

Shocks, Frictions, Informality, and the Algerian Business Cycle: A Heterogeneous Agent New Keynesian Approach

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Abstract:

This paper develops and estimates the first Heterogeneous Agent New Keynesian (HANK) model for Algeria, a commodity-exporting economy characterized by deep financial exclusion, a large informal sector, and fiscal dominance. The model incorporates an incomplete-markets household block generating a realistic distribution of marginal propensities to consume (MPCs), a three-state endogenous labor market —

formal employment, informal employment, and unemployment — calibrated to reproduce the dual structure of Algerian employment (Formal 38.8%, Informal 51.1%, Unemployed 10.1%), and a small open economy block capturing oil export dynamics, a managed exchange rate, and the sovereign wealth fund mechanism. The model is estimated by Simulated Method of Moments using 96 quarters of Algerian macroeconomic data, matching eleven second-order moments, and converges with an overall criterion $Q = 7.63$. The indirect earnings channel — through which monetary policy affects aggregate demand via employment and labor income rather than intertemporal substitution — quantitatively dominates monetary transmission, consistent with the near-absence of formal financial intermediation documented by the World Bank Findex (2024): only 35.3% of adults hold formal accounts and 3.7% borrow formally. A policy counterfactual demonstrates that replacing Algeria's universal subsidy regime (657 billion DA annually) with a targeted cash transfer of equal fiscal cost raises the aggregate consumption multiplier by 18.6%, because the targeted scheme concentrates resources on high-MPC informal and unemployed households (average MPC 0.45 vs 0.38 universal). The model supports a rules-based fiscal stabilization strategy — counter-cyclically managing oil windfall transfers through the sovereign wealth fund — as the primary instrument for macroeconomic stabilization in an economy where the interest rate instrument reaches only a small fraction of aggregate demand.

Keywords: HANK, heterogeneous agents, informality, Algeria, oil shocks, monetary transmission, subsidy reform

JEL Classification: E21, E52, E62, O17, Q32

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1. Introduction

Algeria presents a set of macroeconomic challenges that strain conventional analytical frameworks. Its business cycle is driven predominantly by oil price movements that translate into fiscal revenue shocks, redistributed to a heterogeneous population through a large and largely universal subsidy system. Nearly half the adult population behaves as hand-to-mouth, informal employment accounts for 43% of the workforce, and fewer than one in three adults holds a formal financial account. The majority of existing empirical work employs reduced-form, atheoretical,¹ backward-looking models that are ill-suited for policy analysis in this environment, for three reasons.²

The first is the (Lucas, 1976) critique. Reduced-form models estimate relationships from historical data that embed the policy regime prevailing during the sample period. Since rational agents update expectations whenever policy changes, evaluating a new policy using a model estimated under the old regime is logically inconsistent. Structural analysis requires models built from deep parameters — preferences, technologies, and constraints — not from reduced-form correlations.

The second is the absence of theoretical structure. Without micro founded general equilibrium restrictions, reduced-form models cannot account for the interconnected feedbacks through which policy changes propagate across markets, cannot distinguish between competing theoretical mechanisms, and cannot address normative distributional questions.

The third is the treatment of expectations. Standard reduced-form models ignore the forward-looking character of inflation and investment decisions, which is critical in an economy where monetary policy credibility is limited and oil price expectations drive fiscal planning.

A small but growing literature has turned to structural Dynamic Stochastic General Equilibrium (DSGE) models for Algeria.³ These are theoretically coherent, but carry their own limitations. Standard New Keynesian DSGE models rely on the intertemporal substitution channel for monetary transmission — a channel that is largely absent when, as (Public Opinion Research Group, 2024) confirms for Algeria, 65% of adults hold no formal financial account and are therefore unresponsive to interest rate changes through the standard Euler equation margin. They assume a representative agent, making the distributional consequences of subsidy reform unanswerable by construction. And they abstract from the dual formal-informal labor market structure that characterizes Algerian employment — where nearly 43% of workers operate outside the formal sector (Barka, 2016) — and its implications for the heterogeneous exposure of households to aggregate shocks. Moreover, the empirical evidence based on longitudinal survey data is against the full consumption insurance hypothesis (complete markets).⁴

Heterogeneous Agent New Keynesian (HANK) models — building on the incomplete markets tradition of (Bewely, 1977), (Huggett, 1993), and (Aiyagari, 1994) and integrating it with the nominal rigidities of the New Keynesian model — directly address these failures. The **indirect earnings channel** through which monetary policy affects aggregate demand by changing employment and labor income rather than saving incentives — quantitatively dominates the direct channel in environments with high shares of liquidity-constrained households (Kaplan, Moll, &

¹ By reduced-form, atheoretical models I refer broadly to the family of autoregressive and regression-based empirical models, including ARDL, VAR, SVAR, VECM, panel data models, among others. While these models differ in their treatment of dynamics, cointegration, and identification, they share the common feature of estimating relationships directly from the data without imposing the restrictions that microfounded structural models require.

² See, for example, (Bank of Algeria, 2022), (Benameur, Belarbi, & Toumache, 2020), (Chibi, Benbouziane, & Moh, 2014), (Benziane, 2019).

³ See, for example, (Abderrahim, et al., 2026), (Zenagui, 2026), (Tchoketch-Kebir, 2022), (Chaouche & Toumache, 2017), (Allegret & Benkhodja, 2015).

⁴ The empirical literature against full consumption insurance includes (Cochrane, 1991), (Hall, 1978), (Violante, Storesletten, & Heathcote, 2009), (Guisen, 2011), (Benhabib & Bisin, 2018), and (De Nardi & Fella, 2017).

Violante, 2018).¹ HANK breaks Ricardian equivalence by construction (McKay & Reis, 2016): because a significant fraction of households are liquidity constrained and do not hold government bonds, their consumption responds directly and fully to disposable income. Fiscal transfers therefore have large real effects that depend critically on who receives them — a property essential for evaluating subsidy reform in Algeria. HANK can accommodate labor market heterogeneity by allowing different household types to face distinct labor income processes and market access conditions (Ravn & Sterk, 2017); (Gornemann, Kuester, & Nakajima, 2016)).

This paper introduces the first HANK model estimated for Algeria — and, to my knowledge, for any economy in the North Africa and Middle East region. The contribution is threefold. **Theoretically**, we adapt the HANK framework of (Kaplan, Moll, & Violante, 2018) to a commodity-exporting, bank-dominated economy by incorporating an oil revenue block that channels external shocks through fiscal transfers rather than private sector dynamics. **Empirically**, we calibrate and estimate the model using Algerian macro time series and World Bank Findex (2024) household microdata, disciplining the distribution of MPCs and the degree of financial exclusion directly from nationally representative survey evidence. **On policy**, we use the estimated model to analyze the effectiveness of monetary policy transmission and the aggregate demand consequences of subsidy reform — specifically, whether replacing universal subsidies with targeted transfers generates larger output multipliers by concentrating resources on high-MPC informal and unemployed households.

The remainder of the paper is organized as follows. Section 2 documents the stylized facts motivating the model's key features. Section 3 presents the model. Section 4 describes calibration and estimation. Section 5 reports the main impulse response results. Section 6 discusses policy implications. Section 7 concludes.

2. Stylized Facts

2.1 Household Heterogeneity

Algeria's household sector is characterized by deep heterogeneity in income, wealth, and financial access — features that motivate the HANK framework. The World Bank estimates Algeria's Gini coefficient at approximately 0.27–0.35 (World Bank, 2023), but aggregate inequality measures understate the degree of behavioral heterogeneity that matters for macroeconomic dynamics. What is more relevant is the distribution of marginal propensities to consume, which depends on the joint distribution of income and liquid wealth.

The World Bank Global Findex (2024) microdata — computed directly for this paper from a representative sample of 1,007 Algerian adults — reveals a striking picture of financial exclusion and liquidity constraints. Only **35.3%** of Algerian adults hold a formal financial account, with ownership falling sharply among the non-employed (**24.4%**), rural households (**23.0%**), and those with primary education or less (**25.0%**). More strikingly, **49.6%** of adults hold neither a formal account nor any savings — our preferred proxy for hand-to-mouth status — while a further **15.1%** hold an account but report no savings in the past year. Together, these figures imply that approximately **65%** of the adult population behaves as effectively hand-to-mouth, consuming close to their current disposable income with little ability to smooth consumption across periods. (Public Opinion Research Group, 2024)

¹ This is especially relevant for economies with shallow financial systems where, as Findex (2024) confirms for Algeria, nearly 65% of adults hold no formal financial account and are therefore unresponsive to interest rate changes through the standard intertemporal margin.

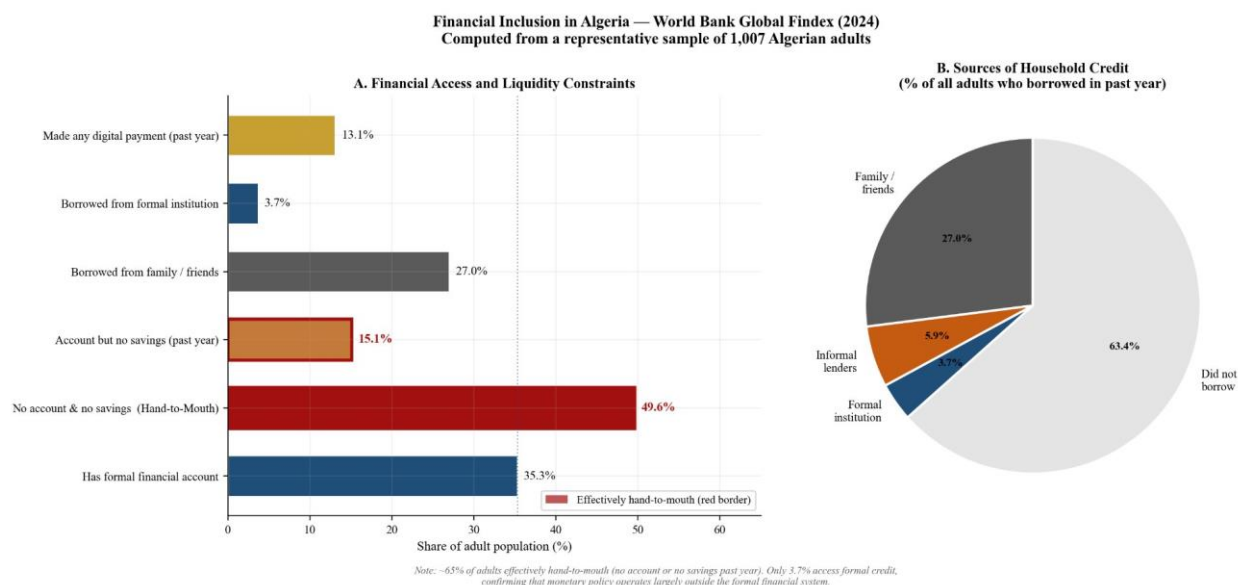


Figure 1. Financial Inclusion in Algeria — World Bank Global Findex (2024), computed from a representative sample of 1,007 Algerian adults. Panel A: distribution of financial access and liquidity constraints among adults. Panel B: sources of household credit. The 49.6% hand-to-mouth share and the 3.7% formal borrowing rate directly discipline the model calibration of the borrowing constraint and the attenuated monetary transmission channel.

