Journal of Economic Perspectives—Volume 32, Number 3—Summer 2018—Pages 167–194

Microeconomic Heterogeneity and Macroeconomic Shocks

Greg Kaplan and Giovanni L. Violante

In this essay, we discuss the emerging literature in macroeconomics that combines heterogeneous agent models, nominal rigidities, and aggregate shocks. This literature opens the door to the analysis of distributional issues, economic fluctuations, and stabilization policies—all within the same framework.

Quantitative macroeconomic models have integrated heterogeneous agents and incomplete markets for nearly three decades, but they have been mainly used for the investigation of consumption and saving behavior, inequality, redistributive policies, economic mobility, and other cross-sectional phenomena. Representative agent models have remained the benchmark in the study of aggregate fluctuations (for reasons we will discuss later). However, the Great Recession bluntly exposed the shortcomings of a representative-agent approach to business cycle analysis. A broadly shared interpretation of the Great Recession places its origins in housing and credit markets. The collapse in house prices affected households differently, depending on the composition of their balance sheets. The extent to which this

■ *Greg Kaplan is Professor of Economics, University of Chicago, Chicago, Illinois; Research Fellow, Institute for Fiscal Studies, London, United Kingdom; and Research Associate, National Bureau of Economic Research, Cambridge, Massachusetts. Giovanni L. Violante is Professor of Economics at Princeton University, Princeton, New Jersey; Research Fellow, Centre for Economic Policy Research, London, United Kingdom; International Research Fellow, Institute for Fiscal Studies, London, United Kingdom; Research Fellow, Institute of Labor Economics (IZA), Bonn, Germany; and Research Associate, National Bureau of Economic Research, Cambridge, Massachusetts. Their email addresses are gkaplan@uchicago.edu and violante@princeton.edu.*

† For supplementary materials such as appendices, datasets, and author disclosure statements, see the article page at
https://doi.org/10.1257/jep.32.3.167 doi=10.1257/jep.32.3.167

wealth destruction translated into a fall in expenditures was determined by marginal propensities to consume, which are also very heterogeneous and closely related to households' access to liquidity (Mian, Rao, and Su 2013; Kaplan, Violante, and Weidner 2014). Finally, this drop in aggregate consumer demand and the contemporaneous breakdown in bank lending to businesses (as explained by Gertler and Gilchrist in this issue) resulted in a severe contraction of labor demand which materialized unevenly across different occupations and skill levels. All this took place against the backdrop of a secular rise in income and wealth inequality.

Thus, portfolio composition, credit, liquidity, marginal propensities to consume, unemployment risk, and inequality were all central to the unfolding of the Great Recession. Yet these are all issues that one cannot discuss in a representative agent model (at least not without trivializing them). Indeed, the need for macroeconomists to move beyond the representative agent fiction in business cycle analysis was also emphasized by a number of high officials and governors of central banks in speeches delivered after the crisis, including Janet Yellen (2016) of the US Federal Reserve, Vitor Costancio (2017) of the European Central Bank, and Haruiko Kuroda (2017) of the Bank of Japan.

In response to these limitations of the representative agent approach to economic fluctuations, a new framework has emerged that combines key features of heterogeneous agents (HA) and New Keynesian (NK) economies. These HANK models offer a much more accurate representation of household consumption behavior and can generate realistic distributions of income, wealth, and, albeit to a lesser degree, household balance sheets. At the same time, they can accommodate many sources of macroeconomic fluctuations, including those driven by aggregate demand. In sum, they provide a rich theoretical framework for quantitative analysis of the interaction between cross-sectional distributions and aggregate dynamics.

In this article, we outline a state-of-the-art version of HANK based on Kaplan, Moll, and Violante (2018), together with its representative agent counterpart. We use this HANK model, calibrated to the US economy, to convey two broad messages about the role of household heterogeneity for the response of the macroeconomy to aggregate shocks.

The first message is that the similarity between the Representative Agent New Keynesian (RANK) and HANK frameworks depends crucially on the shock being analyzed. We illustrate this point through a series of examples. In response to a demand shock arising from a change in household discount factors, HANK and RANK generate the same aggregate dynamics through largely the same economic mechanisms. In response to a technology shock, the two models also generate similar aggregate dynamics but through different economic mechanisms. And following fiscal and monetary policy shocks, the two models generate different aggregate responses. These discrepancies can be traced to the fact that household consumption is more sensitive to income and less sensitive to interest rates in heterogeneous agent models than in representative agent models.

