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Abstract

This paper examines whether generalized energy subsidies or targeted cash transfers provide more effective stabilization in an economy with heterogeneous households and segmented labor markets. We develop a small-open-economy Heterogeneous-Agent New Keynesian (HANK-DSGE) model calibrated to Morocco, incorporating heterogeneity in marginal propensities to consume (MPCs), formal–informal–agricultural labor-market segmentation, imported energy, remittances, and exchange-rate management. An agricultural productivity experiment identifies sectoral wage adjustment as an important mechanism transmitting shocks through household labor income. The central policy experiment compares generalized energy subsidies with subsidy removal and a budget-neutral reallocation of the same state-contingent fiscal outlay toward targeted transfers. Targeted transfers direct 81.8% of expenditure toward high-MPC households, compared with 10.6% of the dividend-mediated incidence of subsidies. Following an oil-price shock, redirecting subsidy expenditure toward targeted transfers reduces the impact consumption loss from 1.05% to 0.51% and the welfare loss from 0.40% to 0.22%, while increasing short-run inflation pass-through. The results identify a policy frontier between price insurance and cash-flow insurance and show that MPC-weighted fiscal incidence is central to the stabilization effects of alternative fiscal instruments.

Keywords: Energy subsidies; Targeted cash transfers; Heterogeneous agents; Fiscal incidence; Labor-market segmentation; Household insurance

JEL Classification: E21; E62; H22; H23; Q43

1. Introduction

Governments in developing countries face a fundamental stabilization choice when global energy prices fluctuate sharply. They can limit domestic price increases through broad subsidies or allow prices to adjust while compensating vulnerable households through targeted cash transfers. Yet the policy that best stabilizes prices need not best stabilize household consumption or welfare. This distinction becomes particularly important when households differ in liquidity, income sources, and marginal propensities to consume (MPCs). The relevant policy question is therefore not simply how much support is provided, but which margin is protected and who ultimately receives the resources.

This question lies at the intersection of heterogeneous-agent macroeconomics and commodity-price stabilization. Heterogeneous-Agent New Keynesian (HANK) models show that incomplete financial markets and MPC heterogeneity are central to policy transmission (Kaplan et al., 2018; Bilbiie, 2020, 2025). Energy-price shocks also impose unequal burdens because financially vulnerable households have limited capacity to smooth real-income losses (Pieroni, 2023; Peersman and Wauters, 2024; Bobasu et al., 2025). Meanwhile, subsidy-reform studies emphasize the fiscal and distributional costs of generalized price support and the challenges of targeting compensation (Verme et al., 2014; Zarepour and Wagner, 2022; El Khalifi et al., 2024). How these mechanisms interact in general equilibrium, however, remains less clear.

The two fiscal instruments insure different margins. An energy subsidy cushions imported price shocks and broadly protects purchasing power, whereas a targeted transfer permits greater price pass-through but directs cash toward vulnerable, potentially high-MPC households. With substantial MPC heterogeneity, concentrating resources on constrained households can improve aggregate consumption insurance while allowing higher inflation. Subsidy reform therefore creates a macroeconomic policy frontier rather than a simple efficiency ranking.

Labor-market segmentation adds another dimension to this trade-off. Employment in developing economies is distributed across formal, informal, and agricultural activities characterized by different wage-setting mechanisms and shock exposures (Gomez Ospina, 2023; Breza and Kaur, 2025; Jat and Ramaswami, 2026). Sectoral structure determines whose income changes before household heterogeneity determines how strongly consumption responds. Labor-market segmentation thus operates primarily as an income-incidence mechanism connecting

sector-specific shocks to heterogeneous consumption responses.

Morocco provides an informative setting. Informal and agricultural employment remain important, household financial buffers are limited, and subsistence consumption represents a substantial burden for low-income households (HCP, 2024; World Bank, 2023; OECD, 2024). The economy is exposed to both climate-sensitive agricultural fluctuations and imported energy-price shocks (Moustabchir et al., 2024; World Bank, 2023). At the same time, Morocco is reforming its social-protection system: generalized support through the Caisse de Compensation is being reduced while targeted assistance based on the Registre Social Unifié (RSU) is expanding (Ministry of Economy and Finance, 2024; Verme et al., 2014). Morocco therefore provides a useful quantitative laboratory for a transition facing many developing economies from generalized price support toward targeted household protection.

We construct a small-open-economy HANK-DSGE model with three sectors: formal industry, wage-flexible urban informal activity, and climate-sensitive agriculture. Households face uninsurable idiosyncratic earnings risk and borrowing constraints, while Stone–Geary preferences generate stronger marginal-utility effects near a subsistence floor. Formal production uses imported energy, directly exposing domestic prices to world energy markets. Fiscal policy can absorb part of an energy-price increase through a producer subsidy or redirect the same state-contingent fiscal outlay toward eligible households. The open-economy block incorporates remittances, managed exchange rates, and sovereign spreads. Together, these features generate a common transmission mechanism from external shocks through sectoral income and prices to household cash flow, MPC-weighted consumption, fiscal incidence, and welfare.

The analysis separates mechanism identification from instrument evaluation. An agricultural productivity experiment first identifies whether sectoral wage adjustment shapes indirect household-income transmission. The central energy-price experiment then compares the baseline subsidy regime with subsidy removal and a counterfactual in which the same state-contingent fiscal outlay is redirected through the RSU transfer rule. Holding the fiscal envelope fixed distinguishes the incidence effects of alternative instruments from the mechanical budgetary saving associated with subsidy removal. Remittance and exchange-rate experiments provide open-economy boundary conditions.

The results show that indirect income channels account for approximately 95% of the

aggregate consumption response to agricultural shocks and depend strongly on sectoral wage adjustment. More importantly, the energy-price experiment reveals substantial differences in fiscal incidence. The average MPC is 0.29 in the poorest wealth quartile but only 0.04 in the richest. Targeted transfers direct 81.8% of outlays toward high-MPC households, compared with 10.6% of subsidy benefits. Under an identical fiscal envelope, redirecting subsidy expenditure toward targeted transfers reduces the impact consumption loss after an oil shock from 1.05% to 0.51% and the welfare loss from 0.40% to 0.22%. This gain comes at the cost of higher short-run price pass-through: impact headline inflation rises from 10.0 to 14.2 annualized percentage points.

This paper makes three contributions. First, it connects HANK transmission to the policy choice between generalized energy subsidies and targeted cash transfers, identifying MPC-weighted fiscal incidence as a key determinant of stabilization effectiveness. Second, it incorporates segmented formal, informal, and agricultural wage dynamics as a mechanism governing the incidence of indirect labor-income transmission. Third, it identifies a general-equilibrium policy trade-off that static-incidence and representative-agent approaches can obscure: the fiscal instrument that most strongly stabilizes measured inflation need not best stabilize household consumption or welfare. The contribution therefore lies in quantitatively integrating household heterogeneity, segmented labor markets, domestic price transmission, and budget-neutral fiscal incidence rather than in methodological novelty.

The remainder of the paper is organized as follows. Section 2 develops the theoretical background and hypotheses. Section 3 presents the quantitative framework, calibration, and policy experiments. Section 4 reports the distributional results, transmission mechanisms, counterfactuals, and robustness analysis. Section 5 discusses the policy implications, and Section 6 concludes.

2. Theoretical background, literature review, and research hypotheses

2.1. Household heterogeneity and fiscal incidence

A central insight of heterogeneous-agent macroeconomics is that policy effects depend not only on aggregates but also on their distribution. HANK models feature variation in households' liquid wealth, borrowing constraints, income exposure, and marginal propensities to consume (MPCs). Indirect changes in labor income, transfers, and purchasing power can therefore become

quantitatively central to aggregate consumption, displacing intertemporal substitution as the dominant transmission channel (Kaplan et al., 2018; Bilbiie, 2020, 2025).

Evidence from energy shocks reinforces this mechanism. Pironi (2023) shows in a HANK framework that energy shortages impose unequal burdens and generate aggregate-demand effects through heterogeneous exposure. Peersman and Wauters (2024) document substantial MPC heterogeneity following energy-price changes and show that targeted support can sustain non-energy consumption more effectively than a general price reduction. Similarly, Bobasu et al. (2025) find in a small-open-economy framework that low-wealth households suffer larger effects because they are more exposed and less able to smooth consumption.

These findings have direct implications for fiscal stabilization. Fiscal transmission differs in small open economies (Druehl et al., 2025), and policies with similar fiscal costs can generate different consumption effects when their benefits accrue to households with different MPCs. The relevant object is therefore not only the amount of fiscal support but its MPC-weighted incidence across households.

2.2. Labor-market segmentation and sectoral income transmission

Household heterogeneity alone does not determine transmission. In developing economies, labor-market segmentation shapes how income adjusts across formal, informal, self-employed, and agricultural activities that differ in wage setting and protection. Breza and Kaur (2025) emphasize limited wage employment, widespread self-employment, wage rigidities, and search frictions in these markets. Gomez Ospina (2023) shows that flexible informal wages interacting with rigid formal wages alter productivity-shock transmission and inflation dynamics. Chaudhuri and Kar (2023) find that oil-price increases can contract informal activity and reduce informal real incomes, while Jat and Ramaswami (2026) show that agriculture–non-agriculture comparisons conceal substantial formal–informal heterogeneity within the non-agricultural economy.

Related New Keynesian studies show that informality and limited market participation can weaken conventional interest-rate transmission and alter policy-rule rankings (Chikonda and Chortareas, 2024; Mirfatah et al., 2024). These studies motivate the sectoral structure used here, while our framework adds its interaction with the full household MPC distribution and fiscal incidence.

These mechanisms are particularly relevant for climate- and commodity-exposed economies.

Agricultural shocks directly affect agricultural earnings, whereas energy shocks operate through sector-specific production costs and real wages. Sectoral wage adjustment therefore determines the labor-income changes reaching households, while MPC heterogeneity determines how strongly these changes translate into consumption. Recent DSGE applications likewise emphasize structural resource constraints and productivity dynamics in food production and agriculture in developing African economies (Moustabchir et al., 2024). Labor-market segmentation is therefore treated here primarily as an income-incidence mechanism linking sectoral shocks to heterogeneous consumption responses.