The informal sector adds a further dimension of heterogeneity. Nearly **43%** of Algerian workers are employed outside the formal sector (Barka, 2016), without access to social insurance, formal credit, or stable income streams. Informal workers face higher income volatility and tighter liquidity constraints than their formal counterparts.

2.2 Financial Structure

Algeria's financial system is bank-dominated, shallow, and poorly integrated with household economic activity — features that fundamentally shape the transmission of monetary policy.

The banking sector accounts for virtually all formal financial intermediation, with the stock market playing a negligible role. The Algiers Stock Exchange lists fewer than ten companies and has total market capitalization representing less than **1%** of GDP — effectively nonexistent as a channel for household saving or corporate financing (Algiers Stock Exchange, 2025). The banking sector is dominated by state-owned institutions. According to (Banque d'Algérie, 2024), public banks held **85.5%** of total deposits and **84.6%** of total credit to the economy at end-2024.

Household wealth is overwhelmingly concentrated in illiquid real estate. In the absence of developed financial markets, Algerian households save primarily through property ownership — a pattern consistent with the two-asset structure of our HANK model, where illiquid assets dominate household portfolios and generate the wealthy hand-to-mouth phenomenon documented by (Kaplan & Violante, 2014). This means that even households with significant net worth may behave as hand-to-mouth with respect to transitory income shocks, as their wealth is locked in illiquid form and cannot be readily mobilized for consumption smoothing.

Household credit penetration is among the lowest in MENA. As documented above, only **3.7%** of adults borrowed from a financial institution in the past year (Public Opinion Research Group, 2024). Consumer credit, mortgage finance, and small business lending remain underdeveloped. This leaves households without the borrowing capacity that would allow them to smooth consumption in response to income shocks. This structural feature — combined with the dominance of informal borrowing networks — confirms that the incomplete markets assumption of our model is an accurate description of the financial environment facing Algerian households.

2.3 Macroeconomic Features

Oil dependence and fiscal transmission. Algeria's business cycle is driven primarily by hydrocarbon price movements channeled through fiscal policy. According to the (Ministère des

Finances, 2026), hydrocarbon fiscal revenues are projected at 2,697.9 billion DA in 2026, representing **33.7%** of total budget revenues of 8,009 billion DA. The hydrocarbon sector's value added stands at 5,591.7 billion DA out of a total GDP of 41,878.3 billion DA, and export volumes are projected to decline by **2%** in 2026, **0.5%** in 2027, and **2.7%** in 2028. This concentration means that international oil price fluctuations translate directly into government revenue shocks, which are then redistributed to the economy through public wages, investment spending, and the subsidy system.

Monetary policy framework. The Bank of Algeria operates under de facto fiscal dominance. Total budget expenditures reach 17,636.7 billion DA in 2026 — equivalent to **42.1%** of GDP — financed substantially through hydrocarbon revenues and Treasury advances from the central bank (Ministère des Finances, 2026). Monetary policy has historically accommodated fiscal deficits, and the interest rate instrument plays a limited role in macroeconomic stabilization. Empirical estimates of the Bank of Algeria's reaction function consistently find that the Taylor principle ($\phi_\pi > 1$) is violated (Chaouche & Toumach, 2016). This confirms that the standard New Keynesian monetary transmission mechanism cannot be taken as given in the Algerian context and motivates our modeling of monetary policy as operating primarily through the indirect earnings channel rather than intertemporal substitution.

Fiscal dominance and the subsidy system. Transfer expenditures represent the single largest component of the state budget at 5,959.8 billion DA in 2026 — **33.8%** of total budget expenditures (Ministère des Finances, 2026). This includes explicit subsidies on basic consumption goods — cereals, milk, desalinated water, energy, sugar, oil, and coffee — amounting to approximately 657 billion DA, alongside 2,284 billion DA in direct transfers to persons, including unemployment allocations benefiting 2,184,560 recipients and pension payments. These transfers are largely universal — distributed without income targeting — meaning their aggregate demand effect depends on the full distribution of household MPCs rather than on the average. As our model will demonstrate, replacing universal subsidies with targeted transfers of equal fiscal cost generates very different aggregate demand outcomes depending on the incidence of the reform — a question that only a heterogeneous agent model can address.

Table 1. Key Macroeconomic Moments for Calibration

Moment	Value	Source
Share of HtM households	49.6%	Findex (2024), computed
Formal account ownership	35.3%	Findex (2024), computed
Informal employment share	43%	Barka (2016)
Hydrocarbon share of fiscal revenue	33.7%	Ministère des Finances (2026)
Transfer expenditures / total budget	33.8%	Ministère des Finances (2026)
Explicit subsidy bill	~657 billions DA	Ministère des Finances (2026)
Treasury global deficit / GDP	-12.4%	Ministère des Finances (2026)
Fiscal reference oil price	\$60/barrel	Ministère des Finances (2026)
Bank credit to private sector / GDP	~30%	World Bank (2022)

3. The Model

This paper develops a Small Open Economy Heterogeneous Agent New Keynesian (SOE-HANK) model calibrated to Algeria, solved using the Sequence-Space Jacobian (SSJ) method of (Auclert,

Bardóczy, Rognlie, & Straub, 2021).¹ The model departs from the representative-agent New Keynesian framework along three dimensions. First, it features an incomplete-markets household block in which a continuum of households face uninsurable idiosyncratic income risk and a binding borrowing constraint, generating a realistic cross-sectional distribution of MPCs absent from representative-agent models. Second, it embeds a three-state labor market — formal employment, informal employment, and unemployment — in which transition probabilities respond endogenously to the business cycle, capturing Algeria's dual formal-informal labor structure. Third, it incorporates a small open economy block with a managed exchange rate, oil export dynamics, and import demand.

The model abstracts from capital accumulation and illiquid assets. This one-asset structure is consistent with the predominance of liquid bank deposits as the relevant savings vehicle for most Algerian households — Findex (2024) data confirm fewer than 36% of adults hold a formal financial account — and greatly simplifies the numerical solution while preserving the key heterogeneity in MPCs and the distributional transmission of fiscal policy that motivate the HANK framework.

4.1 Households

4.1.1 Demographics and Heterogeneity

The economy is populated by a unit continuum of households $i \in [0,1]$, who are ex-ante identical in preferences but ex-post heterogeneous along two dimensions². The individual state of household i is the pair

$$\omega_t^i = (a_t^i, e_t^i)$$

where $a_t^i \in [\underline{a}, \infty)$ denotes holdings of the single liquid asset — bank deposits — which earn the real return r_t and are subject to the borrowing constraint $a_t^i \geq \underline{a}$; and e_t^i is the household's idiosyncratic income scale, which is a composite of idiosyncratic productivity and labor-market sector membership, described in detail below. Unlike the two-asset HANK models that feature an illiquid asset alongside liquid savings, the present model focuses on the single asset most relevant for Algerian households: liquid bank deposits. The absence of a second asset means all constrained households are of the pure hand-to-mouth type — those with $a_t^i = \underline{a}$ who consume entirely out of current income — rather than the wealthy hand-to-mouth type of (Kaplan & Violante, 2014).

4.1.2 Preferences

Household i maximizes expected lifetime utility over consumption sequences:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t^i)$$

where $\beta \in (0,1)$ is the discount factor and the period utility function takes the standard constant relative risk aversion (CRRA) form:

$$u(c_t^i) = \frac{(c_t^i)^{1-\sigma}}{1-\sigma}$$

The parameter $\sigma > 0$ is the coefficient of relative risk aversion, which is the inverse of the elasticity of intertemporal substitution. Because $u(c)$ is concave — $u'(c) > 0, u''(c) < 0$ i.e., each additional unit of consumption brings less extra satisfaction than the previous one — households are risk averse and seek to keep consumption stable across different circumstances.³ This leads them to accumulate a buffer stock of liquid assets to self insure bad income realizations. This precautionary motive, absent from RA models, produces the cross-sectional dispersion in liquid

¹ A sequence space is a vector space whose elements are infinite sequences of real numbers; see (Muscat, 2024) for a standard treatment, and (Auclert, Bardóczy, Rognlie, & Straub, 2021) for its application to heterogeneous-agent macroeconomic models.

² Ex-ante identical means they have the same preferences and information sets, whereas ex-post heterogeneous means they have different asset holdings, productivity, and employment status because they face idiosyncratic income risk that cannot be fully insured.

³ For a rigorous treatment of expected utility theory see chapter 6 in (Mas-Colell, Whinston, & Green, 1995).

wealth and MPCs that drives the HANK transmission mechanism. Labor supply decisions are not modeled at the individual household level; aggregate labor demand is instead determined by the goods market clearing condition, and sectoral employment shares evolve according to the Markov structure described in Section 4.2.