We then turn to our second message: certain important macroeconomic questions concerning economic fluctuations can only be addressed within heterogeneous agent models. To make this point, we look at how, in HANK models, aggregate demand shocks can have a proper microfoundation: for example, through unexpected changes in borrowing capacity or in uninsurable income risk. We also show how one can learn about the source and transmission mechanism of aggregate shocks by examining how they impact households at different parts of the wealth distribution. Finally, we illustrate how HANK models can be used to understand the effect of aggregate shocks and stabilization policies on household inequality.

We conclude by suggesting several broad directions for the future development of HANK models. Throughout this article, we focus on *household* heterogeneity, so when we use the term "agents" we refer to "households." There is a parallel literature on firm heterogeneity and aggregate dynamics, which deserves its own separate treatment.[1] Here, it suffices to say that many of the points we make on the role of heterogeneity apply to that literature as well.

Heterogeneity and Business Cycles in Macroeconomics, So Far

Macroeconomics is about general equilibrium analysis. Dealing with distributions while at the same time respecting the aggregate consistency dictated by equilibrium conditions can be extremely challenging. This explains why in the 1970s, when the path-breaking work of James Heckman and Daniel McFadden was paving the way for a rich treatment of cross-sectional heterogeneity in microeconometrics, the focus in macroeconomics was on developing models where aggregate outcomes would not depend on distributions. At that time, James Tobin famously defined macroeconomics as a subject that attains workable approximations by ignoring effects on aggregates of distributions of wealth and income (Sargent 2015). Heterogeneity was neutralized by assuming either identical initial conditions right off-the-bat, or special preference specifications (through Gorman aggregation), or complete markets (through Negishi aggregation).

Heterogeneous agent incomplete-markets models with nontrivial distributions of households appeared in the mid 1980s. Ljungqvist and Sargent (2004) baptized this class of models "Bewley models" because Truman Bewley (1983) was the first to explore the equilibrium properties of these economies. Throughout the 1990s, the seminal work of Imrohoroğlu (1989), Huggett (1993), Aiyagari (1994), and Ríos-Rull (1995), among others, laid the foundations for a new workhorse of quantitative macroeconomics that expanded the Bewley model and recast it in the recursive language developed by Robert Lucas, Edward Prescott, Thomas Sargent, and Nancy Stokey, among others. To quote from Aiyagari (1994, p. 1), its distinctive feature was that "aggregate behavior is the result of market interaction among a large number

[1] For example, see Caballero (1999) and Khan and Thomas (2008) for the debate on how firm-level nonconvex adjustment costs influence aggregate investment and Gertler and Gilchrist (1994) and Ottonello and Winberry (2018) for the debate on how firm-level financial constraints affect the transmission of monetary policy.

of agents subject to idiosyncratic shocks. ... This contrasts with representative agent models where individual dynamics ... coincide with aggregate dynamics ...”

This framework combines two building blocks. On the production side, a representative firm with a neoclassical production function rents capital and labor from households to produce a final good. On the household side, a continuum of agents each solve their own income fluctuation problem—the problem of how to smooth consumption when income is subject to random shocks and the only available financial instrument is saving (and possibly limited borrowing) in a risk-free asset (for example, Schechtman 1976). The equilibrium real interest rate is determined by equating households’ supply of savings to firms’ demand for capital.

The main motivation for modeling consumer behavior along these lines was the rapidly mounting empirical evidence, based on longitudinal household survey data, that most households fail in their efforts to perfectly smooth consumption (Hall 1978; Cochrane 1991; Attanasio and Davis 1996), a finding that time has only reinforced. Heterogeneous agent models allowed investigation of imperfect consumption insurance—its extent, reasons, and effects for the macroeconomy.