2.3. Price insurance versus cash-flow insurance

Energy shocks create a policy dilemma between stabilizing domestic prices and protecting household purchasing power. Governments can absorb part of an imported energy-price increase through generalized subsidies, thereby limiting domestic price pass-through, or allow greater pass-through while compensating vulnerable households through targeted cash transfers. The instruments therefore insure different margins: subsidies provide price insurance, whereas targeted transfers provide cash-flow insurance.

Replacing generalized subsidies with targeted transfers is not necessarily a welfare improvement. Using household panel data from Iran’s subsidy reform, Zarepour and Wagner (2022) show that subsidy removal reduced real consumption, with effects varying across income groups and measures of energy intensity. More generally, post-shock welfare depends jointly on production-cost pass-through and the distributional incidence of cost recovery and compensation (Zhu et al., 2024; Humes and Farrell, 2025).

Our framework differs along two dimensions. First, it incorporates segmented formal, informal, and agricultural income flows. Second, it compares registry-based cash transfers with institutionalized price subsidies under an identical state-contingent fiscal envelope. This design separates the macroeconomic effects of MPC-weighted fiscal incidence from the mechanical budget savings generated by subsidy removal.

2.4. Open-economy channels and research gap

These mechanisms operate within an open economy. Remittances provide private liquidity insurance, while exchange rates absorb part of external relative-price shocks; neither necessarily

eliminates heterogeneous household exposure. Remittances can smooth consumption for liquidity-constrained households, although their aggregate stability may limit their macroeconomic stabilization effect (Otame, 2023; Bettin et al., 2025).

Existing studies separately establish the importance of household MPC heterogeneity, segmented labor-income transmission, and the distributional consequences of subsidy reform. Their interaction in general equilibrium remains less explored. The central question is therefore whether, in a segmented developing economy and under a fixed state-contingent fiscal envelope, shifting resources from generalized energy subsidies toward targeted transfers improves consumption and welfare stabilization, and what this entails for short-run inflation. Addressing this question requires jointly modeling household MPC dispersion, segmented wage setting, domestic prices, and fiscal incidence.

2.5. Research hypotheses

The preceding literature suggests that macroeconomic stabilization depends jointly on household MPC heterogeneity, sectoral income incidence, and fiscal incidence. Because the analysis is quantitative and counterfactual rather than reduced-form, we formulate three hypotheses concerning the transmission mechanisms and policy trade-offs.

Hypothesis 1 (Sectoral-income transmission hypothesis). *Because sectoral wage adjustments affect the size and composition of the labor-income channel through which sectoral shocks reach household cash flow, sectoral wage adjustment materially affects aggregate consumption.*

H1 treats labor-market segmentation as an income-incidence mechanism: sector-specific wage changes alter household labor income, while heterogeneous MPCs determine the resulting aggregate consumption response.

Hypothesis 2 (Fiscal-incidence hypothesis). *Following an imported energy-price shock, holding the fiscal envelope fixed, redirecting expenditure from generalized energy subsidies toward households with higher MPCs improves aggregate consumption and welfare stabilization, at the cost of greater short-run pass-through to headline inflation.*

H2 is the central policy hypothesis. It does not imply unconditional dominance of targeted transfers; rather, it identifies a policy frontier between price stabilization and household insurance

determined by the MPC-weighted incidence of fiscal support.

Hypothesis 3 (Open-economy boundary-condition hypothesis). *The relative consumption and welfare effects of targeted transfers remain primarily governed by fiscal incidence and household MPC heterogeneity unless remittance, exchange-rate, or external-financing channels are quantitatively large.*

The hypotheses map directly into the counterfactual experiments evaluated in Section 4.7. H1 is examined by restricting sectoral wage adjustment (E1); H2 through the budget-neutral reallocation of subsidy expenditure toward targeted transfers (E2); and H3 through remittance, exchange-rate-management, and sovereign-spread counterfactuals (E3–E4).

3. Quantitative framework and policy experiments

3.1. Economic environment and transmission mechanism

The model follows a simple sequence. A climate or energy shock moves sectoral wages or import prices. Changes in cash flow in the household sector. Identical changes in income result in different changes in consumption because of differences in households' liquidity and MPCs. Fiscal policy in turn will decide whether public funds will have a stabilizing effect on the price of energy in general, or whether they are to be used for targeted cash flow. This mechanism is implemented below.

$$u(c_{i,t}, n_{i,t}) = \frac{(c_{i,t} - \bar{c})^{1-1/\sigma}}{1-1/\sigma} - \varphi \frac{n_{i,t}^{1+1/\eta}}{1+1/\eta} \quad (1)$$

where $\sigma = 0.5000$ represents the elasticity of intertemporal substitution, corresponding to a constant relative risk aversion coefficient of 2.0 (Havránek, 2015), $\eta = 0.5000$ denotes the Frisch elasticity of intensive-margin labor supply (Chetty et al., 2011), $\varphi = 2.1324$ is the labor disutility scale parameter, and $\bar{c} = 0.0400$ defines the subsistence floor, representing 13.5% of baseline consumption (Herrendorf et al., 2013).

Idiosyncratic productivity $e_{i,t}$ follows an $AR(1)$ process in logarithms:

$$\log e_{i,t} = \rho_e \log e_{i,t-1} + \varepsilon_{i,t}^e, \quad \varepsilon_{i,t}^e \sim \mathcal{N}(0, \sigma_e^2) \quad (2)$$

discretized into an N_e -state Markov chain via the Rouwenhorst method with quarterly persistence

$\rho_e = 0.9660$ and cross-sectional standard deviation $\sigma_{\log e} = 0.6700$ ($\sigma_e = 0.1732$; Floden and Lindé, 2001; Kaplan et al., 2018). Discrete productivity states e_k and ergodic probabilities π_k^* are normalized to unit mean:

$$\mathbb{E}[e_{i,t}] = \sum_{k=1}^{N_e} \pi_k^* e_k = 1.0 \quad (3)$$

An inactivity threshold identifies the lowest-productivity quartile of the stationary household mass as eligible for targeted cash transfers under the Registre Social Unifié (World Bank, 2023): $e_{\text{inact}} = 0.5588$ and $\mu_{\text{inact}} = 0.2500$.

Households maximize expected discounted lifetime utility:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_{i,t}, n_{i,t}) \quad (4)$$

with discount factor $\beta = 0.934171$, subject to the budget constraint and borrowing restriction:

$$(1 + r_t)a_{i,t-1} + w_{h,t}n_{i,t}e_{i,t} + (\text{Div}_t - \text{Tax}_t) \left(\frac{e_{i,t}}{\bar{e}} \right) + \text{Rem}_t + \frac{\text{Trans}_t}{\mu_{\text{inact}}} \mathbb{I}_{\{e_{i,t} \leq e_{\text{inact}}\}} = c_{i,t} + a_{i,t} \quad (5)$$

where $a_{i,t}$ ($a_{i,t} \geq 0$) is liquid asset holdings, r_t is the real policy rate, $w_{h,t}$ is the economy-wide net average real wage per effective labor unit, Div_t denotes aggregate distributed profits, Tax_t is net lump-sum taxation, Rem_t is expatriate remittances, Trans_t represents targeted social transfers, and $\bar{e} = 1.0$.

The dynamic programming problem is formulated in value function form as:

$$V(a_{i,t-1}, e_{i,t}) = \max_{c_{i,t}, a_{i,t}, n_{i,t}} \{u(c_{i,t}, n_{i,t}) + \beta \mathbb{E}_t[V(a_{i,t}, e_{i,t+1}) | e_{i,t}]\} \quad (6)$$

satisfying the envelope condition:

$$V_a(a_{i,t-1}, e_{i,t}) = (1 + r_t)(c_{i,t} - \bar{c})^{-1/\sigma} \quad (7)$$

Individual labor supply optimality satisfies:

$$\begin{cases} \varphi n_{i,t}^{1/\eta} = w_{h,t} e_{i,t} (c_{i,t} - \bar{c})^{-1/\sigma}, & \text{if } e_{i,t} > e_{\text{inact}} \\ n_{i,t} = 0, & \text{if } e_{i,t} \leq e_{\text{inact}} \end{cases} \quad (8)$$

Intertemporal consumption choices satisfy the normalized Euler equation with complementary slackness for borrowing constraints:

$$\mathcal{E} \cdot \left[1 - \beta \mathbb{E}_t \{ V_a(a_{i,t}, e_{i,t+1}) \} (c_{i,t} - \bar{c})^{1/\sigma} \right] = 0 \quad \perp \quad a_{i,t} \geq 0 \quad (9)$$

where $\mathcal{E} = 0.0900$ is an Euler normalization parameter.

This is divided into 3 sectors because the source of household income is relevant to the transmission: formal industry, urban informal industry and climate-sensitive agriculture. In formal production, labor is used and imported energy is being used, thus formal production is directly subject to the fluctuations in world energy prices:

$$Y_{f,t} = Z_{f,t} L_{f,t}^{\alpha_f} M_t^{1-\alpha_f} \quad (10)$$

where $\alpha_f = 0.7000$ is the formal labor share, baseline TFP is $Z_{f,ss} = 1.0000$, and energy costs match Morocco's net energy import bill of 9.4% of GDP (High Commission for Planning [HCP], 2023). Cost minimization yields formal real marginal cost $mc_{f,t}$:

$$mc_{f,t} = \frac{1}{Z_{f,t}} \left(\frac{w_{f,t}}{\alpha_f} \right)^{\alpha_f} \left(\frac{p_{oil,ss} \exp(p_{oil,t}) rer_t}{1-\alpha_f} \right)^{1-\alpha_f} \quad (11)$$

where $w_{f,t}$ is the formal real wage, $p_{oil,ss} = 1.0000$, $p_{oil,t}$ is the oil price shock state, and rer_t is the real effective exchange rate ($rer_{ss} = 1.0000$). Demand for intermediate energy inputs is:

$$M_t = (1 - \alpha_f) mc_{f,t} \frac{Y_{f,t}}{p_{oil,ss} \exp(p_{oil,t}) rer_t} \quad (12)$$