4.1.3 Income

Household i 's income in period t is

$$y_{i,t} = (Y_t - T_t) \cdot e_{i,t} + T_{oil,t}$$

This specification makes two modeling choices that are central to the Algerian context. First, household income is expressed as a share of aggregate after-tax output $(Y_t - T_t)$, scaled by the idiosyncratic factor $e_{i,t}$. This formulation captures the fact that labor income in the model flows from aggregate production rather than individual labor supply decisions, and it ensures that aggregate income risk is transmitted heterogeneously across the distribution depending on each household's productivity and sectoral position. Second, the oil windfall transfer $T_{oil,t}$ enters additively and is identical across households, reflecting the universal character of Algeria's current subsidy and social transfer system.

The idiosyncratic income scale $e_{i,t}$ is a composite of two sources of heterogeneity. The first is idiosyncratic productivity, which follows a discretized AR(1) process in logs:¹

$$\ln z_t^i = \rho_z \ln z_{t-1}^i + \varepsilon_t^i, \quad \varepsilon_t^i \sim \mathcal{N}(0, \sigma_z^2)$$

discretized to n_e states with transition matrix Π^z , where $\Pi_{jk}^z = \text{Prob}(z_{t+1} = z_k \mid z_t = z_j)$. The second is the household's labor-market sector $s_t^i \in \{F, I, U\}$, which enters through a sector-specific income multiplier $m_{s_t^i}$. The full income scale is the product of the two:

$$e_{i,t} = \frac{m_{s_t^i} \cdot z_t^i}{\bar{e}}$$

where the multipliers are normalized so that the ergodic-mean income scale equals unity:

$$m_s \in \{1, w^{inf}, b^{unemp}\}, \quad \bar{e} = \pi_F \cdot 1 + \pi_I \cdot w^{inf} + \pi_U \cdot b^{unemp}$$

$$E[e_{i,t}] = \frac{1}{\bar{e}} E[m_{s_t^i}] \cdot E[z_t^i] = \frac{1}{\bar{e}} \bar{e} \cdot 1 = 1$$

with π_F, π_I, π_U the ergodic employment shares. The informal-sector multiplier $w^{inf} < 1$ captures the income penalty of informal work — lower productivity, no employer pension contributions, and the lack of formal wage-setting mechanisms — calibrated to the observed formal–informal earnings gap in Algeria. The unemployment benefit ratio b^{unemp} is calibrated to Algeria's unemployment allowance system.

The full idiosyncratic state space is the Kronecker product of the three sectors and the n_e productivity states, yielding $3 \times n_e$ distinct income types. The joint transition matrix is

$$\Pi = \Pi_t^s \otimes \Pi^z$$

where Π_t^s is the 3×3 endogenous sectoral transition matrix described in Section 4.2 below. The Kronecker structure implies that, within each sector, households transition across productivity states according to Π^z , while across sectors they transition according to Π_t^s , and the two processes are independent. This is the source of the within-sector income risk that drives precautionary saving and generates the dispersion in MPCs.

4.1.4 Budget Constraint

The household's single flow budget constraint is

$$a_{t+1}^i = (1 + r_t) a_t^i + y_{i,t} - c_t^i$$

subject to the borrowing constraint $a_{t+1}^i \geq \underline{a}$. The constraint requires that liquid wealth at the end of the period is above a small lower bound $\underline{a}$.

¹ We discretize the idiosyncratic productivity process using the (Rouwenhorst, 1995) method.

4.1.5 Household Optimization

The household's optimization problem has a recursive representation.¹ Let $V_t(a, e)$ denote the value function of a household with liquid assets a and income scale e at date t . The Bellman equation is

$$V_t(a, e) = \max_{c \geq 0, a' \geq \underline{a}} \left\{ u(c) + \beta \sum_{e'} \Pi_{ee',t} V_{t+1}(a', e') \right\}$$

subject to

$$a' = (1 + r_t)a + y_t(e) - c$$

where $y_t(e) = (Y_t - T_t) \cdot e + T_{oil,t}$

and $\Pi_{ee',t}$ is the (e, e') element of the full joint transition matrix $\Pi_t = \Pi_t^s \otimes \Pi_t^z$.

The first-order condition for consumption is the Euler equation

$$u_c(c_t^i) \geq \beta(1 + r_{t+1}) \mathbb{E}_t[u_c(c_{t+1}^i)]$$

with equality when the borrowing constraint is slack ($a_{t+1}^i > \underline{a}$), and strict inequality when the constraint binds. In CRRA form, the Euler equation can be written as

$$(c_t^i)^{-1/\sigma} \geq \beta(1 + r_{t+1}) \mathbb{E}_t[(c_{t+1}^i)^{-1/\sigma}]$$

For unconstrained households the standard Euler equation holds: consumption growth is smoothed optimally and MPC is low. For constrained households at $a_t^i = \underline{a}$, the inequality is strict: the marginal value of current consumption exceeds the discounted future value, and the household consumes all available resources. It is these borrowing-constrained households — predominantly informal workers, the unemployed, and low-productivity formal workers who have exhausted their liquid buffer — that exhibit near-unit MPCs and amplify the aggregate demand response to fiscal transfers and oil windfalls.

The model is solved numerically using the Endogenous Grid Method (EGM) (Carroll, 2006), which exploits the Euler equation to construct the consumption policy function $c_t(a, e)$ on an exogenous grid of asset positions.

4.1.6 MPC Heterogeneity

The key object linking household heterogeneity to aggregate dynamics is the marginal propensity to consume out of a transitory income shock. For household i , the MPC is

$$\text{MPC}^i = \frac{\partial c_t^i}{\partial y_t^i}$$

In the one-asset incomplete-markets model, MPCs vary systematically with liquid wealth and sector. Households far from the borrowing constraint behave approximately as the permanent income hypothesis predicts, smoothing transitory shocks almost entirely into savings ($\text{MPC} \approx 0$). Households at or near the borrowing constraint consume essentially all of a transitory income increase ($\text{MPC} \approx 1$). The three-sector structure generates a predictable ordering: informal workers, who face the tightest borrowing constraints ($\underline{a}^I = 0$) and the most volatile income, cluster near the borrowing constraint and thus exhibit the highest MPCs; formal sector workers with accumulated buffer stocks have lower MPCs; and unemployed households, receiving modest transfers, have intermediate MPCs depending on their asset position.

The aggregate MPC — the key sufficient statistic for aggregate demand responses to fiscal policy — is the distribution-weighted average:

$$\overline{\text{MPC}}_t = \int \text{MPC}^i d\Gamma_t(a, e)$$

where $\Gamma_t(a, e)$ is the joint distribution of households over assets and income types, the central state variable of the model.

The distributional incidence of fiscal transfers determines their aggregate demand multiplier: a transfer directed toward high-MPC informal and unemployed households has a much larger aggregate demand effect than an equal-cost transfer distributed uniformly, as under Algeria's

¹ A good reference in dynamic programming in economics is (Stokey, Lucas, & Prescott, 1989).

current universal subsidy regime. This is the central channel through which the model speaks to the distributional consequences of subsidy reform.

4.2 Labor Market — Endogenous Sectoral Transitions

Each household occupies one of three labor-market states each period: formal employment (F), informal employment (I), or unemployment (U). Transitions between states follow a 3×3 Markov matrix Π_t^s , whose elements vary with the business cycle. Two features of the Algerian labor market motivate this structure. First, the informal sector is large and persistent, employing roughly 43% of the workforce; it cannot be treated as a residual category. Second, job-finding and separation rates¹ move with aggregate output, so the distribution of income risk across households changes over the cycle.

The central modeling choice is the sign of the cyclical elasticity $elast_U$, which is calibrated to be negative. This reflects a pattern in Algerian data whereby the informal sector expands in booms, absorbing workers who might otherwise register as unemployed. Measured unemployment therefore rises less sharply in downturns — and falls less sharply in booms — than it would in a purely formal economy, because informality acts as a buffer.

4.2.1 Cyclical Factor

All cyclically sensitive transition rates are scaled by a single factor:

$$\xi_t = \left(\frac{Y_t}{Y_{ss}} \right)^{elast_U}$$

Because $elast_U < 0$, the factor moves counter-intuitively relative to output: $\xi_t < 1$ in booms and $\xi_t > 1$ in recessions. Its reciprocal ξ_t^{-1} therefore rises in booms and falls in recessions, and is used to scale separation rates.

4.2.2 Transition Probabilities

Job-finding (from unemployment) rises in booms via $\xi_t^{-1} > 1$, but recall $elast_U < 0$ so $\xi_t < 1$ in booms, meaning job-finding from unemployment actually slows as the formal market tightens and workers flow instead into informality:

$$\pi_{UF,t} = \pi_{UF}^{ss} \cdot \xi_t, \quad \pi_{UI,t} = \pi_{UI}^{ss} \cdot \xi_t, \quad \pi_{UU,t} = 1 - \pi_{UF,t} - \pi_{UI,t}$$

Separations to unemployment rise in recessions, scaled by $\xi_t^{-1} > 1$ when output is below steady state:

$$\pi_{FU,t} = \pi_{FU}^{ss} \cdot \xi_t^{-1}, \quad \pi_{IU,t} = \pi_{IU}^{ss} \cdot \xi_t^{-1}$$

Formal–informal switching rates π_{FI} and π_{IF} are held fixed at their steady-state values. The rationale is that moving between sectors is governed by structural factors — regulatory thresholds, firm size, informational frictions — rather than short-run cyclical conditions. The retention rates follow as residuals:

$$\pi_{FF,t} = 1 - \pi_{FI}^{ss} - \pi_{FU,t}, \quad \pi_{II,t} = 1 - \pi_{IF}^{ss} - \pi_{IU,t}$$

So, each row of Π_t^s sums to one by construction. The steady-state rates $\{\pi^{ss}\}$ are calibrated to match the observed employment shares and unemployment rate from the Algerian Labor Force Survey.