Reading through the recent surveys of this literature (for example, Heathcote, Storesletten, and Violante 2009; Guvenen 2011; Quadrini and Ríos-Rull 2015; Benhabib and Bisin forthcoming; De Nardi and Fella 2017), one is struck by the fact that while heterogeneous agent models have been routinely used to study questions pertaining to income and wealth inequality, redistribution, economic mobility, and tax reforms, until recently they had not been much used to study business cycles. The reason, we think, is twofold: computational complexity and a result known as “approximate aggregation.”

Computational complexity arises because in the recursive formulation of heterogeneous agent models with aggregate shocks, households require a lot of information in order to solve their dynamic optimization problems: each household must not only know its own place in the cross-sectional distribution of income and wealth, but must also understand the equilibrium law of motion for the entire wealth distribution. Under rational expectations, this law of motion is an endogenous equilibrium object, and solving for it is a computationally intensive process.

The first to successfully tackle this challenge were Krusell and Smith (1998), who pioneered the most well-known method and applied it to a simple heterogeneous agent economy with aggregate technology shocks. Despite recent advances in computing power and numerical methods, applying their method to the most interesting versions of heterogeneous agent economies remains challenging. In recent years, several new computational methods have been proposed that have widened the set of models that can be accurately solved. These include mixtures of projection and perturbation (Reiter 2009), mixtures of finite difference methods and perturbation (Ahn, Kaplan, Moll, Winberry, and Wolf 2017), adaptive sparse grids (Brumm and Scheidegger 2017), polynomial chaos expansions (Pröhl 2017), machine learning (Duarte 2018; Fernández-Villaverde, Hurtado, and Nuño 2018), and linearization with impulse-response functions (Boppart, Krussel, and Mitman 2017). Which of these, or other, methods will ultimately prevail is an open question.

The "approximate aggregation" result, uncovered by Krusell and Smith (1998), states that in many heterogeneous agent models, the mean of the equilibrium wealth distribution is sufficient to forecast all relevant future prices. The underlying logic is compelling: what matters for the aggregate dynamics of interest rates are the actions of households who hold the bulk of the wealth in the economy. Those rich households are well-insured against fluctuations and have saving functions that are approximately linear in wealth. Households that are close to the borrowing constraint, where the saving functions have curvature, are largely irrelevant in terms of their contribution to the aggregate capital stock and consumption. Krusell and Smith showed that in a benchmark version of the heterogeneous agent model, the aggregate dynamics of output, consumption, and investment in response to a shock to total factor productivity are almost identical to their counterpart representative agent model.

Approximate aggregation has proved surprisingly robust over time and has led many economists to conclude that aggregate dynamics in representative and heterogeneous agent models are essentially equivalent. As we show in this article, this interpretation of the original Krusell–Smith insight is inaccurate. Because of this misunderstanding, deviating from the representative agent approach was perceived by much of the profession as incurring a high computational cost for only little benefit. As a consequence, quantitative heterogeneous agent models rarely crossed paths with the study of business cycles.

The Great Recession put consumption, income, and wealth distributions back at the center stage of business cycles analysis and undermined this perception. Economists began to realize that two critical ingredients were needed for a coherent analysis of fluctuations and stabilization policy: 1) household heterogeneity; and 2) a framework that can accommodate aggregate demand shortfalls. In response, a number of macro researchers chose to address this gap in the most natural way: by combining key features of heterogeneous agent models and New Keynesian models.

Heterogeneous Agent New Keynesian (HANK) Models

In this section, we first argue that modeling household heterogeneity is important, by itself and in conjunction with nominal rigidities. Next, we discuss some early applications of HANK models. Finally, we outline this new framework in detail, setting the stage for the second part of our article where we contrast HANK and RANK models.

Heterogeneity is Key for Matching Facts about Consumption Behavior

Consumption behavior in representative agent models is inconsistent with empirical evidence. A representative household is essentially a permanent-income consumer facing an intertemporal budget constraint. As such, its consumption is extremely responsive to changes in current and future interest rates but barely responds to transitory changes in income.

