

Heterogeneous Agent Kalman-Filtering Framework for Dynamic Fiscal Multiplier Decomposition Under Incomplete Markets and Stochastic Volatility Regimes

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Abstract. This study proposes a structural estimation framework that integrates heterogeneous agent modeling with Kalman-filter-based signal extraction to decompose state-contingent fiscal multipliers under incomplete asset markets and stochastic volatility. Leveraging a Bewley-Huggett-Aiyagari backbone augmented with Markov-switching variance processes, the model disentangles aggregate demand externalities from precautionary saving channels in government expenditure transmission. Using quarterly panel data from eighteen OECD economies spanning 2000–2023, we apply Bayesian sequential Monte Carlo inference to recover latent volatility states and household-level marginal propensities to consume. Empirical results confirm that fiscal multipliers exhibit strong regime-dependency, exceeding unity during high-volatility contractions while remaining sub-unitary in tranquil expansionary phases. These findings carry direct implications for counter-cyclical fiscal consolidation design and sovereign debt sustainability assessments within post-pandemic macroeconomic stabilization frameworks.

Keywords: fiscal multiplier decomposition, heterogeneous agent macroeconomics, stochastic volatility regimes, Bayesian sequential Monte Carlo, incomplete asset markets, Markov-switching variance, marginal propensity to consume, counter-cyclical fiscal policy, DSGE structural estimation

Introduction

The design and empirical evaluation of fiscal policy effectiveness has emerged as one of the most contested and consequential research agendas in contemporary macroeconomics, particularly in the wake of the COVID-19 fiscal expansions, the post-pandemic inflationary surge, and the ensuing sovereign debt pressures confronting both advanced and emerging market economies through 2024–2026. At the core of this debate lies the fiscal multiplier — the ratio of output change to an exogenous unit change in government expenditure — whose magnitude, sign, and temporal persistence remain deeply sensitive to the underlying structural assumptions embedded in macroeconomic models. Traditional representative-agent New Keynesian frameworks, while analytically tractable, systematically suppress the distributional heterogeneity across households that has been demonstrated, both theoretically and empirically, to be a first-order determinant of aggregate demand responses to fiscal interventions. The recognition that households differ fundamentally in their liquidity constraints, portfolio compositions, and marginal propensities to consume has catalyzed a paradigm shift toward heterogeneous agent New Keynesian (HANK) models. However, a critical and underexplored dimension of this literature pertains to the interaction between cross-sectional household heterogeneity and time-varying macroeconomic uncertainty. Stochastic volatility — the empirically documented phenomenon whereby the variance of macroeconomic shocks itself evolves stochastically over time — generates endogenous fluctuations in precautionary saving behavior, asset market participation rates, and the effective transmission elasticity of fiscal impulses. Existing HANK frameworks predominantly treat volatility as constant or as a simple two-state regime switch, thereby underidentifying the full spectrum of nonlinear fiscal transmission mechanisms that are operative during periods of acute financial stress or sovereign market turbulence. This paper addresses this gap by proposing a Heterogeneous Agent Kalman-Filtering (HAKF) framework that embeds a continuous-time stochastic volatility process — estimated via Bayesian sequential Monte Carlo particle filtering — within a Bewley-Huggett-Aiyagari class incomplete-markets model. The Kalman-filter augmentation enables real-time latent state recovery of time-varying volatility regimes from observable macroeconomic panel data, while the heterogeneous agent backbone preserves the distributional mechanics essential for accurate multiplier decomposition. Our identification strategy exploits cross-country variation in automatic stabilizer generosity, public debt-to-GDP ratios, and household net worth distributions across eighteen OECD economies over the 2000–2023 period as instrumental exclusion restrictions in the structural Bayesian estimation. The remainder of the paper is structured as follows. Section 2 reviews the theoretical literature on fiscal multipliers, heterogeneous agent models, and stochastic volatility in macroeconomic systems. Section 3 develops the formal HAKF structural model and derives the fiscal multiplier decomposition identities. Section 4 describes the data sources, panel construction methodology, and econometric identification strategy. Section 5 presents the main empirical results, including regime-contingent

multiplier estimates and robustness diagnostics. Section 6 discusses policy implications for fiscal consolidation design and sovereign debt sustainability. Section 7 concludes with directions for future research.

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