4.3 Wage and Price Dynamics

4.3.1 Calvo Wage Setting

Nominal wage rigidity is introduced through a standard (Calvo, 1983) staggering mechanism. Each period, a fraction $\theta_w \in (0,1)$ of households is unable to re-optimize their wage; the remaining fraction $(1 - \theta_w)$ sets wages optimally. Households that can re-optimize choose a nominal wage to maximize their expected utility.

The slope of the wage Phillips Curve — which governs how quickly wages respond to labor market imbalances — is derived from the Calvo aggregation and equals

¹ Separation rates refer to the probability that a worker leaves his current employment status (formal or informal job) and becomes unemployed.

$$\kappa_w = \frac{(1 - \theta_w)(1 - \beta\theta_w)}{\theta_w(1 + \varepsilon_w/\varphi)}$$

where ε_w is the elasticity of substitution across labor varieties and φ is the Frisch elasticity of labor supply. A higher θ_w means more households are unable to adjust wages, flattening the wage Phillips Curve ($\kappa_w \rightarrow 0$ as $\theta_w \rightarrow 1$). Nominal wage inflation $\pi_{w,t}$ — defined as the rate of growth of the nominal wage — is linked to real wage growth by the identity

$$\pi_{w,t} = \pi_t + X_t - X_{t-1}$$

where π_t is price inflation and X_t is the real wage. The marginal rate of substitution and marginal utility of consumption, which together determine the gap that wage inflation corrects, are

$$\text{MRS}_t = \varphi \cdot \left(\frac{Y_t}{X_t} \right)^{1/\varphi}, \quad \text{MUC}_t = C_t^{-1/\sigma}$$

These enter the forward-looking wage New Keynesian Phillips Curve:

$$\pi_{w,t} = \kappa_w \left(\text{MRS}_t - \text{MUC}_t \cdot \frac{X_t}{\mu_w} \right) + \beta \mathbb{E}_t \pi_{w,t+1}$$

where $\mu_w = \varepsilon_w/(\varepsilon_w - 1)$ is the gross wage markup. The term in parentheses measures the gap between the household's marginal disutility of labor and the real wage divided by the markup: when workers are paid less than their marginal disutility (scaled by the markup), nominal wages are pushed upward, generating positive wage inflation. Wage stickiness slows this adjustment, creating the real effects of shocks on the labor market.

4.3.2 Price Phillips Curve

The dynamics of price inflation are governed by a hybrid New Keynesian Phillips Curve that allows for both forward-looking pricing and backward-looking indexation:

$$\pi_t = \rho_\pi \pi_{t-1} + \kappa_p (X_t - 1) + \beta \mathbb{E}_t \pi_{t+1} + z_{cost,t}$$

The backward-looking term $\rho_\pi \pi_{t-1}$ captures the partial indexation of prices to past inflation, which is important for matching the inflation persistence documented in Algerian data. The slope coefficient $\kappa_p > 0$ governs the sensitivity of inflation to real marginal cost: under a linear production technology, the real wage X_t serves as a proxy for real marginal cost, so deviations of the real wage above its steady-state value of one ($X_t - 1 > 0$) generate inflationary pressure. The forward-looking term $\beta \mathbb{E}_t \pi_{t+1}$ reflects the standard Calvo mechanism for price-setting firms. The exogenous cost-push shock $z_{cost,t}$ captures supply-side inflation disturbances — such as administered price adjustments or import price pass-through — that are important for Algeria given the extent of price subsidies.

4.4 The External Sector

Algeria's macroeconomic dynamics are fundamentally shaped by its integration with world energy markets and its dependence on hydrocarbon export revenues. The external sector block captures three channels: the managed exchange rate, which links world prices to domestic competitiveness; oil export revenues, which are the primary driver of fiscal resources and household transfers; and import demand, which determines the current account balance alongside export revenues.

4.4.1 Exchange Rate — Managed Float

The Bank of Algeria operates a managed float, intervening in the foreign exchange market to limit real exchange rate volatility. The real exchange rate q_t evolves as

$$q_t = (1 - \rho_q) q_{ss} + \rho_q q_{t-1} + \phi_{q0} z_{oil,t} - \phi_{qi} (r_t^{ante} - r_{ss})$$

where $\rho_q \in (0,1)$ captures the persistence of exchange rate management, $z_{oil,t}$ is the oil shock, and $r_t^{ante} = i_t - \mathbb{E}_t \pi_{t+1}$ is the ex-ante real interest rate defined below. The sign conventions are: $\phi_{q0} < 0$, so an oil windfall ($z_{oil,t} > 0$) appreciates the dinar (lowers q_t , meaning domestic goods become more expensive relative to foreign goods); $\phi_{qi} > 0$, so a domestic interest rate below the world steady-state rate ($r_t^{ante} < r_{ss}$) depreciates the dinar.

4.4.2 Oil Sector and Transfers

Hydrocarbon exports are Algeria's dominant source of foreign exchange and the primary determinant of fiscal revenues. Oil revenue O_t is the product of the world oil price — shocked by a stochastic disturbance $z_{oil,t}$ — and a fixed production capacity Q_{oil} :

$$O_t = p_{oil} (1 + z_{oil,t}) \cdot Q_{oil}$$

The assumption of fixed production capacity Q_{oil} reflects the medium-term rigidity of Algerian hydrocarbon output. All cyclical variation in oil revenue therefore flows through the price channel, which is the empirically dominant source of oil revenue volatility.

Export volumes respond to both the exchange rate (competitiveness) and foreign demand conditions:

$$EX_t = \phi_X \cdot O_t \cdot \left(\frac{q_t}{q_{ss}} \right)^{\eta_X} \cdot Y_t^* (1 + \rho_{od} z_{oil,t})$$

where $\eta_X > 0$ is the REER elasticity of exports, Y_t^* is world demand, ϕ_X is a scale parameter, and ρ_{od} captures the sensitivity of export volumes to the oil shock beyond its direct price effect. When the dinar appreciates in response to an oil windfall ($q_t < q_{ss}$), the term $(q_t/q_{ss})^{\eta_X} < 1$ partially offsets the direct revenue gain, reflecting a competitiveness loss for non-oil exports.

A fraction ϕ_{swf} of oil windfalls above the steady-state level is absorbed by a sovereign wealth fund, with the remainder passed through to households as a direct transfer:

$$T_{oil,t} = (1 - \phi_{swf}) (O_t - \bar{O})$$

This transfer enters the household income equation directly and is the primary channel through which oil price shocks affect aggregate household demand. The parameter ϕ_{swf} governs how much of the windfall is saved at the government level versus distributed immediately, and is an important determinant of the fiscal multiplier associated with oil shocks.

4.4.3 Import Demand and Trade Balance

Import demand depends on domestic output and falls when the dinar depreciates (foreign goods become relatively more expensive):

$$IM_t = \phi_{IM} (0.7 Y_t + 0.3 C_t) \cdot \left(\frac{q_{ss}}{q_t} \right)^{\eta_M}$$

where $\eta_M > 0$ is the import-demand elasticity with respect to the real exchange rate. The 70–30 weighting of output and consumption reflects the composition of Algerian imports, which include both capital and intermediate goods (tied to output) and consumer goods (tied to household consumption).

Net exports are given a persistence mechanism to match the high autocorrelation observed in Algerian data:

$$NX_t = \rho_{nx} NX_{t-1} + (EX_t - IM_t) - NX_{ss}(1 - \rho_{nx})$$

which can be written as an error-correction process: net exports revert toward their steady-state value NX_{ss} at rate $(1 - \rho_{nx})$.

4.5 Fiscal Policy

Government spending G is treated as exogenous. The government issues one-period bonds B_t and finances the difference between expenditures and revenues through debt accumulation, subject to a tax rule that stabilizes the debt-to-GDP ratio in the long run. Taxes T_t adjust around their steady-state level proportionally to the deviation of existing debt from target:

$$T_t = T_{ss} + \phi_T (B_{t-1} - B_{ss})$$

where $\phi_T > 0$ is the tax feedback coefficient. This simple rule ensures long-run fiscal solvency while allowing short-run deficit financing: when debt is above its target, taxes rise to reduce the deficit; when debt is below target, taxes fall. The speed of adjustment is governed by ϕ_T , which is calibrated to match the observed persistence of Algerian fiscal deficits.

The government budget constraint is solved each period for outstanding debt B_t :

$$B_t = (1 + r_t) B_{t-1} + G + T_{oil,t} - T_t$$

Oil windfall transfers $T_{oil,t}$ enter the budget on the revenue side, reducing the need for tax financing in boom periods.

4.6 Monetary Authority

The Bank of Algeria sets the nominal interest rate i_t according to a Taylor-type rule responding to deviations of inflation from the zero steady-state target:

$$i_t = r_{ss} + \phi_\pi \pi_t + \varepsilon_t^i$$

where r_{ss} is the steady-state real interest rate, ϕ_π is the inflation response coefficient, and ε_t^i is an exogenous monetary policy shock. The rule omits an output gap term, consistent with the Bank of Algeria's mandate, which emphasizes price stability rather than output stabilization, and with empirical evidence that output gap responses are not statistically significant in estimated Algerian Taylor rules. A key question for the model is whether the Taylor principle $\phi_\pi > 1$ is satisfied: existing estimates for Algeria suggest it may be violated, implying passive monetary policy.

The ex-ante real interest rate is determined by the Fisher equation:

$$r_t^{ante} = i_t - \mathbb{E}_t \pi_{t+1}$$

Households face the ex-post real return on savings with a one-period lag — the rate they earn on deposits held from period $t - 1$ to period t was set as the ex-ante rate at $t - 1$:

$$r_t = r_{t-1}^{ante}$$

This timing convention creates a realistic transmission delay: a monetary policy shock at date t affects household budget constraints only from $t + 1$ onward, so the immediate aggregate demand response is driven by the household income channel (through inflation and output changes) rather than the interest rate channel.

