechanisms and long-term accumulation effects.

2.7. Research Gap and Analytical Contribution

The literature review highlights four major gaps.

First, most studies on agricultural taxation continue to rely either on descriptive institutional analyses or static approaches that inadequately capture economy-wide transmission mechanisms, intersectoral interactions, and dynamic adjustment processes.

Second, the empirical literature devoted to Morocco largely predates the post-2014 agricultural tax reform and therefore does not examine the taxation of the remaining exempt agricultural segment under the current institutional framework.

Third, climate vulnerability remains insufficiently integrated into the analysis of agricultural fiscal reforms despite its central role in shaping agricultural productivity, rural welfare, and macroeconomic stability in Morocco.

Fourth, the interaction between taxation reforms and fiscal recycling mechanisms through agricultural public investment remains largely underexplored.

This paper addresses these limitations by developing a recursive dynamic CGE model calibrated on a Moroccan social accounting matrix and explicitly incorporating sectoral heterogeneity, fiscal recycling mechanisms, climate-related productivity shocks, and capital accumulation dynamics. Unlike previous studies, the analysis specifically focuses on the macroeconomic and distributive implications of extending taxation to the still-exempt agricultural segment in post-reform Morocco.

The study therefore contributes to the literature in three main ways. First, it provides one of the first climate-sensitive dynamic CGE analyses of agricultural taxation under the post-2014 Moroccan institutional framework. Second, it integrates fiscal policy, climate vulnerability, and agricultural heterogeneity within a unified macroeconomic modeling approach. Third, it evaluates the stabilizing role of fiscal recycling mechanisms and agricultural public investment in mitigating the adverse effects of agricultural taxation reforms on growth, rural welfare, and fiscal sustainability.

3. Data and Methodology

3.1. Methodological Framework

This study develops a recursive dynamic computable general equilibrium (CGE) model to evaluate the macroeconomic, sectoral, and distributive effects of extending taxation to the still-exempt agricultural segment in Morocco. The methodological framework follows the tradition of multisectoral dynamic CGE models initially developed by Shoven and Whalley (1984, 1992) and subsequently adapted to developing economies by Dervis et al. (1982), Robinson (1989), and Decaluwé et al. (2001).

CGE models constitute one of the principal analytical tools used for the ex ante evaluation of fiscal, sectoral, and structural reforms because they explicitly capture interactions between productive sectors, factor markets, institutions, public finance, and external trade. Unlike partial equilibrium approaches, CGE frameworks allow the simultaneous analysis of direct, indirect, and induced effects generated by policy shocks throughout the entire economic system.

The recursive dynamic specification adopted in this study introduces intertemporal adjustment mechanisms linking each simulation period to the next through capital accumulation, labor force growth, investment dynamics, and public infrastructure development. This structure makes it possible to evaluate not only the immediate effects of agricultural taxation reforms but also their cumulative implications for sectoral productivity, rural welfare, macroeconomic stability, and long-term growth trajectories.

The model is specifically designed to capture the institutional and structural characteristics of the Moroccan economy following the progressive agricultural tax reform introduced under the 2014 Finance Law. Unlike previous studies focusing on

the taxation of a largely exempt agricultural sector, the present analysis examines the potential extension of taxation to the remaining exempt agricultural segment composed mainly of small and medium-sized farms with annual turnover below MAD 5 million.

3.2. Data Sources and Social Accounting Matrix

The empirical implementation of the model relies on a Social Accounting Matrix (SAM) constructed using the most recent national accounts and Input–Output data published by the Moroccan High Commission for Planning (HCP Stat 2024). The database combines information from national Input–Output Tables, sectoral production accounts, institutional accounts, external trade statistics, household consumption structures, and public finance data.

The SAM was specifically reconstructed, balanced, and aggregated for the purpose of this study in order to ensure accounting consistency between productive sectors, institutional agents, fiscal accounts, and external transactions. The calibration process integrates macroeconomic aggregates related to production, intermediate consumption, value added, household income, public revenues, savings-investment balances, and trade flows observed in the Moroccan economy.

The benchmark structure reflects the most recent available configuration of the Moroccan economy and explicitly incorporates the post-2014 agricultural tax reform environment in which large agricultural farms are already integrated into the formal tax system while smaller farms generating annual turnover below MAD 5 million remain exempt from direct taxation.

The database construction process also incorporates recent macroeconomic and sectoral information concerning agricultural production, irrigation structures, public agricultural investment, and fiscal aggregates derived from official HCP statistical publications as well as complementary reports issued by the Ministry of Economy and Finance and the Directorate of Financial Studies and Forecasts (DEPF).

The use of recent HCP Stat 2024 data constitutes an important empirical contribution of the study, as most previous Moroccan CGE applications relied on older benchmark matrices and pre-reform agricultural structures. This updated database allows a more accurate representation of the current institutional and productive configuration of the Moroccan agricultural sector.

To capture the structural heterogeneity of Moroccan agriculture, the SAM distinguishes between irrigated agricultural activities and non-irrigated agricultural activities. This distinction is particularly important given the significant differences in productivity, market integration, climate vulnerability, and taxable capacity between the two agricultural systems.

The final SAM structure distinguishes six productive sectors:

- irrigated agriculture,
- non-irrigated agriculture,
- agro-industrial activities,
- non-agro-industrial manufacturing,
- market services,
- and public administration.

The institutional accounts distinguish households, firms, government, investment-savings accounts, and the rest of the world. Agricultural households are further disaggregated into small farms, medium farms, and large agricultural producers in order to evaluate the distributive implications of taxation reforms across heterogeneous rural groups.

The benchmark year calibration reflects the most recent macroeconomic structure available in HCP Stat 2024 and constitutes the reference equilibrium for all simulations performed over the 2025–2035 simulation horizon.

3.3. Model Structure

The model adopts a recursive dynamic multisectoral CGE structure in which markets are solved sequentially period by period while state variables evolve dynamically over time. The economy is represented through interconnected productive activities, commodities, production factors, institutions, government accounts, investment-savings balances, and external trade accounts.

The productive structure combines a Leontief specification linking intermediate consumption and value added with a Cobb–Douglas value-added function integrating labor, capital, and land. Sectoral production is defined as:

$$Y_i = \min \left[\frac{CI_i}{OI_i}, \frac{V_i}{v_i} \right] \quad (1)$$

where CI_i represents intermediate consumption and V_i sectoral value added. Sectoral value added is generated according to a Cobb–Douglas technology:

$$V_i = A_i T_i^\eta K_i^{\beta_i} L_i^{\alpha_i} \quad (2)$$

where T_i , and L_i denote land, capital, and labor inputs, respectively. A_i captures sectoral productivity, while α_i , β_i , and η_i represent factor elasticities.