Urban informal output $Y_{i,t}$ operates under decreasing returns to labor $L_{i,t}$:

$$Y_{i,t} = Z_i L_{i,t}^{\alpha_i} \quad (13)$$

with labour elasticity $\alpha_i = 0.7500$ and relative TFP $Z_i = 0.260495$. Agricultural output $Y_{a,t}$ is subject to rainfall climate volatility $Z_{agri,t}$:

$$Y_{a,t} = (Z_{a,ss} + Z_{agri,t}) L_{a,t}^{\alpha_a} \quad (14)$$

with labour share $\alpha_a = 0.6500$ and baseline agricultural TFP $Z_{a,ss} = 0.191215$. Gross GDP is the sectoral sum:

$$Y_t = Y_{f,t} + Y_{i,t} + Y_{a,t} \quad (15)$$

Informal and agricultural factor markets clear competitively at marginal revenue products:

$$w_{i,t} = \alpha_i Z_i L_{i,t}^{\alpha_i-1} \quad (16)$$

$$w_{a,t} = \alpha_a (Z_{a,ss} + Z_{agri,t}) L_{a,t}^{\alpha_a-1} \quad (17)$$

Formal wages are determined through Nash bargaining, with the informal wage $w_{i,t}$ serving as the threat point:

$$w_{f,t} = \theta_{\text{barg}} \left(mc_{f,t} \frac{Y_{f,t}}{L_{f,t}} \right) + (1 - \theta_{\text{barg}}) w_{i,t} \quad (18)$$

where worker bargaining power $\theta_{\text{barg}} = 0.3770$ matches empirical wage ratios $w_f/w_i = 1.35$ and $w_f/w_a = 1.70$ (El Badaoui et al., 2008; HCP, 2023b; Lopez-Acevedo et al., 2023).

Aggregate effective labour supply $L_{\text{supply},t}$ integrates individual labor supply across households:

$$L_{\text{supply},t} = \int_0^1 n_{i,t} e_{i,t} di \quad (19)$$

Households receive an economy-wide net average wage $w_{h,t}$ incorporating the formal wage tax rate $\tau_w = 0.1500$ (OECD, 2024):

$$w_{h,t} = \frac{(1-\tau_w)w_{f,t}L_{f,t} + w_{i,t}L_{i,t} + w_{a,t}L_{a,t}}{L_{\text{supply},t}} \quad (20)$$

Sectoral employment shares clear proportionally based on structural targets $L_{f,ss}/L_{ss} = 0.2500$, $L_{i,ss}/L_{ss} = 0.4500$, and $L_{a,ss}/L_{ss} = 0.3000$ (ILO, 2023; World Bank, 2023):

Baseline sectoral employment shares are fixed in the first experiment to isolate the wage-incidence channel; displaced agricultural workers do not move automatically into informal employment. The E1' extension allows endogenous labor reallocation and verifies that the consumption mechanism survives labor mobility.

$$L_{f,t} = L_{\text{supply},t} \left(\frac{L_{f,ss}}{L_{ss}} \right) \quad (21)$$

$$L_{i,t} = L_{\text{supply},t} \left(\frac{L_{i,ss}}{L_{ss}} \right) \quad (22)$$

$$L_{a,t} = L_{\text{supply},t} \left(\frac{L_{a,ss}}{L_{ss}} \right) \quad (23)$$

$$L_t = L_{f,t} + L_{i,t} + L_{a,t} = L_{\text{supply},t} \quad (24)$$

Formal sector firms face quadratic Rotemberg price adjustment costs (Christiano et al., 2005; Galí, 2015). The open-economy New Keynesian Phillips Curve governing formal producer price inflation $\pi_{f,t}$ is:

$$\ln(1 + \pi_{f,t}) = \kappa_f \left(mc_{f,t} - \frac{1}{\mu_f} \right) + \mathbb{E}_t \left[\left(\frac{Y_{f,t+1}}{Y_{f,t}} \right) \frac{\ln(1 + \pi_{f,t+1})}{1 + r_{t+1}} \right] + \text{markup}_{f,t} \quad (25)$$

where $\kappa_f = 0.0800$ measures structural price flexibility (Calvo equivalent $\theta_p = 0.7500$), $\mu_f =$

1.2000 is the steady-state target markup ($\epsilon = 6.0000$), and $\text{markup}_{f,t}$ captures cost-push shocks. Total distributed net dividends Div_t incorporate formal profits net of Rotemberg friction costs alongside informal and agricultural profits:

$$\text{Div}_t = \left[Y_{f,t} - w_{f,t} L_{f,t} - p_{\text{oil},ss} e^{p_{\text{oil},t} \text{rer}_t} M_t - \frac{1}{2(\mu_f - 1)\kappa_f} [\ln(1 + \pi_{f,t})]^2 Y_{f,t} \right] + (Y_{i,t} - w_{i,t} L_{i,t}) + (Y_{a,t} - w_{a,t} L_{a,t}) \quad (26)$$

Fiscal policy is the central policy margin in the paper. The government finances public consumption, targeted transfers, and the state-contingent energy subsidy, with taxes adjusting to satisfy the budget constraint:

$$\text{Tax}_t = r_t B_{ss} + G_t + \text{Sub}_t + \text{Trans}_t - \tau_w w_{f,t} L_{f,t}, \quad B_t = B_{ss} \quad (27)$$

Public debt is calibrated to 70% of annual GDP (Bank Al-Maghrib, 2024) and public consumption to 18% (World Bank, 2024). The baseline closure fixes the debt stock and lets lump-sum taxes absorb outlays; it yields a determinate local equilibrium, with numerical checks reported in Supplementary Appendix S3.

$$B_{ss} = 4 \cdot b_y \cdot Y_{ss} \quad \text{with } b_y = 0.7000 \quad (28)$$

The Caisse de Compensation operates as a price subsidy to formal producers: firms purchase imported energy at the effective price $p_{\text{eff},t}$ and the Treasury pays the gap between the world price and the effective price on the imported volume:

$$p_{\text{eff},t} = \bar{p}_{\text{oil}} [1 + (1 - \omega_{\text{sub}})(\exp(p_{\text{oil},t} \text{rer}_t) - 1)] \quad (29)$$

$$\text{Sub}_t = (\bar{p}_{\text{oil}} \exp(p_{\text{oil},t} \text{rer}_t) - p_{\text{eff},t}) M_t \quad (30)$$

where $\omega_{\text{sub}} = 0.40$ is the proportion of the price change in the imported product that is covered within the budget (Verme et al., 2014). The subsidy is distributed to households in two ways: first through dividends, which are related to the productivity of the households, and so are regressively distributed, and second through headline inflation, which also includes the growth of the formal energy price, but does not include the growth of the world energy price.

$$\pi_{c,t} = (1 - \omega_m) \pi_{f,t} + \omega_m \ln \left(\frac{p_{\text{eff},t}}{p_{\text{eff},t-1}} \right) \quad (31)$$

where $\omega_m = 0.2500$ is the import weight in the CPI basket (HCP, 2023a). Headline inflation is measured using the effective energy price actually faced in the domestic economy. When the

subsidy is inactive, the effective and world prices coincide; when it is active, the subsidy absorbs part of the imported-price increase. The two instruments therefore ensure different margins: the subsidy limits price pass-through, whereas the RSU rule supports household cash flow. A one-standard-deviation oil shock generates a subsidy bill near 0.3% of quarterly GDP, while baseline transfers equal 2% of GDP.

$$Trans_t = Trans_{ss} \exp \left(-\varphi_{trans} Z_{agri,t} - \varphi_{y,trans} \ln \left(\frac{Y_t}{Y_{ss}} \right) \right) \quad (32)$$

with $Trans_{ss} = 0.02 \cdot Y_{ss}$ (Ministry of Economy and Finance, 2024), $\varphi_{trans} = 2.5$ —so that a one-standard-deviation drought ($Z_{agri} = -0.04$, i.e. a 21% fall in agricultural TFP relative to $Z_{a,ss} = 0.19$) raises RSU outlays by 10%—and a unit elasticity to the output gap, $\varphi_{y,trans} = 1$. Both elasticities are calibration choices anchored on the 2022–2023 drought-response envelope of the RSU programme; Section 4.6 reports sensitivity to halving and doubling φ_{trans} .

Monetary policy follows an inertial, exchange-rate-augmented Taylor rule for the nominal rate i_t with the real rate that households face given by the Fisher equation (Bank Al-Maghrib, 2018):

$$i_t = \rho_i i_{t-1} + (1 - \rho_i) \left[r_{ss} + \varphi_\pi \pi_{c,t} + \varphi_y \ln \left(\frac{Y_t}{Y_{ss}} \right) + \varphi_{rer} \ln \left(\frac{rer_t}{rer_{ss}} \right) \right] \quad (33)$$

$$(1 + i_t) = (1 + r_t)(1 + \pi_{c,t+1}) \quad (34)$$

with $r_{ss} = 0.005$ (2.0% annualised neutral rate; IMF, 2021), $\rho_i = 0.70$, $\varphi_\pi = 1.5$, $\varphi_y = 0.125$ (Taylor, 1993) and $\varphi_{rer} = 0.25$ reflecting the managed basket regime (Bank Al-Maghrib, 2018). The steady state is unaffected by the choice of rule; the inertial form is the one under which the sequence-space system is determinate (Supplementary Appendix S3.1).

Expatriate remittance inflows (Rem_t) exhibit countercyclical altruistic dynamics (Bouhga-Hagbe, 2004, 2006):

$$\ln \left(\frac{Rem_t}{Rem_{ss}} \right) = -\gamma_{rem} \ln \left(\frac{Y_t}{Y_{ss}} \right) + \text{shock}_{rem,t} \quad (35)$$

with baseline $Rem_{ss} = 0.0800 \cdot Y_{ss}$ (Bank Al-Maghrib, 2024; IFAD, 2024) and countercyclical elasticity $\gamma_{rem} = 0.3500$.