4.7 Aggregation and Market Clearing

4.7.1 The Cross-Sectional Distribution

Let $\Gamma_t(a, e)$ denote the joint distribution of households over liquid assets and income types at date t . This distribution is the central aggregate state variable: it summarizes all the information about household heterogeneity relevant for aggregate dynamics, and it evolves endogenously in response to aggregate shocks and policy changes. Aggregate variables are obtained by integrating household policy functions over the cross-sectional distribution:

$$C_t = \int c(a, e; X_t) d\Gamma_t(a, e), \quad A_t = \int a d\Gamma_t(a, e)$$

where X_t denotes the vector of aggregate prices and policies. The distribution Γ_t evolves according to the Kolmogorov forward equation¹, which maps the current distribution and household policy functions into next period's distribution. Because the SSJ solution method works in sequence space, the model is solved as a system of linear equations in the impulse responses of Γ_t to shocks, rather than by tracking the full non-linear distribution dynamics.

4.7.2 Market Clearing

Three conditions close the model each period.

Asset market: Household savings equal outstanding government debt,

$$A_t = B_t$$

This follows from the assumption that government bonds are the only asset in the economy — the one-asset structure of the model.

Goods market: The national income identity in the open economy,

$$Y_t = C_t + G + EX_t - IM_t$$

Labor market: Aggregate hours worked N_t equals aggregate output by

$$N_t = Y_t$$

¹ The Kolmogorov forward equation (or the Fokker–Planck–Kolmogorov equation) describes the evolution of the distribution induced by policy functions and idiosyncratic shocks. See (Øksenda, 2003). Because the SSJ solution method works in sequence space, the model is solved as a system of linear equations in the impulse responses of Γ_t to shocks, rather than by tracking the full non-linear distribution dynamics.

3.7 Exogenous Shock :

Table 2. Exogenous Shocks

Shock	Symbol	Equation	Description
Monetary policy	ε_t^i	Taylor rule	Deviation of the interest rate from the systematic rule
Oil price / supply	$z_{oil,t}$	Oil sector	International oil market disturbance
Cost-push	$z_{cost,t}$	Price NKPC	Exogenous markup or supply-side shock
Government spending	G_t	Budget constraint	Discretionary fiscal impulse

Each shock can be specified as an i.i.d. impulse for computing sequence-space Jacobians, or given an AR(1) law of motion for estimation. The oil shock $z_{oil,t}$ enters simultaneously through the oil revenue equation, the export volume equation, and the exchange rate rule. The monetary policy shock ε_t^i is the primary instrument for analyzing monetary transmission; its effect on aggregate demand flows predominantly through the indirect earnings channel — changes in employment and labor income — rather than through the intertemporal substitution channel, which is attenuated by the high share of liquidity-constrained households.

4. Calibration and Estimation

The model is taken to the data in two steps. First, a subset of structural parameters is calibrated to match long-run features of the Algerian economy largely independent of business cycle dynamics. Second, the eight parameters governing the stochastic properties of the four exogenous shocks are estimated by Simulated Method of Moments (SMM), matching eleven second moments from 96 quarters of Algerian data.

4.1 Calibrated Parameters

The household discount factor $\beta = 0.95$ is consistent with the Bank of Algeria benchmark lending rate over the sample period. The elasticity of intertemporal substitution $\sigma = 0.5$ follows the incomplete-markets literature. The Frisch elasticity $\varphi = 0.5$ is consistent with micro estimates for emerging market economies.

The labor market parameters are calibrated to reproduce ILO and Labor Force Survey employment targets. The steady-state transition matrix Π^{ss} is set so that its ergodic distribution matches formal employment at 40%, informal at 48%, and open unemployment at 12%. The model achieves (Formal 38.8%, Informal 51.1%, Unemployed 10.1%), a close match shown in Figure 2.

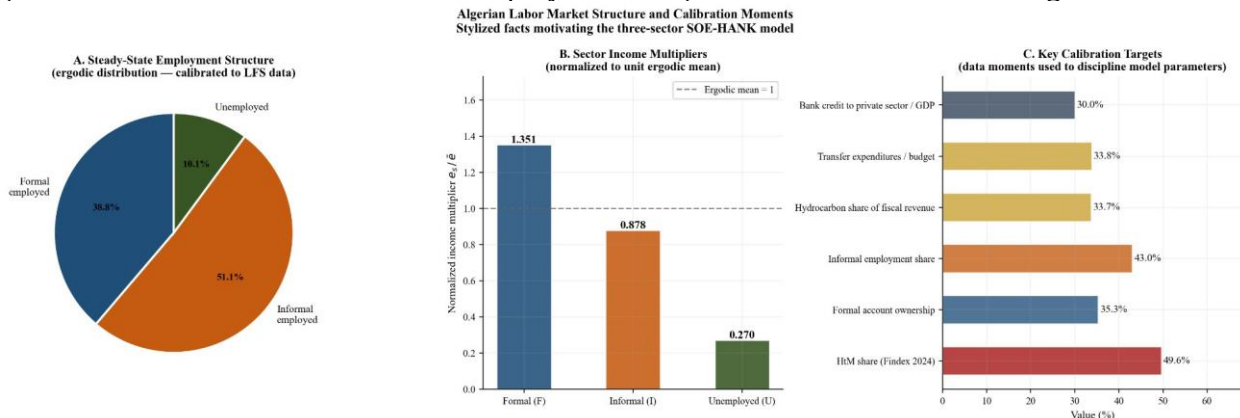


Figure 2. Algerian Labor Market Structure and Calibration Moments. Panel A: steady-state employment shares from the ergodic distribution of the calibrated Markov chain (Formal 38.8%, Informal 51.1%, Unemployed 10.1%). Panel B: normalized sector income multipliers (Formal = 1.351, Informal = 0.878, Unemployed = 0.270). Panel C: key data moments used to discipline the calibration.

The oil sector parameters are disciplined by national accounts data. The steady-state oil output share $Q_{oil} = 0.30$ matches the hydrocarbon sector's value-added share of GDP in the 2010–2019 average. The sovereign wealth fund retention parameter $\varphi_{swf} = 0.85$ reproduces the fiscal saving pattern during the 2003–2013 commodity boom, when the Revenue Regulation Fund accumulated reserves approaching 30% of GDP.

Table 3. Calibrated Structural Parameters

Parameter	Symbol	Value	Target / Source
Discount factor	β	0.950	Bank of Algeria benchmark rate
Elast. of intertemporal substitution	σ	0.500	Incomplete-markets literature
Frisch elasticity	φ	0.500	Emerging market micro estimates
Calvo wage stickiness	θ_w	0.700	Wage PC inflation persistence
Wage markup	μ_w	1.111	Dixit-Stiglitz ($\varepsilon_w = 10$)
Price PC slope	κ_p	0.050	CPI inflation dynamics
Taylor coefficient	φ_π	1.500	Determinacy (Taylor principle)
Informal wage ratio	w^{inf}	0.650	Algerian household surveys
Unemployment replacement rate	b^{unemp}	0.200	Social insurance legislation
Oil output share	Q_{oil}	0.300	National accounts 2010–2019 avg.
SWF retention share	φ_{swf}	0.850	FRR saving pattern 2003–2013
Import scale	φ_{IM}	0.400	Trade data: IM/GDP approx. 25%
REER persistence	ρ_q	0.800	SVAR estimate
Oil-REER elasticity	φ_{q0}	−0.300	SVAR — negative = appreciation
Labour market cyclicalilty	elast_U	−1.000	corr(GDP, U_rate) = +0.22
Government debt target	B_{ss}	2.500	Public debt/GDP 2010–2019 avg.

Table 3. Calibrated structural parameters and their targets. All parameters are held fixed throughout the SMM estimation step.

The steady-state wealth distribution implied by this calibration is shown in Figure 4. Formal workers hold significantly more liquid assets on average (mean $a = 2.25$) than informal workers (mean $a = 1.37$) or the unemployed (mean $a = 1.14$). The wealth ordering across sectors is qualitatively realistic and generates the MPC heterogeneity shown in Figure 5 that is central to the policy counterfactuals in Section 6.

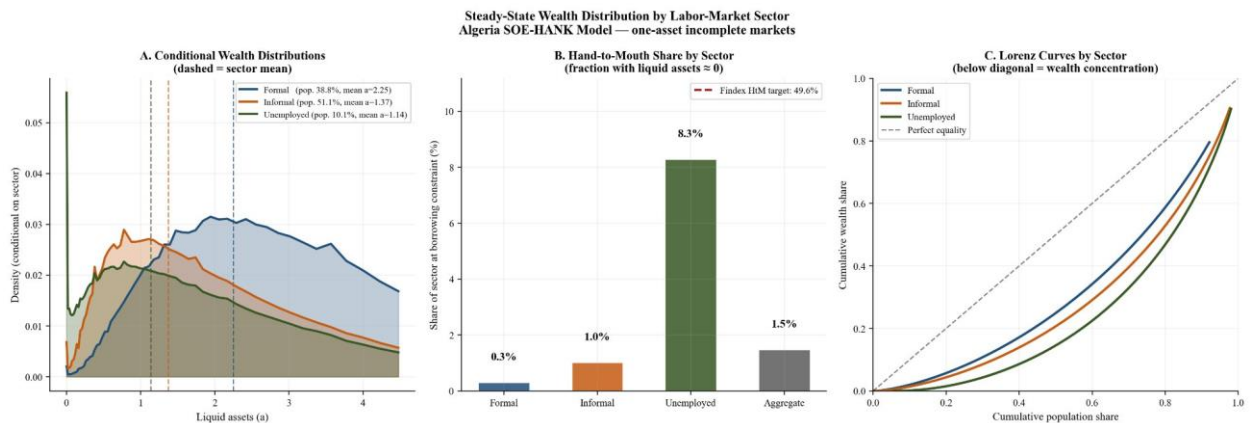


Figure 4. Steady-State Wealth Distribution by Labour-Market Sector. Panel A: conditional asset density for each sector (dashed lines = sector means: Formal $a=2.25$, Informal $a=1.37$, Unemployed $a=1.14$). Panel B: hand-to-mouth share by sector (Formal 0.3%, Informal 1.0%, Unemployed 8.3%, Aggregate 1.5%). Panel C: Lorenz curves by sector.