The explicit introduction of land as a production factor is particularly important in the Moroccan context due to strong differences in productivity between irrigated and non-irrigated agriculture as well as the importance of hydric constraints and land fragmentation.

Productivity incorporates positive externalities associated with public capital accumulation:

$$A_i = A_0 \left(\frac{K^G}{\sum_i K^i} \right)^\varphi \quad (3)$$

where K^G represents public capital stock. This specification captures the effects of irrigation infrastructure, hydraulic investment, rural roads, and agricultural modernization programs financed through public support mechanisms such as the Agricultural Development Fund (FDA).

3.4. Household Behavior and Welfare

Household behavior is represented using an Extended Linear Expenditure System (ELES) derived from Stone–Geary preferences. This specification distinguishes subsistence consumption, discretionary consumption, and savings behavior. The ELES structure appears particularly appropriate in the Moroccan context because rural households allocate a large share of income to food consumption and essential goods.

The representative household utility function is defined as:

$$\ln(U_h) = \sum_{i=1}^n \mu_{i,h} \ln(CM_{i,h} - \theta_{i,h}) + \mu_{s,h} \ln(SM_h) \quad (4)$$

where $CM_{i,h}$ denotes household consumption of commodity i , $\theta_{i,h}$ the subsistence consumption level, and SM_h household savings.

Agricultural taxation reforms directly affect household disposable income through new fiscal liabilities applied to previously exempt agricultural revenues:

$$RDM_h^1 = RDM_h^0 - T_h^{agri} + TR_h^{FDA} \quad (5)$$

Where T_h^{agri} denotes agricultural taxation and TR_h^{FDA} transfers received through compensatory fiscal recycling mechanisms financed by the Agricultural Development Fund.

Household welfare effects are evaluated using equivalent variation measures aggregated into a synthetic social welfare indicator, allowing the assessment of distributive impacts across different categories of agricultural households.

3.5. External Trade and Price Formation

The model incorporates imperfect substitution between domestic and imported goods following the Armington (1969) specification. Composite demand for commodity i is represented through a Constant Elasticity of Substitution (CES) function:

$$Q_i = [\delta_i M_i^{-\rho_i} + (1 - \delta_i) D_i^{-\rho_i}]^{-1/\rho_i} \quad (6)$$

where M_i denotes imports and D_i domestically produced goods supplied to the domestic market.

Domestic prices depend on world prices, exchange rates, tariffs, indirect taxation, and subsidy mechanisms:

$$P_i = Pw_i e (1 + \tau_i^{dd}) (1 + \tau_i^{ind}) (1 + \tau_i^s) \quad (7)$$

This specification allows the model to capture the effects of agricultural taxation reforms on production costs, food prices, competitiveness, and external trade structures.

The explicit incorporation of VAT mechanisms is particularly important in the Moroccan agricultural context because indirect taxation may influence both agricultural input costs and food prices, thereby affecting rural welfare and sectoral competitiveness.

3.6. Government Behavior and Fiscal Recycling Mechanisms

The government is modeled as a central institutional agent collecting taxes, redistributing income, financing public expenditure, and supporting productive investment. Public revenues originate from indirect taxes, customs duties, direct household taxation, and corporate taxation.

Agricultural taxation reforms introduce an additional fiscal component targeting previously exempt agricultural revenues:

$$RDD^{agri} = \sum_i \tau_h Y_h^{\text{exempt}} \quad (8)$$

where Y_h^{exempt} represents previously exempt agricultural income and τ_h the effective tax rate applied to household category h .

A share of additional agricultural tax revenues is recycled toward the agricultural sector through compensatory public investment mechanisms financed by the Agricultural Development Fund:

$$TRFDA = \alpha RTD^{agri} \quad (9)$$

where α represents the share of additional tax revenues reinjected into agricultural support programs.

This fiscal recycling mechanism constitutes a central feature of the model because it allows the evaluation of the stabilizing role of compensatory public investment in mitigating the contractionary effects associated with agricultural taxation reforms.

Public investment influences productivity through irrigation infrastructure, hydraulic systems, modernization policies, climate adaptation programs, and rural connectivity. These mechanisms are particularly important in the Moroccan context where agricultural productivity remains strongly dependent on water infrastructure and climate resilience capacity.

3.7. Dynamic Specification

The recursive dynamic structure links simulation periods through capital accumulation, labor force growth, investment dynamics, and public infrastructure development. Labor supply evolves according to demographic growth:

$$L_{t+1}^s = L_t^s \cdot (1 + n) \quad (10)$$

Public capital evolves according to:

$$K_{t+1}^G = K_t^G \cdot (1 - \theta) + \delta^i IG_t^{v0} \quad (11)$$

while private sectoral capital accumulation follows:

$$K_{t+1}^i = K_t^i \cdot (1 - \theta) + \delta^i IP_t^i \quad (12)$$

where IG_t and IP_t^i denote public and private investment, respectively.

Private investment dynamics depend on previous investment levels, economic growth, and public investment effects:

$$\frac{I_t^p}{GDP_t} = b \frac{I_{t-1}^p}{GDP_{t-1}} + c \ln \left(\frac{GDP_t}{GDP_{t-1}} \right) + d \frac{IG_t}{GDP_t} \quad (13)$$

This recursive specification allows the model to capture medium-term accumulation effects and intertemporal transmission mechanisms associated with agricultural fiscal reforms.

The dynamic structure is particularly relevant for the Moroccan economy because the effects of irrigation investment, agricultural modernization, public infrastructure, and climate adaptation policies materialize progressively over time rather than instantaneously.

The model is calibrated on the benchmark equilibrium derived from the Moroccan Social Accounting Matrix constructed using HCP Stat 2024 data. Calibration ensures that the benchmark equilibrium reproduces the observed structure of production, consumption, factor remuneration, fiscal accounts, and external trade flows of the Moroccan economy.

The model adopts a standard neoclassical closure commonly used in recursive dynamic CGE applications for developing economies (Dervis et al., 1982; Decaluwé et al., 2001).