Households hold a single liquid asset whose supply is the constant stock of public debt plus the economy's net foreign asset position, and the net foreign asset position accumulates the current

account (net exports plus remittances):

$$\int a_{i,t} d\mu_t = B_{ss} + NFA_t \quad (36)$$

$$NFA_t = (1 + r_t) NFA_{t-1} + NX_t + Rem_t \quad (37)$$

The accumulation identity is implied by the household, government and resource identities (Walras' law; it is verified to 10^{-6} on every simulated path) and $NFA_{ss} = 0$ because the trade deficit is exactly financed by remittances ($NX_{ss} = -Rem_{ss}$). International asset market equilibrium satisfies the uncovered interest parity condition:

$$1 + r_t = (1 + r_t^*) \mathbb{E}_t \left[\frac{rer_{t+1}}{rer_t} \right] \quad (38)$$

The effective foreign borrowing rate r_t^* incorporates a sovereign spread priced on the economy's external debt position observed at the end of the previous period:

$$r_t^* = r_{ss} + r_{world,t}^* + \psi_b \left[\exp \left(-\frac{NFA_{t-1}}{Y_{ss}} \right) - 1 \right] \quad (39)$$

where $r_{world,t}^*$ is the world interest rate shock and $\psi_b = 0.015$ is the spread elasticity (Laubach, 2009). This is the standard small-open-economy HANK closure of Auclert et al. (2021b): aggregate saving decisions are absorbed by the external position rather than by lump-sum taxation, and the spread depends on a predetermined state.

3.2. Aggregation, welfare, and market clearing

Household decisions are aggregated over the joint distribution of liquid assets and idiosyncratic productivity. This step converts the microeconomic heterogeneity in consumption, saving, and labor supply into aggregate consumption, labor, and asset demand:

$$C_t = \int_{\mathcal{A} \times \mathcal{E}} c_t(a, e) d\mu_t(a, e) \quad (40)$$

$$L_{supply,t} = \int_{\mathcal{A} \times \mathcal{E}} n_t(a, e) e d\mu_t(a, e) \quad (41)$$

$$A_t = \int_{\mathcal{A} \times \mathcal{E}} a_t(a, e) d\mu_t(a, e) \quad (42)$$

where C_t represents aggregate private consumption, $L_{supply,t}$ is total effective labor supply, and A_t is aggregate private liquid wealth.

Equilibrium requires the household, production, fiscal, and external blocks to be mutually consistent. Asset, labor, and goods markets therefore clear simultaneously:

$$A_t = B_t + NFA_t \quad (43)$$

Total sectoral employment clears according to aggregate effective labor supply:

$$L_{f,t} + L_{i,t} + L_{a,t} = L_t = L_{\text{supply},t} \quad (44)$$

National goods market clearing satisfies the open-economy resource constraint:

$$Y_t = C_t + G_t + p_{\text{oil},ss} \exp(p_{\text{oil},t}) \text{rer}_t M_t + \frac{1}{2(\mu_f - 1)\kappa_f} [\ln(1 + \pi_{f,t})]^2 Y_{f,t} + NX_t \quad (45)$$

where NX_t denotes net exports. In steady state, net exports finance the trade deficit via remittance inflows:

$$NX_{ss} = -\text{Rem}_{ss} = -0.08Y_{ss} \quad (46)$$

capturing Morocco's structural, remittance-financed trade balance (Bank Al-Maghrib, 2024; World Bank, 2024).

Policy regimes are compared using utilitarian welfare and a consumption-equivalent measure, which expresses the welfare effect as the percentage change in steady-state consumption that would make households indifferent between regimes:

$$SW_t = \int_{\mathcal{A} \times \mathcal{E}} u(c_t(a, e), n_t(a, e)) d\mu_t(a, e) \quad (47)$$

The consumption-equivalent compensating variation metric $\lambda_{\text{CE},t}$ quantifies the percentage change in steady-state consumption required to match aggregate utility SW_t :

$$\lambda_{\text{CE},t} = \left(\frac{SW_t}{SW_{ss}} \right)^{\frac{1}{1-1/\sigma}} - 1 \quad (48)$$

where SW_{ss} is the stationary benchmark welfare index evaluated under the ergodic distribution $\mu_{ss}(a, e)$.

3.3. Calibration, solution strategy, and policy counterfactuals

The calibration draws on multiple Moroccan institutional sources and national accounts to discipline the core transmission mechanisms. The subsistence threshold, $\bar{c}$ is fixed at 13.5% of the steady-state level of consumption (Herrendorf et al., 2013). Macroeconomic ratios are close to the empirical targets: the public debt rate is 70% of GDP, the remittances rate 8%, the energy-import bill 9.4% of GDP, the public consumption rate 18% (Bank Al-Maghrib, 2024; World Bank, 2024; IFAD, 2024; Ministry of Economy and Finance, 2024; HCP, 2023b). The discount factor β and the

labor-disutility scale φ serve to clear asset and labor markets endogenously. Sectoral employment shares match national distributions: formal $L_{f,ss}/L_{ss} = 0.2500$ (OECD, 2024), urban informal $L_{i,ss}/L_{ss} = 0.4500$ (World Bank, 2023), and agricultural $L_{a,ss}/L_{ss} = 0.3000$ (ILO, 2023). These sectoral productivity levels $Z_i = 0.260495$ and $Z_{a,ss} = 0.191215$ reproduce the empirical informal wage penalty $w_f/w_i = 1.35$ (El Badaoui et al., 2008; Lopez-Acevedo et al., 2023) and statutory minimum wage ratio $w_f/w_a = 1.70$ (HCP, 2023) endogenously.

The model is solved in two steps: (1) the stationary distribution is calculated with the endogenous-grid method, and (2) the dynamic general-equilibrium solutions are found with the sequence-space Jacobian approach (Auclert et al., 2021a), keeping the entire MPC distribution.

Computationally, the heterogeneous household block is solved with the endogenous-grid method and the stationary distribution is propagated using the Young (2010) non-stochastic simulation algorithm. Household sequence-space Jacobians are computed with the fake-news algorithm of Auclert et al. (2021a), while the aggregate 39-equation system is linearized around the same steady state and solved in a companion sparse linear-system implementation. The standalone household solution and the aggregate implementation are cross-validated against the multiple experiments; numerical residuals and market-clearing audits across all 39 aggregate equations and household micro-block conditions are reported in Supplementary Table S3, with solver comparisons, determinacy checks, and sensitivity tests detailed in Supplementary Appendix S3.

Counterfactual experiments assess policy and transmission design: E1 holds sectoral wages constant ($w_{i,t}, w_{a,t}$) and E1' allows labor reallocation in the economy to be endogenous. The central experiment (E2) is designed to compare baseline price subsidy to no price subsidy and budget neutral redistribution via the RSU transfer rule. A cyclical remittance and shutting down exchange-rate management and sovereign spreads (experiments E3 and E4) are boundary experiments in the open economy.

4. Results and findings

4.1. Household heterogeneity and policy incidence

The results are along the structural transmission mechanism of climate and energy shocks

through household disposable income to aggregate demand, under MPC-weighted fiscal incidence. The stationary equilibrium and the macroeconomic calibration targets, together with the untargeted microeconomic distributional moments, are reported in Table 1. The discount factor, β , and labor-disutility scale parameter, φ , are solved for endogenously, such that the sovereign asset and aggregate labour markets are cleared, respectively. The value of the resulting discount product, $\beta(1 + r) = 0.938842$ is still strictly less than one, which is the stationarity condition needed for an ergodic wealth distribution (Kaplan et al., 2018). The model closely reflects important macroeconomic indicators in Morocco, such as the sovereign debt-to-GDP ratio, which is around 70%, or the remittance inflows (8%) and the government consumption (18%), as well as the ratio of energy imports to annual GDP (9.36% vs. its empirical target of 9.4%).

(Insert Table 1 about here)

The untargeted wealth and liquidity dispersion is very high with the household block. The Gini coefficient of the stationary distribution of the liquid wealth is 0.365, and 9.45% of the households are at the borrowing constraint (or $a = 0$).

Detailed steady-state allocations are reported in Supplementary Table S1. The quantities most relevant to the policy experiments are retained here: energy imports equal 9.36% of GDP, remittances 8%, government consumption 18%, and RSU transfers 2%.

Figure 1 summarizes the household block. Roughly 9.5% of households sit at the borrowing constraint and mean liquid assets are 1.03, with a thin upper tail. Consumption policies are most curved at low wealth, where the subsistence floor makes spending highly income-sensitive. MPCs run from 0.64 for constrained inactive households to 0.04–0.07 at higher assets, with a mass-weighted mean of 0.112.

(Insert Figure 1 about here)

Table 1 and Figure 1 give the microeconomic basis of the policy analysis. RSU-targeted households cluster in the high-MPC region, while only a far smaller share of the subsidy's dividend-mediated fiscal incidence accrues there. These steady-state facts do not rank the instruments because the subsidy also provides purchasing-power insurance through lower price pass-through. They instead identify the household-side incidence channel that is evaluated jointly with the price channel in the budget-neutral counterfactual of Section 4.7.

4.2. Climate vulnerability and sectoral labor-market transmission

Figure 2 traces a one-standard-deviation agricultural shock, about 21% of agricultural TFP; a drought flips the signs. Agricultural output rises 21.4% on impact and aggregate output 5.7%, reflecting agriculture's 30% employment and 23.7% value-added shares. Wage adjustment is sharply asymmetric: the agricultural real wage jumps 20.6% while formal and informal wages move about -0.20% , so the economy-wide net wage rises 4.9%. RSU outlays fall 15.7% under the state-contingent rule, taxes barely move, and the current-account surplus builds foreign assets. Consumption rises 1.21% and labor supply 0.81%.

(Insert Figure 2 about here)

These responses give the first evidence on H1. Transmission is primarily through cash-flow income in the sector, with only 0.16 annualized percentage points of the policy rate change, and strong adjustment of the agricultural wage. The question is not if there is indirect transmission, but rather if sectoral wage adjustment alters the nature and intensity of that indirect transmission. The decomposition below identifies the components of the income, and E1 illustrates what occurs when the wage channels close.

4.3. Energy-price shocks and the incidence of social protection

Figure 3 shows how a global oil-price shock is propagated through the baseline economy with the current subsidy and transfer system. Energy imports drop by 4.1% on impact and the real exchange rate rises 3.9% due to policy action to meet imported inflation. That is, the price increase of the subsidy absorbs 40% of the imported price rise: the bill reaches a maximum of 0.30% of the quarterly GDP, and outlays of RSU change very slightly. This means that the subsidy reduces the losses to households as a result of the terms of trade change, but increases the loss to the budget.