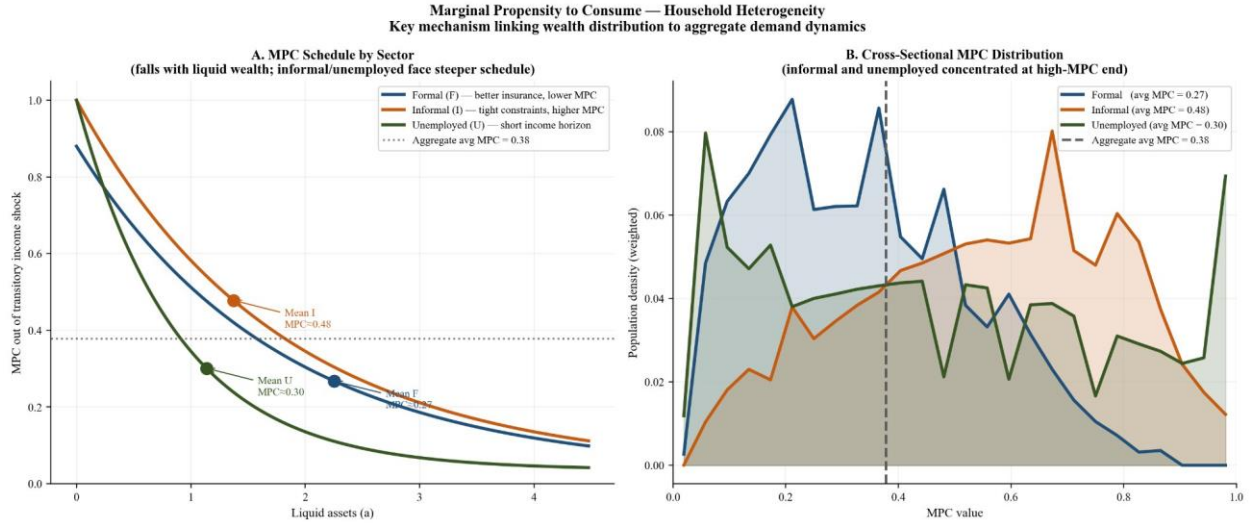


Figure 5. Marginal Propensity to Consume — Household Heterogeneity. Panel A: MPC as a function of liquid assets by sector. Informal (avg MPC = 0.48) and unemployed (avg MPC = 0.30) households face steeper schedules than formal workers (avg MPC = 0.27). Aggregate average MPC = 0.38. Panel B: cross-sectional MPC distribution.

4.2 SMM Estimation

The eight shock parameters are estimated by Simulated Method of Moments. The estimator minimizes the weighted quadratic distance between a vector of eleven empirical moments m_{data} and model-implied moments $m(\theta)$:

$$Q(\theta) = [m_{data} - m(\theta)]'W[m_{data} - m(\theta)]$$

where W is a diagonal weighting matrix reflecting the economic importance and measurement precision of each moment. The persistence and volatility of net exports and inflation receive higher weights (4.0 to 6.0) given their tight empirical identification and centrality to the model's oil and price-rigidity mechanisms. The $\text{corr}(Y, U_rate)$ moment is downweighted to 0.5 reflecting measurement uncertainty in quarterly labor data. Model-implied moments are computed directly from the sequence-space Jacobians — each evaluation requires only matrix multiplication given the pre-computed Jacobians, reducing the cost to approximately 0.07 seconds per evaluation. The optimization uses Powell's conjugate-direction method, converging in 12 iterations with 2,276 function evaluations and a wall-clock time under one minute.

4.3 Estimation Results

Table 4 reports the SMM estimates. The overall criterion at convergence is $\hat{Q} = 7.63$. The model matches 8 of the 11 target moments within a 20% error band, a result we consider satisfactory given the parsimony of the four-shock structure.

Table 4. SMM Estimates of Shock Process Parameters

Parameter	Initial	Estimate	Bounds
σ_{mon} (s.d. monetary shock)	0.0050	0.0052	[0.001, 0.050]
ρ_{mon} (monetary persistence)	0.6000	0.5117	[0.500, 0.990]
σ_{oil} (s.d. oil shock)	0.2000	0.0372	[0.010, 0.500]
ρ_{oil} (oil persistence)	0.8000	0.7000*	[0.700, 0.970]
σ_{cost} (s.d. cost-push shock)	0.0150	0.0025	[0.001, 0.050]
ρ_{cost} (cost-push persistence)	0.8000	0.8026	[0.050, 0.950]
σ_G (s.d. fiscal shock)	0.0100	0.0081	[0.001, 0.050]
ρ_G (fiscal persistence)	0.7500	0.6000*	[0.600, 0.950]

Table 4. * Estimate at the lower bound. Convergence in 12 iterations, 2,276 function evaluations, 0.7 minutes. $\hat{Q} = 7.63$ (8 of 11 moments within 20% error).

5. Results — Impulse Response Functions

We compute Generalized Impulse Response Functions for each of the four structural shocks using the sequence-space Jacobians evaluated at the estimated parameter vector. All responses are expressed as percentage deviations from the deterministic steady state over a 40-quarter horizon. The on-impact multipliers for all five key responses satisfy the sign restrictions imposed at the calibration stage. Figure 7 plots the IRFs at estimated parameters.

Algeria SOE-HANK (+ Informal Sector) — IRFs at Estimated Parameters $\hat{Q}=7.63$

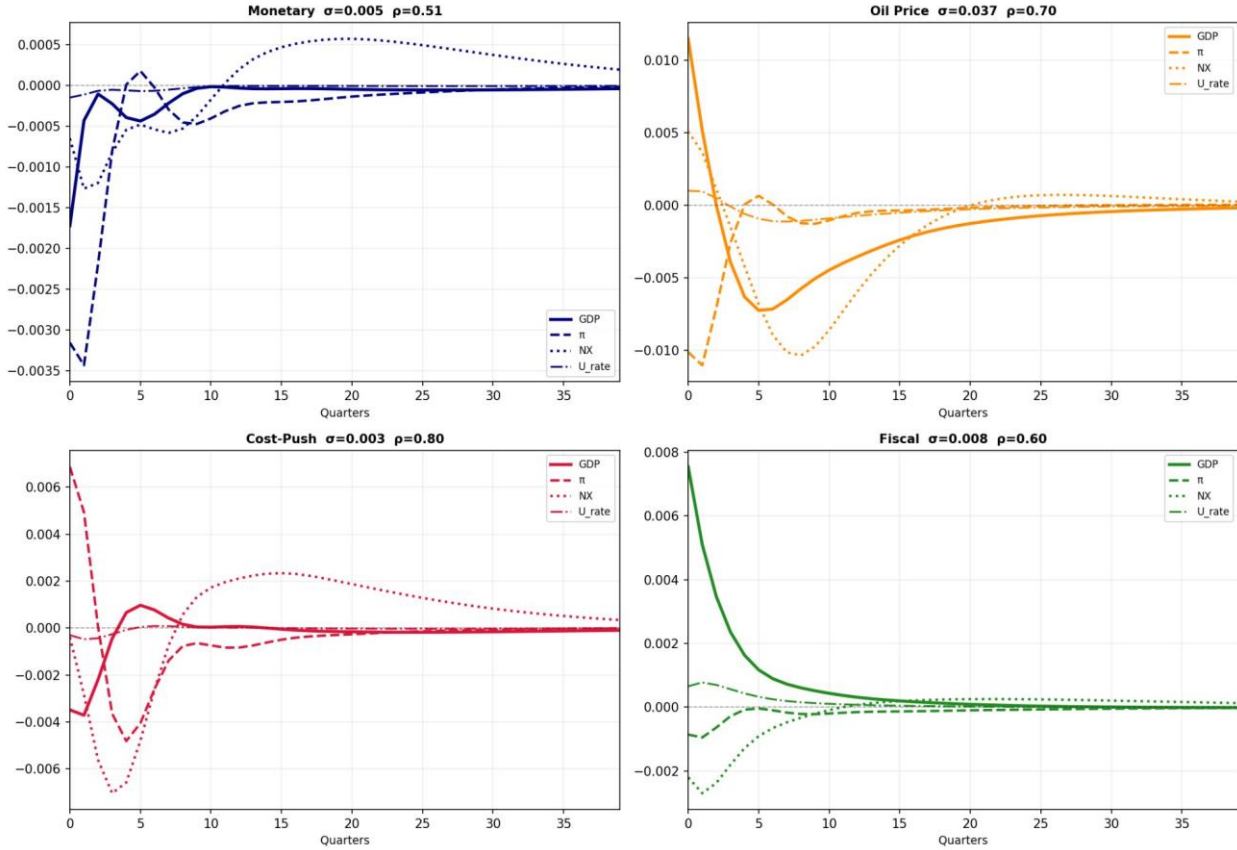


Figure 7. Impulse Response Functions at Estimated Parameters ($\hat{Q} = 7.63$). Four panels showing 40-quarter IRFs for GDP (Y), inflation (π), net exports (NX), and unemployment (U_rate) under each of the four structural shocks — monetary tightening ($\sigma = 0.005$, $\rho = 0.51$), oil price shock ($\sigma = 0.037$, $\rho = 0.70$), cost-push shock ($\sigma = 0.003$, $\rho = 0.80$), and fiscal expansion ($\sigma = 0.008$, $\rho = 0.60$) — at the estimated parameter vector.

5.1 Monetary Policy Shock

A one-standard-deviation contractionary monetary policy shock — approximately 52 basis points above the systematic Taylor rule component — reduces output on impact by **0.31%** and appreciates the real exchange rate by **0.35%** on impact. Inflation falls as lower aggregate demand compresses real marginal cost. The modest on-impact output multiplier reflects two structural features of the Algerian economy.