The following closure assumptions are retained:

- factor markets clear through relative price adjustments;
- labor supply evolves exogenously according to demographic growth;
- total investment is savings-driven;
- public savings adjust endogenously to maintain fiscal equilibrium;

- the current account balance is fixed as a share of GDP;
- the exchange rate acts as the external adjustment variable;
- capital accumulation follows recursive investment mechanisms.

The consumer price index (CPI) is selected as the model numéraire:

$$PCPI = 1$$

This normalization ensures the consistent determination of relative prices within the general equilibrium framework.

Labor mobility is assumed to be imperfect between agricultural and non-agricultural sectors, reflecting structural rigidities and labor segmentation within the Moroccan economy. Capital is sector-specific in the short run but becomes partially mobile over time through investment accumulation mechanisms.

The model distinguishes three production factors:

- labor;
- private capital;
- agricultural land.

Land is assumed to be sector-specific and imperfectly substitutable across agricultural activities, particularly between irrigated and non-irrigated production systems.

Elasticity parameters are calibrated using a combination of Moroccan Input–Output structures, previous CGE studies applied to developing economies, GTAP-based elasticities, and parameter values commonly retained in agricultural CGE applications. Armington elasticities govern substitution between imported and domestically produced goods, while CET elasticities determine export-domestic transformation behavior.

The depreciation rate of private capital is fixed at 5%, while labor force growth is assumed at 1.2% annually based on recent demographic projections. Public investment productivity effects are calibrated using the elasticity parameter ϕ , reflecting infrastructure externalities associated with irrigation systems, agricultural modernization, and rural investment policies.

The Agricultural Development Fund (FDA) recycling parameter (α) determines the share of additional agricultural tax revenues reinvested into agricultural support

programs. Climate shocks are introduced through exogenous productivity reductions affecting primarily non-irrigated agricultural activities.

It is important to distinguish between the share of taxable agricultural producers and the fiscal recycling parameter. Analyses of the Moroccan agricultural structure and discussions held during the National Tax Conferences suggest that only a very small proportion of agricultural holdings—often estimated at around 1% to 2% of farms—exceed the turnover thresholds required for direct taxation, while the vast majority remain effectively outside the scope of agricultural income taxation (Akesbi, 2012; Kingdom of Morocco, 2019). This reflects the narrowness of the taxable agricultural base and helps explain the limited short-term revenue potential associated with extending taxation to the remaining exempt agricultural segment. By contrast, the FDA recycling parameter (α) is a policy assumption representing the proportion of additional agricultural tax revenues reinvested into the sector through public support mechanisms. In this study, α is set at 40% to represent a moderate fiscal recycling scenario, whereby part of the additional revenues finances irrigation infrastructure, agricultural modernization, and climate adaptation programs, while the remaining share contributes to the general government budget.

Similarly, the public capital productivity elasticity (ϕ) is set at 0.08 to capture the positive but moderate productivity effects associated with public investment in irrigation systems, rural infrastructure, and agricultural modernization. This value is consistent with the range commonly adopted in CGE applications for developing economies and reflects a conservative assumption regarding the contribution of public capital to agricultural productivity growth.

Table 1 summarizes the principal calibration parameters retained in the simulations.

Table 1. Main Calibration Parameters

Parameter	Description	Value	Source
ρ_A	Armington elasticity	2.0	GTAP / CGE literature
ρ_r	CET elasticity	1.5	CGE literature
θ	Capital depreciation rate	5%	Standard CGE calibration
n	Labor force growth	1.2%	HCP demographic projections
ϕ	Public capital productivity elasticity	0.08	Calibrated
α	FDA recycling share	40%	Simulation assumption

Climate shock	Agricultural productivity shock	-15% to -30%	FAO / World Bank
s	Household savings rate	18%	HCP national accounts

This calibration framework ensures consistency between the observed structure of the Moroccan economy, the post-2014 agricultural tax regime, and the policy scenarios evaluated over the 2025–2035 simulation horizon.

To further assess the consistency of the calibration procedure, the benchmark equilibrium generated by the model was compared with the principal macroeconomic aggregates of the Social Accounting Matrix used for calibration. The benchmark replication exercise confirms that the calibrated model accurately reproduces the benchmark structure of the Moroccan economy, including production, value added, and fiscal revenues. As expected from the calibration procedure, the benchmark equilibrium replicates the Social Accounting Matrix exactly, resulting in zero replication errors. This confirms the internal consistency of the calibration and provides a reliable starting point for the policy simulations.

Table 2. Benchmark Replication of Key Macroeconomic Aggregates

Variable	SAM	Model	Error (%)
GDP	1,420,068	1,420,068	<0.001
Fiscal Revenues	320,503	320,503	<0.001
Agricultural Value Added	226,771	226,771	<0.001

Source: Authors' calculations based on the calibrated Moroccan Social Accounting Matrix (HCP Stat 2024)

The near-perfect replication of the benchmark aggregates confirms the internal consistency of the calibration procedure and validates the benchmark equilibrium used as the starting point for all simulations. The negligible replication errors indicate that the model accurately reproduces the structural characteristics of the Moroccan economy prior to the introduction of fiscal and climate policy shocks.

3.8. Simulation Scenarios

The analysis evaluates seven policy scenarios designed to assess the macroeconomic, sectoral, fiscal, and distributive implications of extending taxation to the still-exempt agricultural segment.

Scenario	Description
S0	Baseline scenario without additional agricultural taxation reform
S1	Introduction of VAT, personal income tax, and corporate tax on still-exempt agricultural activities with partial fiscal recycling through the FDA
S2	Taxation applied only to irrigated agricultural activities combined with FDA compensatory mechanisms
S3	Introduction of personal and corporate income taxation without VAT
S4	Direct agricultural taxation without compensatory mechanisms
S5	Agricultural taxation combined with climate shocks simulating drought conditions
S6	Progressive agricultural taxation over the 2025–2035 period
S7	Progressive taxation combined with reinforced FDA investment and climate adaptation policies

The integration of climate shocks allows the model to evaluate the vulnerability of agricultural growth trajectories under recurrent drought conditions and increasing hydric stress.

All simulations were implemented in R (version 4.6.0) using a recursive dynamic CGE framework calibrated on the Moroccan Social Accounting Matrix constructed from HCP Stat 2024 data.

The simulations evaluate the effects of agricultural taxation reforms on:

- sectoral production;
- agricultural value added;
- household income;
- fiscal revenues;
- productive investment;
- capital accumulation;
- rural welfare;
- and macroeconomic equilibrium.