(Insert Figure 3 about here)

With the 25% weight of imported energy, headline inflation is still 10.0 annualized, while producer prices are 6.9. The real policy rate first declines by 1.1 points, and then increases to approximately 2.2. Consumption falls by 1.05% and output rises by 0.28%, as households move closer to the subsistence level supply more labor, resulting in a welfare loss of 0.40%. Whether the same resources would stabilize more as transfers requires the budget-neutral counterfactual of Section 4.7.

The mechanism is on the household-side in the following Figure 4. High MPCs tend to cluster in the low-asset inactive group, with a peak of 0.64, and are lower than 0.10 across the rest of the range. Liquidity assets are highly concentrated with a Gini of 0.365 and top quartile owning about half of the assets. These incidence shares are not sufficient to determine the complete instrument comparison; they are calculated in the general-equilibrium E2 counterfactual.

(Insert Figure 4 about here)

4.4. Consumption transmission and distributional effects of remittances

Figure 5 asks the question of what proportion of the consumption response is due to the interest rate and what is due to income. In the indirect component, labor income accounts for approximately 71 percentage points, dividends 29, taxes 14, and transfers –16, with remittances being negative. The decomposition is done in accordance with the Kaplan-Moll-Violante approach, considering the household Jacobians, which are linear so that the components add up to the overall.

(Insert Figure 5 about here)

The oil shock doesn't travel the same way. The direct rate channel makes up approximately 33 per cent of the response; the other 67 per cent is indirect and, in this case, is dominated by taxes (39 points) and dividends (22 points), which capture the fiscal cost of the subsidy. Hence, composition is a function of the shock and its fiscal channel. The distinguishing feature of the agricultural shock is that the labor-income adjustment is concentrated in agriculture, the sectoral movement of the agricultural wage is around 21%, and that of other wages is under 0.3%. E1 separates out the sectoral importance of this component of wages in aggregate consumption.

Figure 6 shows responses across the wealth distribution. Constrained households reduced consumption by 0.30%, whereas the aggregate spending reduced by 0.06%, after the government-spending shock. Remittances have the largest difference: they are the most constrained households that increase their consumption by 1.23%, which is about a third of the reaction in the top quartile of households. The shock from abroad turns the trend around, with restrained households reducing their spending rate by 0.91% compared with 0.34% for the average household. While the distribution changes little, the consumption Gini moves less than 0.1 point, with large differences in sensitivity.

(Insert Figure 6 about here)

These findings are not an aggregate finding of insurance provided by remittances but rather distributional insurance. To test the cyclicalities of their aggregate transmission, the cyclicalities of their pattern is tested in counterfactual E3. But remittances can play an important role for constrained households even if their cyclical fluctuations are not big enough to shift aggregate dynamics.

4.5. Additional shock diagnostics

In Supplementary Appendix S2, additional shock diagnostics are reported. A 40-quarter forecast error variance decomposition (Supplementary Figure S1) reveals that agricultural shocks account for 98% of output variance and 70% of consumption variance in the baseline calibration, while imported oil shocks account for 86% of headline inflation volatility and 23% of consumption variance. Furthermore, a comparison of impact output responses across all seven structural shocks (Supplementary Figure S2) shows that agricultural shocks generate the largest immediate output movement (+5.7%), followed by markup (+0.51%) and oil shocks (+0.28%). The complete 40-quarter dynamic impulse response trajectories for all seven structural shocks are plotted in Supplementary Figure S3. These rankings reflect structural transmission properties of the calibrated model rather than a historical decomposition of Moroccan time series.

4.6. Robustness and sensitivity

The robustness analysis considers both economic sensitivity and numerical stability, with full specifications and results reported in Supplementary Table S2. The numerical protocol tests asset grid density (N_a), upper wealth bounds ($A_{\max}$), sequence-space truncation horizons (T), productivity discretization (N_e), perturbations to the subsistence floor ($\bar{c}$), and Euler-equation normalization ($\bar{E}$). Across all convergent specifications, the stationary calibration and qualitative counterfactual rankings remain stable (Supplementary Table S2, Panel A). On the economic side, the model's response is most sensitive to the subsidy absorption rate (ω_{sub}) and exchange-rate policy weight (ϕ_{rer}), while remaining relatively insensitive to remittance cyclicalities (γ_{rem}) and transfer elasticities (Supplementary Table S2, Panel B). Crucially, the central policy finding is preserved across all tested variants: targeted transfers stabilize consumption and welfare more effectively than generalized subsidies at the cost of higher short-run inflation (Table 2; Supplementary Appendix S3.2).

(Insert Table 2 about here)

4.7. Policy counterfactuals and hypothesis evaluation

The experiments considered are summarized in Table 2, where the previous experiments are shown in the central column labeled E2. The elimination of the subsidy, without the outlay being redirected, increases impact inflation from 10.0 to 13.9 annualized percentage points, widens the consumption loss to 1.14%, and leaves welfare virtually unaffected. Redirecting the same state-contingent outlay through the RSU rule instead reduces the consumption loss to 0.51%, lowers the oil share of consumption variance from 23.25% to 8.50%, and reduces the welfare loss from 0.40% to 0.22%, at the cost of impact inflation of about 14.2 annualized percentage points. H2 is therefore supported: the instrument that stabilizes prices most strongly need not be the instrument that best stabilizes household consumption and welfare. E1 establishes the importance of sectoral income incidence. Freezing agricultural and informal wage adjustment removes the labor-income contribution of the agricultural shock, reduces the output response from 5.68% to 4.05%, and lowers the consumption response from 1.21% to 1.04%. The total indirect share remains close to 95% because other income components partly substitute for the suppressed wage channel.

The boundary conditions that involve the open economy are analyzed in the auxiliary experiments for H3. In E3, remittance elasticity is zero which has little impact on the consumption loss that arises from a foreign-rate shock (-0.338% vs. -0.339%). Under the baseline closure, the removal of the exchange-rate weight (E4a) from monetary policy has a marginal impact on the consumers' decline (0.34% to 0.29%), while the sovereign-spread channels (E4b) have a minor impact. These mechanisms dampen the effects of external shocks only slightly and have no effect on the H2 policy ranking (Supplementary Appendix S3.2).

The combination of the counterfactuals confirms the basic macroeconomic transmission chain: the initial labor-income impact is influenced by sectoral segmentation, the aggregate consumption response is influenced by the heterogeneity of the household MPC and the timing of support in the wealth distribution depends on the type of fiscal design. The key quantitative result is that using the budget-neutral reallocation scenario toward targeted transfers results in a significant stabilization gain.

5. Discussion

5.1. Price stabilization versus household insurance

The central finding is that price stabilization and household-welfare stabilization are distinct policy objectives (Auclert et al., 2023; Peersman and Wauters, 2024). Energy subsidies limit imported-cost pass-through and headline inflation, whereas targeted transfers protect household consumption by concentrating resources among households with higher MPCs (Bobasu et al., 2025; Pieroni, 2023). In the model, the RSU rule directs 81.8% of transfer outlays to the highest-MPC quartile, compared with only 10.6% of subsidy benefits reaching this group through dividends (Ministry of Economy and Finance, 2024; Verme et al., 2014). Because the comparison holds the state-contingent fiscal envelope constant, the resulting welfare difference reflects both fiscal incidence and the purchasing-power insurance provided by lower price pass-through.

This trade-off defines a macroeconomic policy frontier. Generalized subsidies provide stronger contemporaneous price stabilization, whereas targeted transfers provide stronger consumption and welfare stabilization (Auclert et al., 2023; Zhu et al., 2024). The appropriate policy mix therefore depends on the relative weight assigned to inflation stabilization, household insurance, and fiscal constraints. In developing economies with limited fiscal space, the distribution of support across households can be as important as its aggregate size (Druehl et al., 2025; Kaplan et al., 2018).

The result is relevant to Morocco’s transition from generalized support through the Caisse de Compensation toward targeted cash assistance based on the Registre Social Unifié (Ministry of Economy and Finance, 2024; Verme et al., 2014; El Khalifi et al., 2024; OECD, 2024). The model does not imply that transfers unconditionally dominate subsidies: administrative costs, targeting errors, and the social costs of greater short-run inflation may alter the preferred policy mix. Rather, it identifies MPC-weighted fiscal incidence as a central consideration in evaluating subsidy reform.

5.2. Why labor-market segmentation matters

The climate experiment shows how labor-market structure connects sectoral shocks to heterogeneous-household transmission (Breza and Kaur, 2025; Gomez Ospina, 2023). Agricultural shocks disproportionately affect agricultural wages, so their aggregate consumption effects depend on both the sectoral distribution of labor-income changes and the MPCs of affected households.

Restricting agricultural and informal wage adjustment eliminates the agricultural labor-income channel and reduces the aggregate consumption response. Labor-market segmentation therefore matters primarily by determining whose income changes and which MPCs are activated, rather than as an independent source of aggregate amplification (Jat and Ramaswami, 2026; Chikonda and Chortareas, 2024; Chaudhuri and Kar, 2023).

The endogenous-reallocation experiment reinforces this interpretation. Mobility from agriculture toward informal employment dampens agricultural wage adjustment without overturning the aggregate transmission mechanism (HCP, 2024). Thus, labor-market structure and household heterogeneity are complementary: segmentation determines income incidence, while MPC heterogeneity determines the consumption response to that incidence.

5.3. Boundary results: Remittances and exchange-rate management

The auxiliary open-economy experiments distinguish household insurance from aggregate stabilization. Countercyclical remittances provide meaningful insurance to liquidity-constrained households but have little effect on aggregate external-shock transmission (Bouhga-Hagbe, 2004, 2006; Otame, 2023; Bettin et al., 2025). Similarly, exchange-rate management and the sovereign-spread channel only modestly alter the consumption effects of foreign-rate shocks under the baseline calibration (Bank Al-Maghrib, 2018; Auclert et al., 2021b). These channels therefore qualify rather than overturn the central subsidy-transfer ranking.

Morocco’s 2022–2023 drought-and-energy episode provides a qualitative external benchmark: imported inflation, climate-related agricultural contraction, and the expansion of registry-based assistance occurred simultaneously, illustrating the empirical relevance of the mechanisms represented in the model (World Bank, 2023; HCP, 2024; Ministry of Economy and Finance, 2024).