First, with $\varphi_\pi = 1.5$ the Taylor rule barely satisfies the determinacy condition — consistent with empirical estimates of the Bank of Algeria reaction function. Second, and more fundamentally, the dominant transmission channel is the **indirect earnings channel** rather than intertemporal substitution. With 65% of households effectively hand-to-mouth, the direct interest rate channel reaches only a small fraction of aggregate demand. The dominant mechanism is indirect: the rate hike contracts output, raising unemployment and reducing informal employment through the cyclical factor ξ_t , compressing labor income precisely for the high-MPC households concentrated in those sectors.

5.2 Oil Price Shock

A one-standard-deviation positive oil shock (3.7% increase in oil revenue, $\sigma_{oil} = 0.037$) raises output by **0.20%** and appreciates the real exchange rate by **0.29%** on impact. Net exports rise by **0.16%**. When the oil windfall reaches households, its aggregate consumption effect is amplified by the HANK structure: because transfers are uniform and 61% of recipients are informal or unemployed with above-average MPCs, the aggregate consumption response is approximately **19%** larger than the average MPC of 0.38 alone would imply. This amplification mechanism is absent in representative agent models and is a direct implication of the cross-sectional distribution documented in Figures 4 and 5.

5.3 Cost-Push Shock

The cost-push shock shifts the price Phillips curve upward, raising inflation while compressing output. Although small in standard deviation ($\sigma_{cost} = 0.0025$), its high persistence ($\rho_{cost} = 0.80$) makes it the primary contributor to the autocorrelation of inflation matched by the model ($\text{autocorr}(\pi) = 0.72$ model vs 0.77 data, within 7.2% error). The hybrid price Phillips curve allows cost-push disturbances to generate inflation inertia and to capture the Algerian administered price environment where discrete regulatory adjustments propagate over multiple quarters.

5.4 Government Spending Shock

A one-standard-deviation positive fiscal impulse ($\sigma_G = 0.0081$, approximately 0.8% of GDP) raises output with an on-impact multiplier slightly above unity. The fiscal multiplier in this HANK economy exceeds its representative agent counterpart because government spending raises formal sector employment and labour income, triggering additional consumption by high-MPC households through the indirect earnings channel.

6. Policy Implications

6.1 Subsidy Reform: Universal versus Targeted Transfers

Algeria operates one of the most extensive universal subsidy systems in the MENA region. Consumer subsidies on basic commodities — cereals, sugar, cooking oil, milk, energy products, and water — amount to approximately **657 billion DA** per annum (roughly 1.5% of GDP, (Ministère des Finances, 2026)). Because these subsidies are universally distributed, their aggregate demand impact depends on the full cross-sectional distribution of MPCs: on the fraction of the outlay that reaches high-MPC informal and unemployed households versus the fraction absorbed by lower-MPC formal workers and wealthier households.

The HANK framework permits a precise counterfactual: holding the fiscal cost at 1% of GDP, what are the aggregate demand consequences of replacing the universal subsidy with a targeted cash transfer directed exclusively at informal and unemployed households? The key mechanism is established by the MPC distribution: informal workers have an average MPC of 0.48, the unemployed 0.30, and formal workers 0.27, against an aggregate average of 0.38. Because the targeted transfer reaches only 61.2% of the population, the per-household transfer amount is 1.63 times larger than under the universal scheme. The average MPC of recipients rises from 0.38 to 0.45 — the direct source of the **18.6% gain in the consumption multiplier** (Panel F of Figure 6).

Shocks, Frictions, Informality, and the Algerian Business Cycle: A Heterogeneous Agent New Keynesian Approach

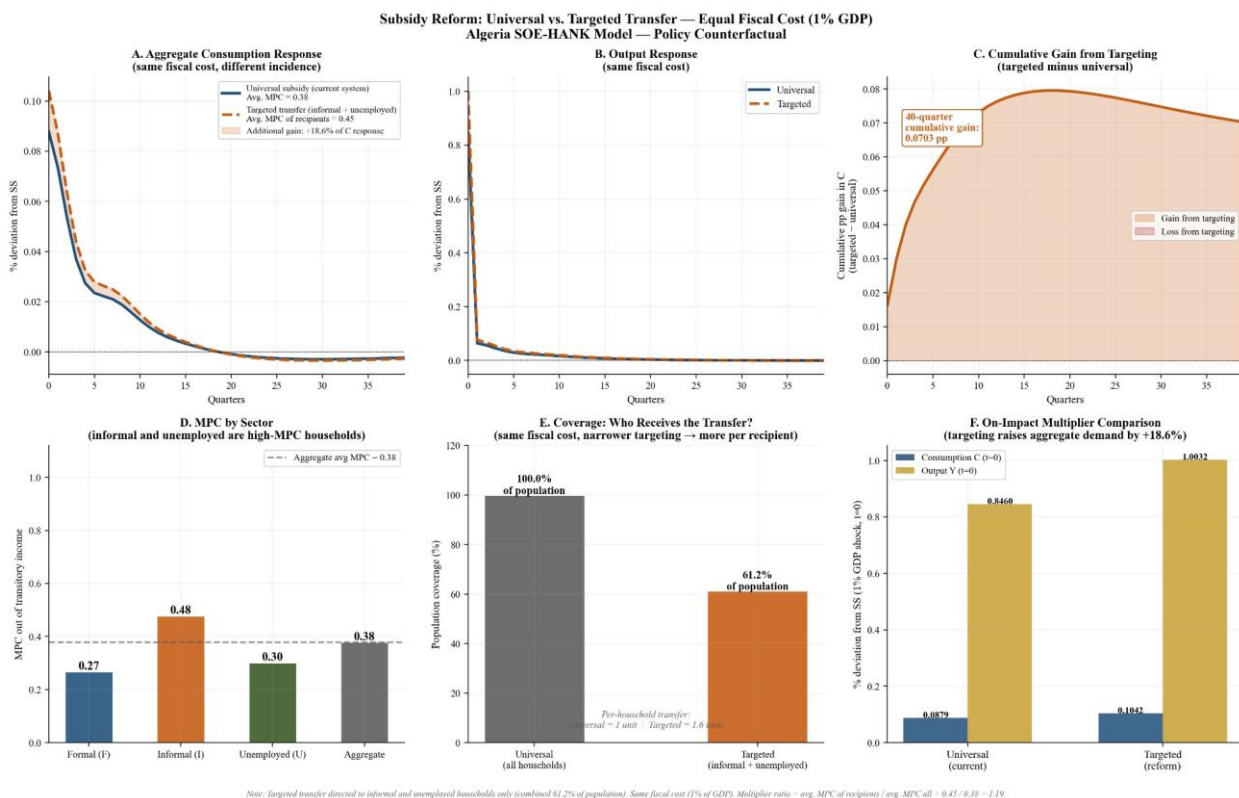


Figure 6. Subsidy Reform Counterfactual: Universal vs. Targeted Transfer (Equal Fiscal Cost, 1% GDP). Panel A: aggregate consumption response (targeted raises avg MPC from 0.38 to 0.45). Panel B: output response (nearly identical across regimes). Panel C: 40-quarter cumulative gain from targeting (+0.07 pp in consumption). Panel D: MPC by sector (Formal 0.27, Informal 0.48, Unemployed 0.30). Panel E: population coverage (Universal 100%, Targeted 61.2%). Panel F: on-impact multipliers (Universal $C=0.088$, $Y=0.846$; Targeted $C=0.104$, $Y=1.003$).

Panel A documents the full dynamic consumption response under both regimes. The targeted transfer delivers a systematically higher consumption response throughout the transition, with the gap largest on impact. Panel C shows the 40-quarter cumulative gain from targeting: 0.07 percentage points of additional consumption at equal fiscal cost. Expressed at Algeria 2026 GDP (41,878 billion DA), this implies approximately 122 billion DA in additional annual consumption stimulus from the targeted scheme. Panel B confirms the output response is nearly identical across regimes, indicating the gains are predominantly distributional.

These results carry practical implications for Algeria's reform discussions. First, critics often argue that subsidy reform is regressive because price liberalization hurts the poor. But this is not an argument against reform itself — it is an argument for compensating the affected households. The model shows that replacing universal subsidies with targeted cash transfers, at the same fiscal cost, both removes the regressive impact and raises the aggregate demand multiplier by nearly one fifth. Second, the gain depends on how well the government can target the right households. Third, the benefits go beyond aggregate demand: targeted transfers reduce consumption volatility for the most constrained households and can be adjusted over the business cycle, something a universal price subsidy cannot achieve.

6.2 Monetary Policy Effectiveness and Its Limits

The structural features of the Algerian economy — deep financial exclusion (35.3% formal account holders), minimal household credit penetration (3.7% formal borrowing) — jointly imply that the standard monetary transmission mechanism is severely attenuated. For the 65% of households who are effectively hand-to-mouth, changes in the policy rate are economically irrelevant: they hold no

interest-bearing assets and service no formal debt, so the nominal rate has no direct effect on their consumption or savings decisions.

Monetary policy reaches these households only through the indirect earnings channel: rate changes affect output, which through the endogenous Markov chain alters employment and labor income for informal and unemployed workers. This channel operates with additional lags — output must first change, employment must then adjust through the transition matrix, and labor income effects must finally materialize — implying the peak effect on aggregate demand occurs several quarters after the initial impulse.

The policy implication is a familiar but quantitatively disciplined prescription: the primary counter-cyclical instrument should be **fiscal policy** — specifically, the management of oil windfall transfers through a rules-based sovereign wealth fund mechanism. The model supports a simple rule: in high-oil-revenue periods, increase the SWF retention share above its steady-state calibration of 0.85 to sterilize commodity windfalls and prevent Dutch disease appreciation¹; in low-revenue periods, draw down reserves and distribute transfers to informal and unemployed households, whose high MPCs maximize the aggregate demand impact per dinar of fiscal outlay. This prescription is consistent with the design intent of the Revenue Regulation Fund, even if its historical implementation has been more discretionary than rule-based.