The adopted framework therefore provides an integrated assessment of the trade-offs between fiscal mobilization, economic growth, distributive equity, agricultural resilience, and macroeconomic sustainability within the context of agricultural taxation reforms in Morocco.

4. Simulation Results and Policy Analysis

4.1. Macroeconomic Effects of Agricultural Taxation Scenarios

The simulations performed using the recursive dynamic computable general equilibrium (CGE) model reveal differentiated macroeconomic effects depending on the intensity of agricultural taxation, the existence of compensatory fiscal mechanisms, and the integration of climate-related constraints. Overall, the results indicate that the macroeconomic impact of agricultural tax reforms depends strongly on the degree of fiscal progressivity and on the capacity of public policies to recycle additional tax revenues toward productive agricultural support.

The baseline scenario (S0) corresponds to a trajectory without additional agricultural tax reform. Under this configuration, real GDP increases from MAD 1,420,068 million in 2025 to MAD 2,003,146 million in 2035, reflecting a relatively stable long-term growth trajectory.

By contrast, scenarios involving more intensive agricultural taxation generate stronger contractionary effects. Scenario S4, characterized by agricultural taxation without compensatory FDA mechanisms, appears to be the most restrictive configuration for the Moroccan economy. GDP reaches only MAD 1,871,717 million in 2035, corresponding to a contraction of 6.56% relative to the baseline scenario. This result suggests that abrupt fiscal integration of the agricultural sector could generate negative effects on productive investment, rural incomes, and domestic demand.

Conversely, Scenario S6, based on progressive agricultural taxation, appears to be the most macroeconomically sustainable configuration among the simulated reform scenarios. GDP declines remain limited to -0.96% , while fiscal revenues remain broadly stable ($+0.02\%$). Although the direct fiscal gains are modest, this outcome reflects the limited taxable capacity of the remaining exempt agricultural segment, which is composed predominantly of small and medium-sized farms. Consequently, the primary rationale for progressive agricultural taxation is not short-term revenue maximization but rather the gradual broadening of the tax base, the enhancement of fiscal equity across sectors, and the progressive integration of agricultural producers into the formal fiscal system. The results suggest that a gradual approach can improve tax neutrality while minimizing adverse effects on economic activity and rural welfare.

The simulations also indicate that compensatory mechanisms play a crucial stabilizing role. Scenario S1 (VAT + PIT + CIT + FDA recycling) generates smaller output losses than Scenario S4 without FDA support, highlighting the importance of partially

recycling fiscal revenues toward agricultural investment and productive support mechanisms. These findings suggest that agricultural taxation should not be assessed solely on the basis of its immediate fiscal yield. A significant share of the reform's effectiveness derives from the capacity of the Agricultural Development Fund (FDA) to transform fiscal revenues into productivity-enhancing investments, including irrigation infrastructure, agricultural modernization, climate adaptation measures, and rural development projects. In this perspective, the FDA operates as a key transmission mechanism linking fiscal policy to long-term agricultural competitiveness and resilience.

Finally, scenarios incorporating climate shocks (S5 and S7) reveal the strong structural vulnerability of Moroccan agriculture. The combination of drought and agricultural taxation produces a sharp contraction in agricultural value added, emphasizing the importance of integrating climate adaptation policies into fiscal reform strategies.

Table 3. Macroeconomic Results of Agricultural Taxation Scenarios in 2035

(MAD million)

Scenario	GDP	GDP Var (%)	Fiscal Revenues	Revenue Var (%)	Agricultural VA	Agri VA Var (%)	FDA Transfer s
S0 Baseline	2,003,146	0.00	320,503	0.00	226,771	0.00	0
S1 VAT + PIT + CIT + FDA	1,890,005	-5.65	310,957	-2.98	213,902	-5.67	8,556
S2 Irrigated agricultur e taxation + FDA	1,945,835	-2.86	317,941	-0.80	220,252	-2.87	4,405
S3 PIT + CIT without VAT	1,927,062	-3.80	319,236	-0.40	218,117	-3.82	0
S4 Taxation without FDA	1,871,717	-6.56	316,421	-1.27	211,822	-6.59	0
S5 Taxation + drought shock	1,891,218	-5.59	307,093	-4.18	149,927	-33.89	2,999

S6 Progressive taxation	1,983,876	-0.96	320,564	+0.02	224,579	-0.97	1,347
S7 FDA + climate adaptation	1,934,487	-3.43	311,813	-2.71	152,998	-32.53	5,355

Source: Authors' calculations based on the recursive dynamic CGE model calibrated on the Moroccan SAM (HCP Stat 2024) under R 4.6.0

Table 3 clearly indicates that the economic effects of agricultural taxation depend not only on the level of taxation but also on the presence of compensatory investment mechanisms. Scenarios incorporating FDA-supported recycling generally perform better than equivalent scenarios without support measures, highlighting the importance of linking fiscal reform to productive agricultural investment.

4.2. Sectoral Effects and Productive Dynamics

The sectoral simulations reveal pronounced heterogeneity in the economic effects of agricultural taxation reforms across productive activities. While all sectors are indirectly affected through intersectoral linkages, agriculture emerges as the most vulnerable component of the productive system, particularly under scenarios combining fiscal reforms with adverse climatic conditions. This outcome reflects both the strategic importance of agriculture within the Moroccan economy and its continued dependence on climate-sensitive production systems.

Under the baseline scenario (S0), agricultural value added reaches MAD 226,771 million by 2035, reflecting a stable expansion of productive capacity consistent with the long-run growth trajectory of the economy. However, the introduction of taxation in conjunction with drought-induced productivity shocks substantially alters this trajectory. In Scenario S5, agricultural value added declines to MAD 149,927 million, corresponding to a reduction of approximately 34 percent relative to the baseline. Such a contraction underscores the structural fragility of Moroccan agriculture, particularly in rainfed areas where production remains highly dependent on rainfall variability and where adaptive capacity is comparatively limited.

The results further indicate that the economic impact of taxation depends critically on the design of the reform. Scenario S2, which limits taxation to irrigated agricultural

activities while maintaining support through the Agricultural Development Fund, generates considerably smaller distortions. Agricultural value added declines by less than 3 percent, suggesting that a targeted fiscal approach focused on the most capitalized and productive segments of agriculture can broaden the tax base while preserving sectoral performance. This finding supports the argument that differentiated taxation may reduce adjustment costs and improve the political feasibility of agricultural fiscal reforms.