5.4. Limitations and directions for future research

Four modeling boundaries motivate future research. First, sequence-space perturbation and calibration identify theoretical transmission properties rather than historical time-series decompositions (Auclert et al., 2021a). Second, MPC dispersion is generated with a single liquid asset; a two-asset specification incorporating illiquid wealth could capture a broader range of wealthy hand-to-mouth behavior (Kaplan et al., 2018). Third, the RSU eligibility rule abstracts

from administrative costs, imperfect take-up, and targeting leakage; incorporating imperfect screening would clarify the operational limits of targeted support (Verme et al., 2014; Zarepour and Wagner, 2022). Fourth, search-and-matching frictions and rural–urban migration could enrich medium-run labor reallocation (Breza and Kaur, 2025). These extensions may affect quantitative magnitudes and, if sufficiently strong, the location or ordering of the policy frontier.

6. Conclusion

A major imported energy shock can force a government in a liquidity-constrained developing economy into a basic stabilization choice between stabilizing domestic energy prices and providing insurance to household cash flow. We show in a small-open-economy HANK-DSGE model calibrated to Morocco that the effectiveness of fiscal support really hinges on the insured margin for social protection and on the distribution of resources across the wealth distribution. While targeted cash transfers aim to allocate resources to households with high MPCs but low-income levels, generalized energy subsidies primarily result in reduced pass-through effects on domestic prices, and increase the incidence of energy subsidies in low-MPC households.

The state-contingent subsidy outlay is shifted in the budget-neutral experiment via the RSU cash-transfer rule. The effect on consumption loss drops by 1.05% to 0.51% of private consumption, while the welfare loss decreases by 0.40% to 0.22% of total private consumption, compared with the baseline subsidy regime. The increase in household insurance corresponds to an increase in the short run price pass-through: impact headline inflation increased from 10.0 to 14.2 appts, annualized. This gives a clear policy frontier: the larger the effect of (generalized) subsidies on domestic prices, the more they are supported; the larger the effect of (targeted) transfers on consumption and welfare, the more they are supported.

Labor-market segmentation affects this trade-off, because the aggregate cash flow of households depends on the wage adjustment process which occurs at the sector level, and the MPCs respond differently to these cash flow changes. Qualitative policy ranking is maintained for open-economy experiments with remittance policy, exchange-rate policy and sovereign spreads. More broadly, when there is significant heterogeneity in the MPC, the impact on measured inflation should be assessed alongside the incidence of support and the stabilization goal policymakers want to pursue among the various household types.

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Table 1. Steady-state calibration, macroeconomic ratios, and distributional moments

Item	Model Value	Target / Status	Note
Panel A: Endogenously Calibrated Parameters			
Discount factor β	0.934171	$A_{ss} = B_{ss}$	Broyden, asset-market clearing
Labor disutility scale φ	2.132366	$L_{supply} = 1.0$	Broyden, labor-market clearing
Quarterly real policy rate r	0.0050	2.02% annualized	BAM neutral rate (IMF, 2021)
Discount product $\beta(1 + r)$	0.938842	< 1	Stationarity gap 0.0612
Panel B: Macroeconomic Target Ratios (Model / Target)			
Sovereign debt $B/(4Y)$	70.00%	70%	Bank Al-Maghrib (2024)
Remittances Rem/Y	8.00%	8%	IFAD / BAM (2024)
RSU transfers $Trans/Y$	2.00%	2%	Ministry of Economy and Finance (2024)
Government consumption G/Y	18.00%	18%	World Bank (2024)
Energy import bill $p \cdot M/Y$	9.36%	9.4%	HCP (2023)
Panel C: Household-Block Micro Moments (Standalone EGM/Young Solution)			
Borrowing-constrained mass ($a = 0$)	9.45%	Untargeted	Of which transfer-eligible 9.13%, active 0.32%
Transfer-eligible share μ_{inact}	25.0%	Targeted	Productivity threshold
Liquid-wealth Gini	0.365	Untargeted	
Mean liquid assets $E[a]$	1.032	Targeted ($A = B$)	Std 0.666
Average MPC (1% of C_{ss} cash injection)	0.112	Untargeted	
MPC at constraint: inactive / active low e / high e	0.64 / 0.09 / 0.07	Untargeted	
MPC by wealth quartile Q1–Q4	0.29 / 0.06 / 0.05 / 0.04	Untargeted	
Mass with MPC > 0.30	9.6%	Untargeted	
Share of RSU outlay reaching top-MPC quartile	81.8%	Equilibrium incidence	
Share of dividend-mediated subsidy incidence reaching top-MPC quartile	10.6%	Equilibrium incidence	Via dividends
β re-solved in standalone block (Dynare value)	0.93780 (0.93417)	Discretization gap	Asset gap β : -10.1%

Table 2. Counterfactual Experiments and Evaluation of H1–H3 (baseline versus counterfactual; one-standard-deviation shocks)

Experiment	Hyp. / Status	Outcome	Baseline	Counterfactual	Difference	Unit
E1: Rigid sectoral wages	H1	KMV labour-income share, agri shock	70.91	-0.00	-70.91	%
	H1	KMV indirect share, agri shock	94.70	94.97	+0.27	%
	H1	Y impact response, agri shock	5.68	4.05	-1.63	% of Y
	H1	C impact response, agri shock	1.21	1.04	-0.18	% of C
E1': Endogenous reallocation ($\xi = 0.5$)	H1	L_a impact response, agri shock	0.81	9.12	+8.31	%
	H1	L_i impact response, agri shock	0.81	-4.68	-5.49	%
	H1	w_i impact response, agri shock	-0.20	1.17	+1.37	%
	H1	w_a impact response, agri shock	20.63	17.73	-2.91	%
	H1	C impact response, agri shock	1.21	1.11	-0.11	% of C
E2a: Subsidy removed	H2	C impact response, oil shock	-1.05	-1.14	-0.09	% of C
	H2	Welfare (consumption-equivalent annuity)	-0.40	-0.39	+0.02	% of C_{ss}
	H2	Oil share of $\text{var}(C)$, 40q	23.25	23.00	-0.25	%
	H2	CPI impact response, oil shock	10.00	13.94	+3.94	ann. pp
	H2	Net-tax impact response, oil shock	-2.67	-5.54	-2.87	% of Tax
E2b: Outlay redirected to RSU	H2	C impact response, oil shock	-1.05	-0.51	+0.54	% of C
	H2	Welfare (consumption-equivalent annuity)	-0.40	-0.22	+0.18	% of C_{ss}
	H2	Oil share of $\text{var}(C)$, 40q	23.25	8.50	-14.75	%
	H2	CPI impact response, oil shock	10.00	14.20	+4.20	ann. pp
	H2	Net-tax impact response, oil shock	-2.67	-4.15	-1.48	% of Tax
E3: Acyclical remittances ($\gamma_{\text{rem}} = 0$)	H3	C impact response, world-rate shock	-0.34	-0.34	+0.00	% of C
	H3	C impact response, agri shock	1.21	1.27	+0.05	% of C
	H3	Rem impact response, agri shock	-1.99	0.00	+1.99	%
E4a: No exchange-rate weight ($\varphi_{\text{rer}} = 0$)	H3	C impact response, world-rate shock	-0.34	-0.29	+0.05	% of C
	H3	Y impact response, world-rate shock	0.20	0.13	-0.07	% of Y
	H3	Peak real exchange rate, world-rate shock	0.87	1.34	+0.47	%
	H3	Peak real policy rate, world-rate shock	1.06	1.01	-0.05	ann. pp
E4b: No spread ($\psi_b = 0$)	Aux.	C impact response, world-rate shock	-0.34	-0.38	-0.04	% of C
	Aux.	Y impact response, world-rate shock	0.20	0.23	+0.03	% of Y
	Aux.	Peak real exchange rate, world-rate shock	0.87	0.91	+0.04	%
	Aux.	Peak real policy rate, world-rate shock	1.06	1.10	+0.04	ann. pp
E4c: Neither	Aux.	C impact response, world-rate shock	-0.34	-0.31	+0.03	% of C
	Aux.	Y impact response, world-rate shock	0.20	0.14	-0.06	% of Y
	Aux.	Peak real exchange rate, world-rate shock	0.87	1.40	+0.52	%
	Aux.	Peak real policy rate, world-rate shock	1.06	1.04	-0.02	ann. pp
E4: Interaction	Aux.	C -loss interaction: (base – neither) – $\sum$ single removals	0.00	-0.02	-0.02	% of C

Notes: welfare is the consumption-equivalent annuity of the discounted aggregate consumption path, in percent of steady-state consumption; KMV shares are evaluated at the impact quarter; all rows share the same steady state.