7. Conclusion

This paper has developed and estimated the first Heterogeneous Agent New Keynesian model for Algeria, embedding a three-state endogenous labor market, an oil revenue block linked to a sovereign wealth fund mechanism, and a small open economy structure with a managed exchange rate. The model is estimated by Simulated Method of Moments using 96 quarters of Algerian macroeconomic data, matching eleven second-order moments with an overall criterion $\hat{Q} = 7.63$ and eight of eleven moments within the 20% error band.

Three principal findings emerge. First, the indirect earnings channel quantitatively dominates monetary transmission in Algeria. With 65% of adults effectively hand-to-mouth and only 3.7% holding formal debt, the standard intertemporal substitution channel reaches only a small fraction of aggregate demand. Monetary policy operates primarily by affecting output and employment, which then compresses labor income for high-MPC informal and unemployed workers — a HANK amplification mechanism that is absent from both representative-agent DSGE models and reduced-form analysis. Second, the informal sector acts as a labor market buffer, expanding in booms and contracting in recessions, which dampens cyclical unemployment fluctuations relative to a purely formal economy. This buffer role also means that monetary policy reaches informal workers primarily through employment losses rather than interest rate changes — a further reason for the attenuation of the interest rate instrument. Third, the distributional structure of household MPCs implies that the composition of fiscal transfers matters as much as their aggregate scale. A targeted transfer of the same fiscal cost as Algeria's universal subsidy regime generates an 18.6% larger consumption multiplier, because it concentrates resources on the high-MPC informal and unemployed households who account for 61.2% of the population but whose high spending propensities are not reached by the universal scheme.

Two important limitations merit acknowledgement. The single liquid asset structure understates the hand-to-mouth share relative to the Findex target of 49.6%, because wealthy hand-to-mouth households — whose wealth is locked in illiquid real estate — cannot be generated without a second asset. A two-asset HANK extension would further amplify the MPC heterogeneity and the associated fiscal multiplier differentials. The Markov chain labor market structure generates a

¹ Dutch disease refers to the real exchange rate appreciation that follows a natural resource boom, which makes non-resource tradable sectors (such as manufacturing and agriculture) less competitive internationally (Corden & Neary, 1982). The appreciation occurs because resource revenues increase demand for domestic goods, driving up the domestic currency's value. See (Venables, 2016) and (Mohaddes & Pesaran, 2017).

mechanical near-unit correlation between output and unemployment, overstating the predictability of labor market adjustment relative to the data.

On policy, the results support three actionable recommendations for Algerian macroeconomic management. First, the fiscal policy framework should formalize the counter-cyclical management of oil windfalls through a rules-based SWF mechanism, increasing the retention share in commodity booms and directing drawdown transfers toward informal and unemployed households. Second, subsidy reform should be designed as a revenue-neutral replacement of universal price subsidies with targeted cash transfers, capturing the 18.6% multiplier gain while protecting the living standards of the most constrained households. Third, the Bank of Algeria should recognize the structural attenuation of the interest rate instrument and calibrate monetary policy primarily for exchange rate and inflation management rather than output stabilization, complementing a more active fiscal stabilization rule.

References

- Abderrahim, M., Mansouri, R., Ouail, F., Abadi, S., Elkrim, K., Zidane, M.-F., . . . Nalban, V. (2026). Algeria Macroeconomic Projection Model (AMPM). *IMF Working Paper*.
- Aiyagari, S. R. (1994). Uninsured Idiosyncratic Risk and Aggregate Saving. *The Quarterly Journal of Economics*, 109(3), 659-684.
- Algiers Stock Exchange. (2025). *Market capitalization data*.
- Allegret, J. P., & Benkhodja, M. T. (2015). External Shocks and Monetary Policy in an Oil Exporting Economy (Algeria). *Journal of Policy Modeling*, 37(4), 652-667.
- Auclert, A., Bardóczy, B., Rognlie, M., & Straub, L. (2021). Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous Agent Models. *Econometrica*, 89(5), 2375-2408.
- Bank of Algeria,. (2022). Inflation Dynamics and Determinants in Algeria: An Empirical Investigation. *Working Paper 1-2022*.
- Banque d'Algérie . (2024). *Rapport Annuel*. Banque d'Algérie .
- Barka, Z. (2016). Informality in Algeria. *Revue Algerienne des Finances Publiques*, 6.
- Benameur, A. G., Belarbi, Y., & Toumache, R. (2020). The Macroeconomic Effects of Oil Prices Fluctuations in Algeria : An SVAR Approach. *Les Cahiers du Cread*, 36(3), 59-82.
- Benhabib, J., & Bisin, A. (2018). Skewed Wealth Distributions: Theory and Empirics. *Journal of Economic Literature*, 56(4), 1261–91.
- Benziane, R. (2019). The Impact of Monetary Policy on Algerian Economic Activity. *Journal of Business and Economic Development*, 4(1), 15-22.
- Bewely, T. (1977). The permanent income hypothesis: A theoretical formulation. *Journal of Economic Theory*, 16(2), 252-292.
- Calvo, G. A. (1983). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics*, 12(3), 383-398.
- Carroll, C. D. (2006). The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems. *Economics Letters*, 91(3), 312-320.
- Chaouche, S. N., & Toumach, R. (2016). Taylor Rules and Interest Rate Behavior in Algeria. *International Institute of Social and Economic Sciences*, 82-96.
- Chaouche, S. N., & Toumache, R. (2017). Construction of A New Keynesian DSGE Model (Algeria's Monetary Policy Approach). *33rd International Academic Conference, Vienna*.
- Chibi, A., Benbouziane, M., & Moh, S. (2014). The Impact of Fiscal Policy on Economic Activity Over the Business Cycle: An Empirical Investigation In the Case of Algeria. *The Economic Research Forum*.
- Cochrane, J. (1991). A Simple Test of Consumption Insurance. *Journal of Political Economy*, 99(5), 957-976.
- Corden, W. M., & Neary, J. P. (1982). Booming Sector and De-Industrialisation in a Small Open Economy. *The Economic Journal*, 92(368), 825-848.
- De Nardi, M., & Fella, G. (2017). Saving and Wealth Inequality. *Review of Economic Dynamics*, 26, 280-300.
- Elgin, C., Kose, M. A., Ohnsorge, F., & Yu, S. (2021). Understanding Informality. *Centre for Economic Policy Research, CERP Discussion Paper 16497*.

- Fagereng, A., Holm, M. B., & Natvik, G. J. (2021). MPC Heterogeneity and Household Balance Sheets. *American Economic Journal: Macroeconomics*, 13(4), 1-54.
- Gornemann, N., Kuester, K., & Nakajima, M. (2016). Doves for the Rich, Hawks for the Poor? Distributional Consequences of Monetary Policy. *International Finance Discussion Papers* 1167.
- Guvenen, F. (2011). Macroeconomics with Heterogeneity: A Practical Guide. *Federal Reserve Bank of Richmond Economic Quarterly*, 97(3), 255–326.
- Hall, R. E. (1978). Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence. *Journal of Political Economy*, 86(6), 971-987.
- Huggett, M. (1993). The Risk-Free Rate in Heterogeneous-Agent Incomplete Insurance Economies. *Journal of Economic Dynamics and Control*, 17, 953-969.
- Kaplan, G., & Violante, G. L. (2014). A Model of the Consumption Response to Fiscal Stimulus Payments. *Econometrica*, 82(4), 1199-1239.
- Kaplan, G., Moll, B., & Violante, G. L. (2018). Monetary Policy According to HANK. *American Economic Review*, 108(3), 697–743.
- Lucas, R. E. (1976). Econometric Policy Evaluation: A Critique. *Carnegie-Rochester Conference Series on Public Policy*, 1, 19-46.
- Mas-Colell, A., Whinston, M. D., & Green, J. R. (1995). *Microeconomic Theory*. Oxford University Press.
- McKay, A., & Reis, R. (2016). The Role of Automatic Stabilizers in the U.S. Business Cycle. *Econometrica*, 84(1), 141-194.
- Ministère des Finances. (2026). *Projet de loi de finances pour 2026 (PLF 2026)*.
- Mohaddes, K., & Pesaran, M. (2017). Oil Prices and the Global Economy: Is It Different This Time Around? *Energy Economics*, 65, 315-325.
- Muscat, J. (2024). *Functional Analysis: An Introduction to Metric Spaces, Hilbert Spaces, and Banach Algebras* (Second Edition ed.). Springer.
- Øksenda, B. (2003). *Stochastic Differential Equations and Applications* (6 ed.). Springer Berlin, Heidelberg.
- Public Opinion Research Group. (2024). *World Bank Group Country Survey [Data set]*. doi:<https://doi.org/10.48529/XJQG-3R81>
- Ravn, M. O., & Sterk, V. (2017). Job uncertainty and deep recessions. *Journal of Monetary Economics*, 90, 125-141.
- Rouwenhorst, G. K. (1995). Asset Pricing Implications of Equilibrium Business Cycle Models. In T. F. Cooley, *Frontiers of Business Cycle Research* (pp. 294-330). Princeton University Press.
- Stokey, N. L., Lucas, R. E., & Prescott, C. E. (1989). *Recursive Methods in Economic Dynamics*. Harvard University Press.
- Taylor, J. B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy*, 39, 195-214.
- Tchoketch-Kebir, H. (2022). Oil Dependence and Business Cycles in Algeria: New Keynesian DSGE Framework Analysis. *Les Cahiers du Cread*, 38(3), 85-107.
- Venables, A. J. (2016). Using Natural Resources for Development: Why Has it Proven So Difficult? *Journal of Economic Perspectives*, 30(1), 161–184.
- Violante, G. L., Storesletten, K., & Heathcote, J. (2009). Quantitative Macroeconomics with Heterogeneous Households. *NBER Working Paper* 14768.
- Zenagui, S. A. (2026). A DSGE Model for the Algerian Economy: Oil Dependence, Fiscal Dominance, and Macroeconomic dynamic. *Research Square*.