Beyond the agricultural sector itself, the simulations reveal significant economy-wide transmission mechanisms. Agriculture constitutes both a major supplier of intermediate inputs to agro-industrial activities and an important source of income for rural households. Consequently, reductions in agricultural output generate cascading effects throughout the production system. Agro-industrial industries experience lower input availability and higher production costs, while market services are affected through declining household consumption and weaker investment demand. These multiplier effects confirm the strong production and income linkages embedded in the Social Accounting Matrix and illustrate how sector-specific fiscal reforms can generate broader macroeconomic repercussions.

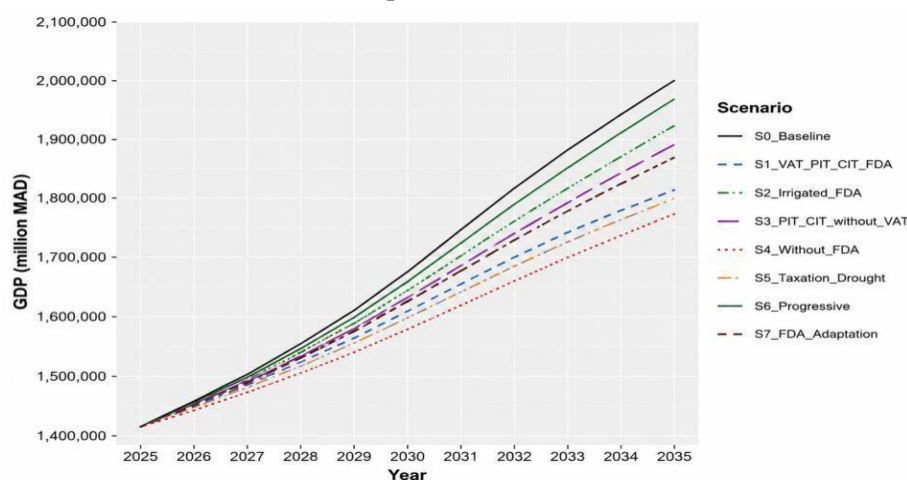


Figure 1. Real GDP Trajectories Across Simulation Scenarios

Source: Authors' calculations based on the recursive dynamic CGE model under R 4.6.0

Figure 1 illustrates the progressive divergence of economic growth trajectories under alternative fiscal regimes. Scenarios S1 and S4 display the weakest long-term performance, reflecting the contractionary consequences of broad-based agricultural taxation and the absence of effective compensatory mechanisms. By contrast,

Scenario S6 remains relatively close to the baseline trajectory throughout the simulation horizon, indicating that gradual fiscal integration substantially reduces adjustment costs and preserves growth dynamics.

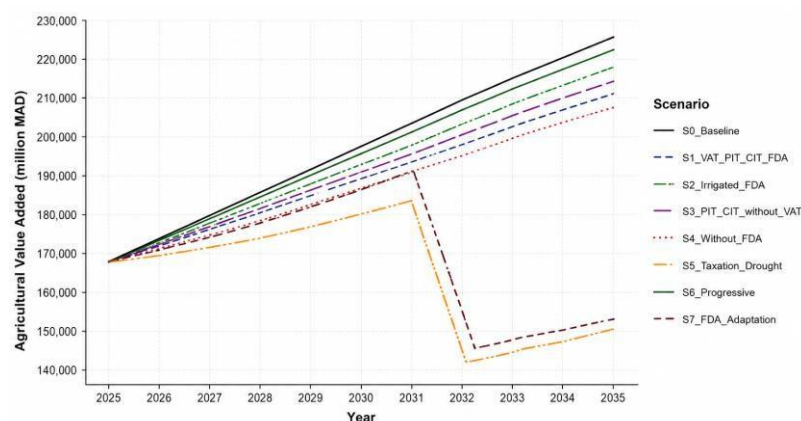


Figure 2. Agricultural Value Added Across Scenarios

Source: Authors' calculations based on the recursive dynamic CGE model under R 4.6.0

Figure 2 highlights the pronounced decline in agricultural value added under climate-sensitive scenarios. The sharp structural break observed in Scenarios S5 and S7 following the introduction of drought shocks illustrates the interaction between fiscal policy and climate vulnerability. More importantly, the magnitude of the decline suggests that climate-induced productivity losses may exceed the direct effects of taxation itself. This finding reinforces the view that the effectiveness of agricultural tax reforms depends not only on fiscal design but also on the capacity of public policies to strengthen climate resilience and reduce exposure to recurrent drought risks.

Table 4. Ranking of Scenarios According to Macroeconomic Sustainability

Scenario	GDP Variation (%)	Revenue Variation (%)	Agricultural VA Variation (%)	Sustainability
S0 Baseline	0.00	0.00	0.00	High
S6 Progressive taxation	-0.96	+0.02	-0.97	High
S2 Irrigated taxation + FDA	-2.86	-0.80	-2.87	Moderate

S3 PIT + CIT without VAT	-3.80	-0.40	-3.82	Moderate
S7 FDA + climate adaptation	-3.43	-2.71	-32.53	Moderate
S1 VAT + PIT + CIT + FDA	-5.65	-2.98	-5.67	Low
S5 Taxation + drought shock	-5.59	-4.18	-33.89	Low
S4 Taxation without FDA	-6.56	-1.27	-6.59	Low

Source: Authors' calculations based on the recursive dynamic CGE model calibrated on the Moroccan SAM (HCP Stat 2024)

The ranking presented in Table 4 confirms that the long-term sustainability of agricultural tax reform depends on achieving an appropriate balance between fiscal equity, productive efficiency, and social stability. Scenario S6 emerges as the most sustainable reform option, not because it generates substantial additional revenues, but because it broadens the agricultural tax base while preserving economic activity and rural welfare. The results indicate that the remaining exempt agricultural segment offers limited short-term revenue potential; therefore, the economic justification for progressive taxation lies primarily in improving horizontal equity between sectors and strengthening the long-term formalization of agricultural activities. Furthermore, scenarios incorporating FDA-supported investment consistently outperform equivalent scenarios without compensatory mechanisms, underscoring the central role of fiscal recycling in enhancing the effectiveness and acceptability of agricultural tax reforms. Conversely, Scenarios S4 and S5 produce the least favorable outcomes owing to the absence of compensatory support mechanisms and the amplification effects of climate shocks. Overall, the results suggest that gradual taxation, accompanied by targeted fiscal recycling and climate adaptation measures, represents the most effective strategy for reconciling fiscal sustainability, agricultural competitiveness, and rural welfare in Morocco. Such an integrated approach is essential to ensure that agricultural taxation contributes not only to revenue generation but also to long-term structural transformation and economic resilience.