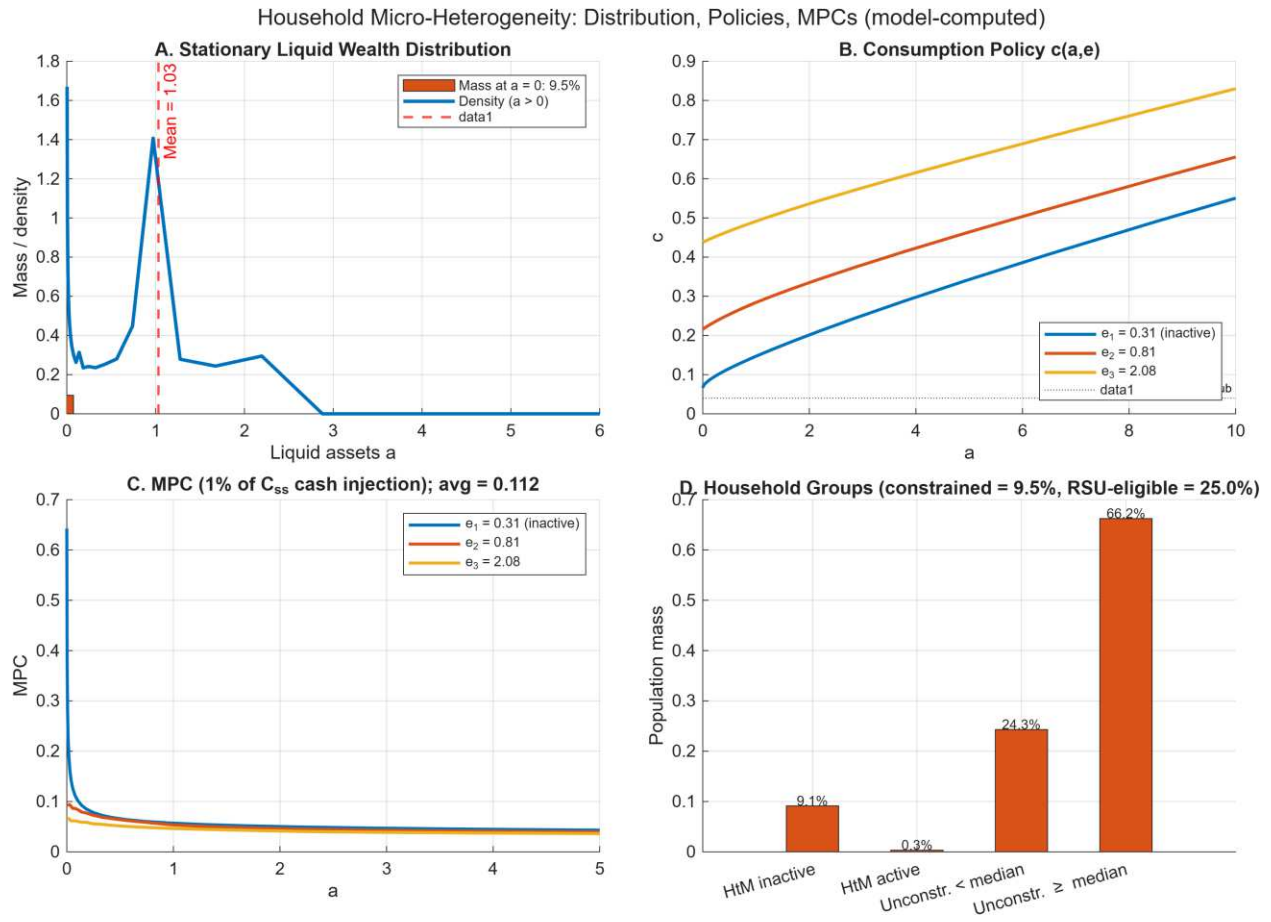


Figure 1. Household wealth, consumption policies, and marginal propensities to consume

Agricultural productivity shock (one s.d. = +21% agricultural TFP; a drought is the mirror image)

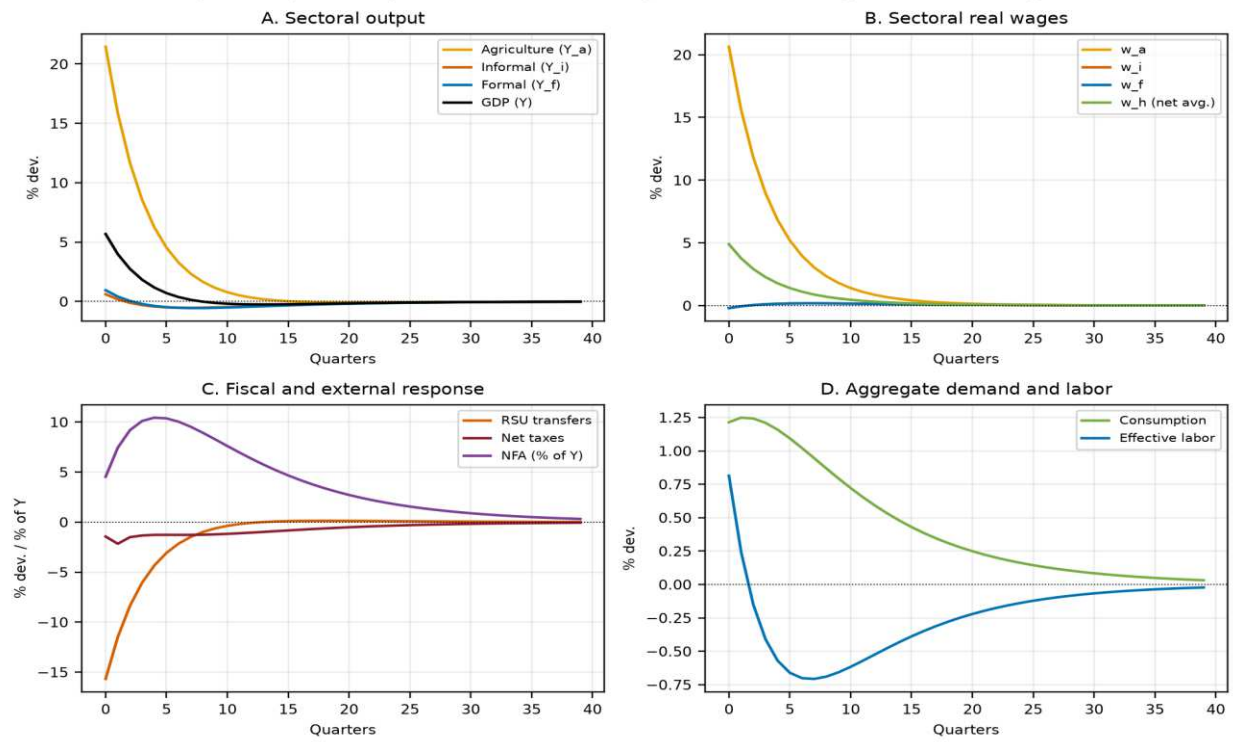


Figure 2. Transmission of an agricultural productivity shock across sectoral labour markets

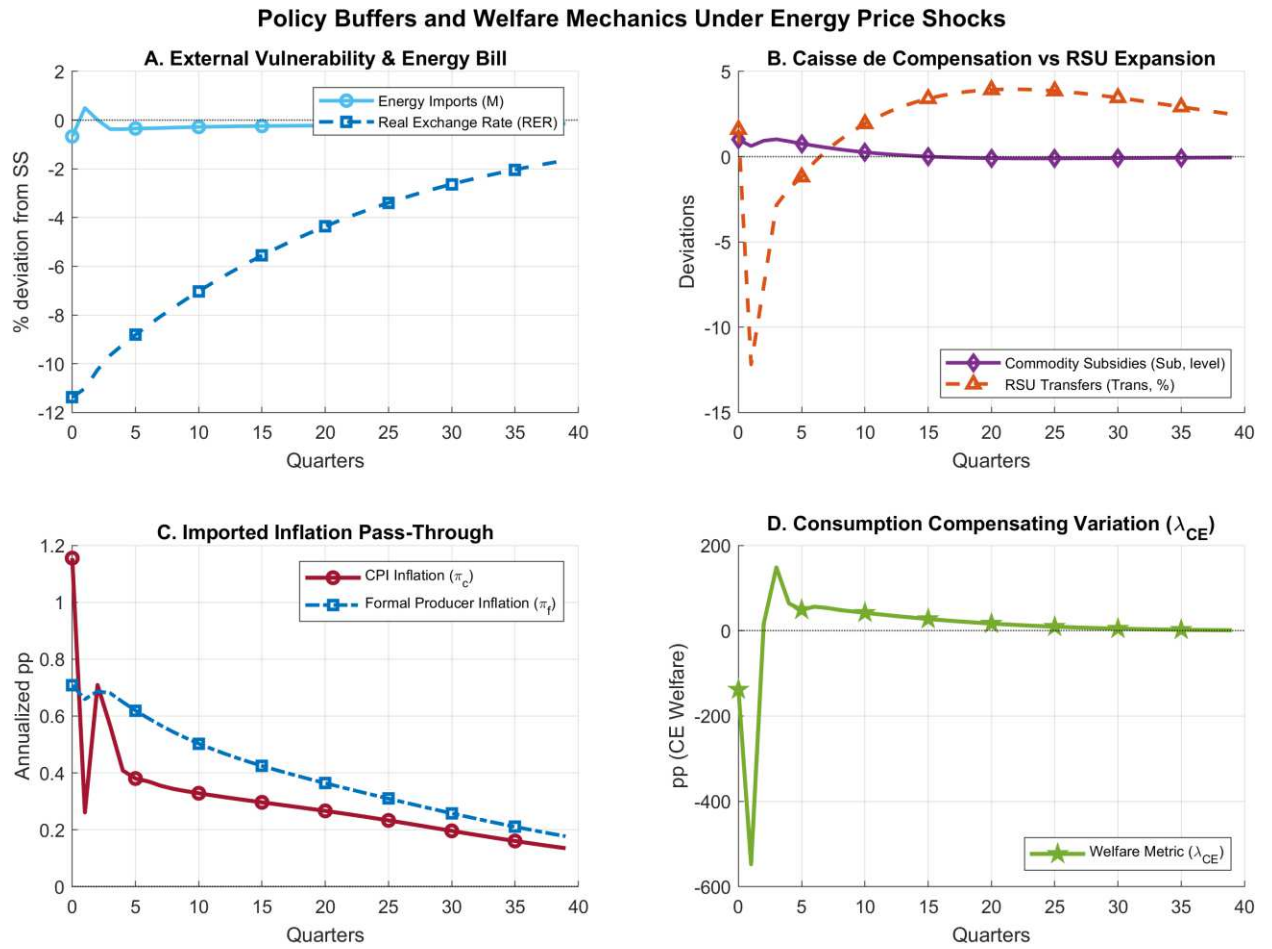


Figure 3. Transmission of a global oil-price shock under the baseline social-protection regime