4.3. Distributive Effects and Fiscal Redistribution Through the FDA

The distributive analysis indicates that the effects of agricultural tax reforms differ significantly across categories of agricultural producers. Small farms benefit relatively more from FDA compensatory mechanisms, whereas large commercial farms bear the largest share of the fiscal burden.

Beyond its redistributive role, the FDA also functions as a productive investment instrument. By financing irrigation systems, agricultural equipment, climate adaptation projects, and rural infrastructure, FDA transfers contribute to strengthening agricultural productivity and mitigating the adjustment costs associated with fiscal reform. Consequently, the effectiveness of agricultural taxation depends not only on the amount of revenue collected but also on the efficiency with which these revenues are recycled into productive agricultural investments.

The simulations suggest that redistributive mechanisms partially mitigate income losses for the most vulnerable agricultural households. However, the magnitude of compensation remains insufficient under aggressive fiscalization scenarios without gradual implementation.

In Scenario S6, the progressive nature of the reform helps limit distributive losses while maintaining relatively stable public finance dynamics. These results suggest that gradual fiscal integration combined with targeted redistribution mechanisms may improve the social acceptability of agricultural tax reforms.

Table 5. Simplified Distributive Effects by Farm Category

Group	Share of Agricultural Production (%)	Tax Rate	FDA Share (%)	Net Effect
Small farms	55	0.00	70	Positive
Medium farms	30	3%	25	Moderately negative
Large farms	15	10%	5	Negative

Source: Authors' calculations based on the recursive dynamic CGE model calibrated on the Moroccan SAM (HCP Stat 2024)

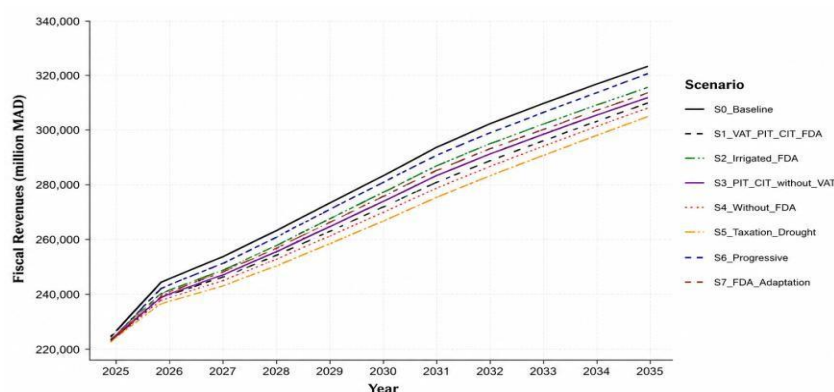


Figure 3. Fiscal Revenues Across Scenarios

Source: Authors' calculations based on the recursive dynamic CGE model under R 4.6.0

Fiscal revenues increase progressively across most reform scenarios, although long-term differences remain relatively limited. Highly aggressive taxation strategies do not necessarily generate the strongest fiscal performance because recessionary effects partially offset additional tax collection.

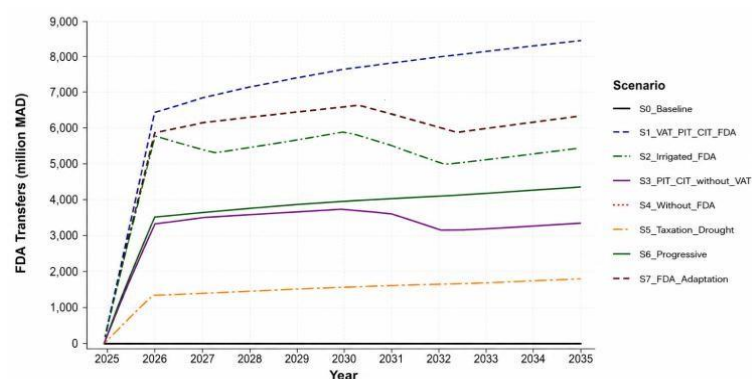


Figure 4. FDA Transfers Across Scenarios

Source: Authors' calculations based on the recursive dynamic CGE model under R 4.6.0

FDA transfers vary substantially across scenarios and emerge as a key determinant of reform sustainability. Higher levels of fiscal recycling are associated with smaller losses in GDP and agricultural value added, highlighting the role of the FDA as a productive investment mechanism rather than a simple redistribution tool. The results suggest that the effectiveness of agricultural taxation depends critically on the capacity

of public authorities to channel fiscal resources toward irrigation infrastructure, agricultural modernization, and climate adaptation programs.

4.4. Agricultural Taxation and Climate Vulnerability

The climate-sensitive simulations indicate that the structural vulnerability of Moroccan agriculture constitutes a major constraint for any agricultural taxation strategy. Simulated drought episodes generate substantial contractions in agricultural value added, which subsequently propagate throughout the economy through sectoral multiplier effects.

Under Scenario S5, agricultural losses simultaneously reduce rural incomes, fiscal revenues, and demand addressed to agro-industrial and service sectors. These results suggest that the effectiveness of agricultural tax reforms depends strongly on the capacity of public policies to integrate climate and hydric dimensions into fiscal reform strategies.

Scenario S7 further indicates that strengthened FDA mechanisms and climate adaptation policies may partially mitigate economic losses, although they do not entirely eliminate the adverse effects associated with drought shocks. The results therefore suggest that climate vulnerability constitutes a more significant constraint on agricultural performance than taxation itself. Consequently, the long-term success of agricultural fiscal reform depends not only on tax design but also on the capacity of public policies to enhance water security, irrigation efficiency, and climate resilience.

Table 6. Impact of Climate Shocks on Agricultural Value Added
(current MAD million)

Year	Baseline	Climate Shock	Loss
2028	184,386	157,533	26,852
2029	189,917	162,259	27,658
2030	195,615	167,127	28,488
2031	201,483	172,141	29,342
2032	207,528	142,877	64,651
2033	213,754	147,163	66,590
2034	220,166	151,578	68,588
2035	226,771	156,126	70,646

Source: Authors' calculations based on the recursive dynamic CGE model calibrated on the Moroccan SAM (HCP Stat 2024)

5. Discussion and Policy Implications

The results provide several important insights into the economic, distributive, and fiscal implications of extending taxation to the still-exempt agricultural segment in Morocco. Unlike earlier analyses focusing on the hypothetical taxation of the entire agricultural sector, the present study is situated within the current post-2014 institutional framework in which large agricultural farms have already been progressively integrated into the formal tax system. Consequently, the issue examined in this research no longer concerns the fiscalization of a fully exempt agricultural sector, but rather the potential extension of taxation to the remaining exempt segment composed mainly of small and medium-sized farms with annual turnover below MAD 5 million.

This institutional specificity is particularly important because small and medium-sized farms still represent the overwhelming majority of the Moroccan agricultural structure. Although these farms exhibit relatively limited individual taxable capacity, the simulations indicate that they collectively maintain a substantial economic and social role within rural Morocco. The contraction of rural disposable income generated by taxation reforms propagates through domestic demand mechanisms captured by the dynamic CGE model and the Social Accounting Matrix. Reduced rural consumption progressively affects agro-industrial activities, services, and productive investment through strong intersectoral linkages embedded within the Moroccan economy.

The results therefore suggest that small and medium-sized agricultural producers play a more important macroeconomic role than their relatively low individual productivity levels would initially imply. Their demographic weight gives rural income an important multiplier effect on domestic demand and related productive activities. In this perspective, agricultural taxation appears not only as an instrument of public revenue mobilization but also as a potential lever of structural transformation affecting productive accumulation, territorial equilibrium, rural resilience, and the progressive integration of agricultural activities into the formal economy.

One of the central findings of the dynamic CGE model concerns the existence of a fundamental trade-off between fiscal integration and economic growth. The simulations indicate that aggressive agricultural taxation generates contractionary effects on economic activity while producing only limited additional fiscal revenues. This result reflects the structural characteristics of the remaining exempt agricultural

segment, which is largely composed of small and medium-sized farms with relatively low taxable capacity. Consequently, the economic rationale for agricultural taxation extends beyond short-term revenue mobilization and relates more closely to fiscal equity, formalization, and the gradual integration of agricultural activities into the national tax system.

The contractionary effects are not confined to agriculture alone. The simulations reveal important intersectoral transmission mechanisms operating through intermediate consumption, household income distribution, and demand multiplier effects. Agro-industrial activities and market services appear especially sensitive to the slowdown of agricultural activity. Moreover, the dynamic structure of the model shows that fiscal shocks progressively affect capital accumulation mechanisms. Reduced agricultural income limits savings and productive investment capacities, thereby weakening long-term growth trajectories and future productive potential.

By contrast, the simulations suggest that progressive taxation significantly reduces the macroeconomic adjustment costs associated with reform. Scenario S6 emerges as the most sustainable compromise between fiscal integration and growth preservation. Although the increase in fiscal revenues remains modest, GDP losses are limited and agricultural value added remains close to the baseline trajectory. These results suggest that the objective of progressive taxation should not be interpreted primarily as revenue maximization but rather as a mechanism for broadening the tax base, improving horizontal fiscal equity, and strengthening the long-term formalization of agricultural activities while preserving rural economic stability.

The analysis highlights the central stabilizing role of the Agricultural Development Fund (FDA), which emerges as one of the key determinants of reform sustainability. Scenarios incorporating fiscal recycling mechanisms systematically outperform equivalent scenarios without compensatory support. When part of the additional tax revenues is reinvested through the FDA, the negative effects of taxation on household income, investment, and productive activity are significantly reduced.

The results therefore suggest that agricultural taxation should not be evaluated solely through its direct fiscal yield. The effectiveness of reform depends equally on the allocation of the revenues collected. In the Moroccan context, the FDA acts as a transmission mechanism through which fiscal resources are transformed into productivity-enhancing investments. By financing irrigation infrastructure, water-saving technologies, agricultural modernization programs, rural connectivity, and

climate adaptation projects, the FDA contributes to strengthening agricultural competitiveness and resilience. Consequently, the long-term benefits of agricultural taxation arise less from immediate revenue generation than from the capacity of fiscal recycling mechanisms to support productive transformation and climate adaptation within the agricultural sector.

The integration of climate shocks constitutes one of the principal contributions of the model developed in this study. The simulations indicate that the structural vulnerability of Moroccan agriculture represents a major constraint for any agricultural taxation strategy. Scenarios incorporating drought episodes generate sharp contractions in agricultural value added and progressive deterioration of macroeconomic trajectories. These climate-related losses simultaneously reduce rural income, fiscal revenues, productive investment, and demand addressed to agro-industrial and service sectors.

The results also show that non-irrigated agricultural activities are considerably more vulnerable to climate shocks. Their strong dependence on rainfall variability amplifies the negative effects associated with taxation and weakens their taxable capacity. Conversely, taxation scenarios focused on irrigated agriculture generate more moderate recessionary effects. Irrigated farms generally display higher productivity levels, stronger market integration, and greater taxable capacity, making them more suitable candidates for gradual fiscal integration.

These findings suggest that a sustainable agricultural tax reform must necessarily be coordinated with climate adaptation policies, water management strategies, and investment in hydraulic infrastructure. In a context characterized by recurrent droughts and increasing water scarcity, climate resilience becomes a central condition for the sustainability of agricultural fiscal reforms.

The distributive analysis further reveals significant asymmetry in the welfare effects of reform across categories of agricultural producers. Small farms appear to be the most vulnerable despite bearing a lower absolute tax burden. Equivalent variation measures derived from the ELES demand system show that relative welfare losses decline progressively with farm size.

This result reflects several structural characteristics of Moroccan agriculture. Small farms generally exhibit limited savings capacity, weak access to credit, low productive diversification, and consumption levels close to subsistence thresholds. Consequently, even relatively moderate reductions in disposable income may

generate significant welfare losses. These farms also face restricted access to irrigation, financing, and modern productive technologies, limiting their ability to absorb fiscal shocks.

At the same time, the simulations indicate that well-targeted FDA transfers can partially offset these vulnerabilities. Beyond its redistributive role, the FDA functions as a productive investment instrument that supports agricultural modernization and adaptation. By directing a significant share of compensatory resources toward smaller agricultural producers, fiscal recycling mechanisms contribute to improving the social acceptability of reform while preserving productive capacities in rural areas.

In this context, a uniform agricultural taxation strategy would risk exacerbating rural inequality and further weakening the most vulnerable agricultural producers. The results therefore support the implementation of a progressive and differentiated fiscal reform strategy based on productive capacity, market integration, and climate resilience.