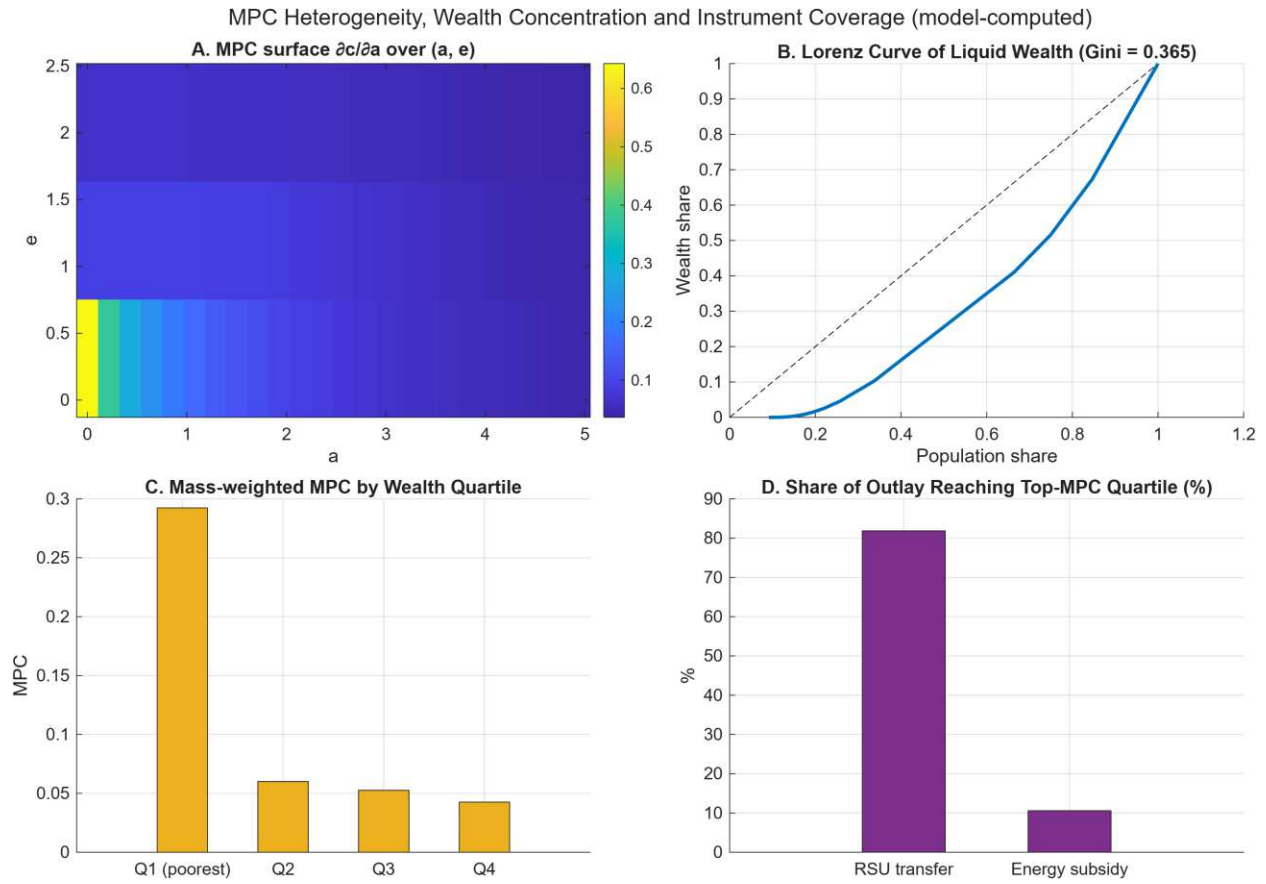


Figure 4. MPC heterogeneity, liquid-wealth concentration, and policy incidence

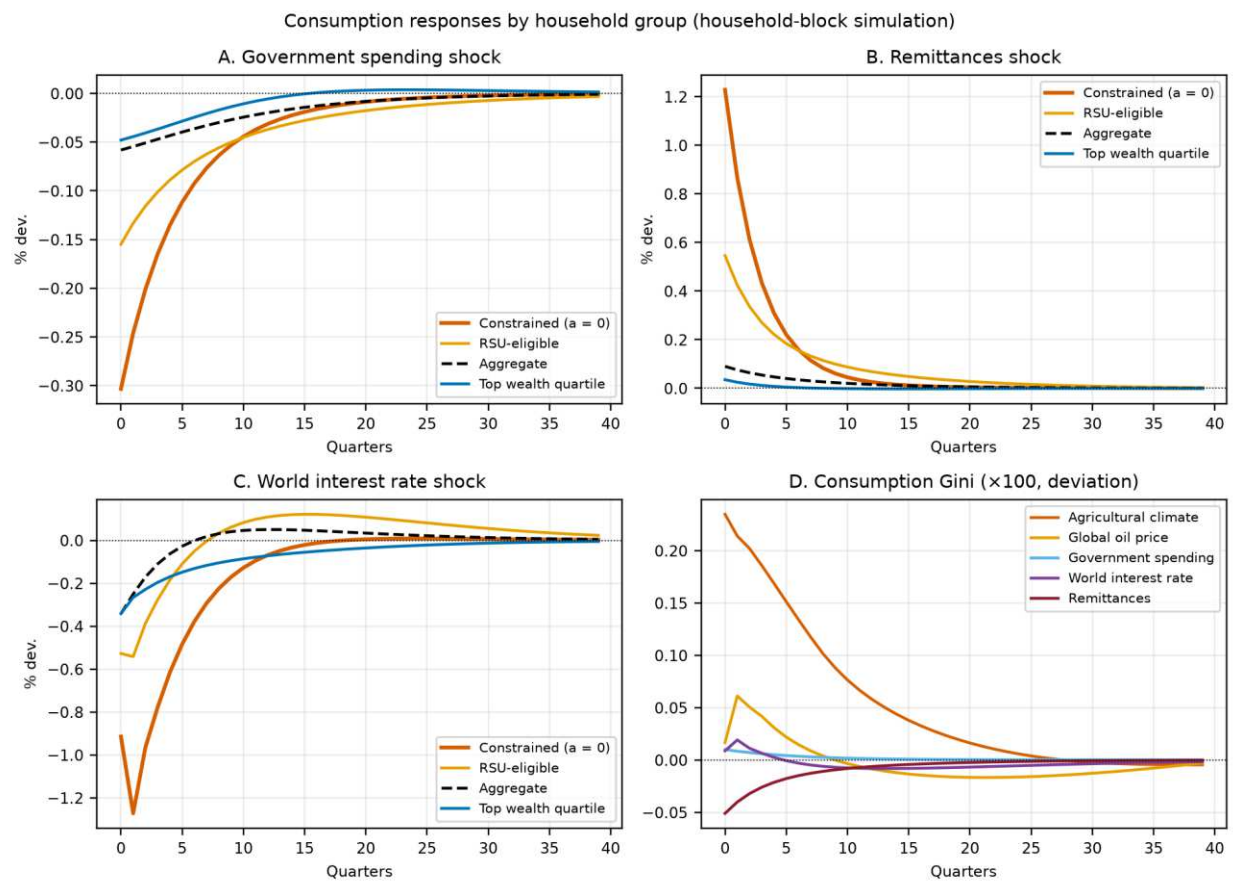


Figure 5. Decomposition of aggregate consumption transmission channels

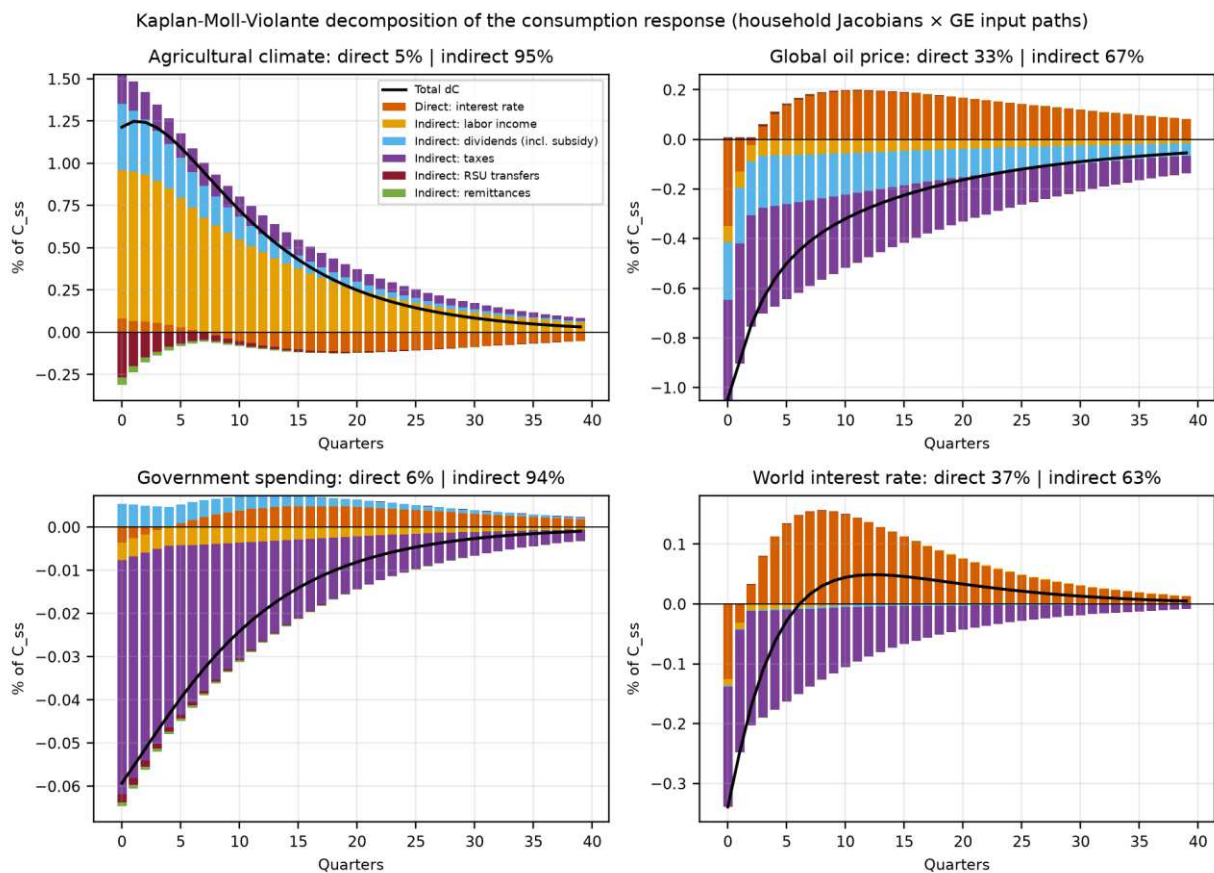


Figure 6. Heterogeneous consumption responses across household wealth groups

Supplementary Files

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