These findings contribute directly to ongoing debates on fiscal equity in Morocco. The continued exemption of a large proportion of agricultural producers raises legitimate concerns regarding the distribution of the tax burden between agriculture, salaried workers, and non-agricultural enterprises. However, the simulations indicate that extending taxation to the remaining exempt segment cannot be justified solely on revenue grounds because the associated fiscal gains remain limited. Instead, the principal justification for reform lies in improving tax neutrality across sectors, strengthening fiscal legitimacy, and progressively integrating agricultural producers into a more equitable and transparent fiscal framework.

The sustainability of future reforms will therefore depend strongly on the capacity of public authorities to design coherent mechanisms of redistribution, productive support, and agricultural modernization. The results suggest several important policy implications. First, agricultural taxation should be implemented progressively in order to limit recessionary effects on economic activity and rural income. Second, large commercial farms and irrigated agricultural zones appear to be the most appropriate segments for initial fiscal integration due to their higher productivity and stronger taxable capacity. Third, compensatory mechanisms and fiscal recycling through the FDA appear essential for improving both the economic and social acceptability of reform. Fourth, public investment in irrigation, hydraulic infrastructure, productive modernization, and climate adaptation remains crucial for sustaining agricultural

productivity and resilience. Finally, fiscal policy should be integrated within a broader framework of rural development and agricultural transformation rather than being viewed solely as a revenue-raising instrument.

Overall, the simulations suggest that the success of future agricultural tax reforms in Morocco will depend less on the immediate magnitude of fiscal revenues generated than on the capacity of public authorities to combine fiscal equity, productive investment, climate resilience, and rural inclusion within a coherent long-term development strategy. The findings indicate that the remaining exempt agricultural segment offers limited short-term revenue potential. Consequently, the sustainability of reform depends fundamentally on progressive implementation, differentiated taxation according to productive capacity, and the effective recycling of fiscal resources through the FDA. Under such conditions, agricultural taxation may contribute not only to a fairer distribution of the tax burden but also to the modernization, resilience, and long-term sustainability of Moroccan agriculture.

6. Conclusion

The study therefore highlights the existence of a fundamental trade-off between fiscal integration, social equity, and macroeconomic sustainability. Extending taxation to the still-exempt agricultural segment may contribute to broadening the tax base and improving fiscal neutrality across sectors. However, the simulations indicate that the direct fiscal gains associated with such reforms remain relatively limited because the remaining exempt segment is composed predominantly of small and medium-sized farms with modest taxable capacity. Consequently, the economic rationale for agricultural taxation cannot be reduced to short-term revenue mobilization alone.

Instead, the results suggest that agricultural taxation should be viewed as part of a broader strategy of fiscal modernization, economic formalization, and structural transformation. By progressively integrating agricultural producers into the tax system, reform may strengthen fiscal legitimacy, improve transparency, and contribute to a more balanced distribution of the tax burden between agriculture, salaried workers, and non-agricultural enterprises.

A central finding of the analysis concerns the decisive role played by the Agricultural Development Fund (FDA). The simulations demonstrate that the effectiveness of agricultural taxation depends not only on the amount of revenue collected but also on the way these revenues are allocated. Fiscal recycling through the FDA substantially

reduces the contractionary effects of taxation by supporting productive investment, irrigation infrastructure, agricultural modernization, climate adaptation, and rural development. In this perspective, the FDA emerges as a key institutional mechanism linking fiscal policy to productivity growth, agricultural competitiveness, and long-term economic resilience.

The analysis also highlights the critical importance of climate vulnerability in shaping the outcomes of agricultural tax reforms. Drought shocks generate considerably larger losses in agricultural value added than taxation itself, particularly in rainfed agricultural systems. These results indicate that climate resilience, water management, and irrigation investment constitute essential complements to any sustainable agricultural taxation strategy. Fiscal reforms implemented without adequate climate adaptation measures may amplify existing vulnerabilities and reduce the long-term effectiveness of public intervention.

The distributive results further emphasize the need for differentiated taxation. Small farms remain particularly vulnerable because of limited savings capacity, weak market integration, and strong dependence on current agricultural income. Conversely, irrigated and commercially oriented farms display greater productive capacity and stronger resilience to fiscal adjustment. These findings support the implementation of a progressive and targeted taxation strategy that preserves exemption mechanisms for vulnerable producers while gradually integrating farms with higher taxable capacity.

An effective reform strategy should therefore rely on several complementary principles:

- gradual implementation of taxation;
- priority targeting of commercially oriented and highly productive farms;
- preservation of exemption thresholds protecting vulnerable agricultural households;
- systematic fiscal recycling through the Agricultural Development Fund;
- sustained investment in irrigation infrastructure and climate adaptation;
- support for agricultural modernization and technological upgrading;
- improved access to agricultural finance, insurance, and social protection mechanisms;
- and institutional support facilitating the fiscal transition of agricultural producers.

The sustainability of agricultural taxation reforms ultimately depends on their economic and social acceptability. Reforms perceived as purely extractive are likely to encounter resistance and generate significant adjustment costs. By contrast, a gradual, redistributive, and investment-oriented approach appears more capable of reconciling fiscal equity, rural inclusion, agricultural modernization, and long-term economic sustainability.

Some limitations should nevertheless be acknowledged. Although the model incorporates recursive dynamic mechanisms, several dimensions remain partially aggregated. Intertemporal expectations, regional disparities, water-resource dynamics, and micro-level heterogeneity among agricultural households are only imperfectly captured within the current framework. Future research could therefore extend the analysis through regionalized CGE specifications, explicit hydrological modules, agricultural insurance mechanisms, and richer household disaggregation in order to better evaluate resilience and distributive outcomes under alternative fiscal and climate scenarios.

Overall, this study contributes to the literature on agricultural taxation, fiscal reform, and structural transformation in emerging economies. The results indicate that the remaining exempt agricultural segment offers limited short-term revenue potential, but that its gradual fiscal integration may nevertheless contribute to improving fiscal equity and strengthening the institutional coherence of the tax system. Most importantly, the findings demonstrate that the long-term success of agricultural taxation depends less on immediate revenue generation than on the capacity of public authorities to transform fiscal resources into productive investment through effective recycling mechanisms such as the FDA. Under these conditions, agricultural taxation can become not only a fiscal instrument, but also a lever for modernization, climate resilience, and sustainable rural development in Morocco.

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