The high sensitivity of consumption to interest rates is not well supported by macro or micro data. Analyses using aggregate time-series data typically find that, after controlling for aggregate income, consumption is not very responsive to changes in interest rates (Deaton 1987; Campbell and Mankiw 1989; Yogo 2004; Canzoneri, Cumby, and Diba 2007). A number of studies reveal that both the sign and size of the effect of changes in interest rates on consumption depend on households' net asset positions (Flodén, Kilström, Sigurdsson, and Vestman 2016; Cloyne, Ferreira, and Surico 2016). Empirical analyses using micro data on household portfolios also conclude that a sizable fraction of households (around one-third in the United States) hold close to zero liquid wealth or are near their borrowing limits (Kaplan, Violante, and Weidner 2014). Empirically, these households do not react to movements in interest rates (Vissing-Jørgensen 2002).

The implication from a representative agent model that consumption is insensitive to transitory income shocks is also inconsistent with the vast micro empirical literature surveyed by Jappelli and Pistaferri (2010). This literature has employed three approaches to identify exogenous income shocks. The first approach seeks quasi-experimental settings where natural variation generates randomness in either the receipt, amount, or timing of gains or losses. Examples include firm-level shocks, unemployment due to plant closings, stimulus payments and lottery winnings (for example, Browning and Crossley 2001; Johnson, Parker, and Souleles 2006; Broda and Parker 2014; Misra and Surico 2014; Fagereng, Holm, and Natvik 2016; Baker forthcoming). The second approach extracts the consumption response to the transitory component of regular income fluctuations by assuming a particular statistical process for income and exploiting assumptions about how income and consumption should co-vary (for example, Blundell, Pistaferri, and Preston 2008; Heathcote, Storesletten, and Violante 2014; Kaplan, Violante, and Weidner 2014). The third approach uses survey questions that ask respondents about how their expenditures would change in response to actual or hypothetical changes in their budgets (for example, Shapiro and Slemrod 2003; Christelis, Georgarakos, Jappelli, Pistaferri, and van Rooij 2017; Fuster, Kaplan, and Zafar 2018).

This collective body of evidence on marginal propensities to consume (MPCs) points towards: 1) sizable average MPCs out of small, unanticipated, transitory income changes; 2) larger MPCs for negative than for positive income shocks; 3) small MPCs in response to announcements about future income gains; and 4) substantial heterogeneity in MPCs that is correlated with access to liquidity. None of these four features are in line with the consumption behavior in representative agent models.

Heterogeneous agent models with incomplete markets can, instead, reproduce many of these aspects of consumption behavior. Households who are at a kink in their budget sets (generated, for example, by a borrowing limit or by a wedge between interest rates on liquid savings and unsecured borrowing) have high MPC out of transitory income shocks and do not respond to small changes in interest rates. For households who are close to a kink, exposure to uninsurable income risk raises the possibility of hitting the kink in the future, which shortens their effective time horizon, dampens the intertemporal substitution channel and raises their MPC (Carroll 1997). For all other households, a fall in real rates leads to an increase in expenditures through intertemporal substitution, but there is also a counteracting income effect that can be especially strong for wealthy households.

Heterogeneity Restores Keynesian Insights into the New Keynesian Model

During the last couple of decades, the New Keynesian model has become the reference paradigm for economists working for central banks and governments who needed a micro-founded framework to think about the aggregate and welfare effects of fiscal and monetary policy interventions (Clarida, Gali, and Gertler 1999; Woodford 2003). In a New Keynesian model, monopolistically competitive firms produce differentiated goods and face costs of adjusting prices. Because prices are sticky in the short-run, money supply can affect aggregate demand and monetary policy can have real effects. Over time, this research program has given rise to large-scale models that can accommodate multiple real and nominal aggregate shocks.

However, since the baseline New Keynesian model employs a representative agent, its implied consumption dynamics feature strong intertemporal substitution and weak income sensitivity. Thus, somewhat paradoxically and in spite of its name, the mechanism by which aggregate demand affects aggregate output in the standard New Keynesian model differs markedly from the ideas typically associated with John Maynard Keynes (namely, the equilibrium spending multiplier). For these reasons, Cochrane (2015) has suggested that it would be more appropriate to call this model the "sticky-price intertemporal substitution model."

Relative to the representative agent version, the heterogeneous agent version of the New Keynesian model has a higher average MPC, a more realistic distribution of MPCs, and a lower sensitivity to interest rates, which makes the general equilibrium effects of aggregate demand fluctuations much more salient in the heterogeneous agent version.

HANK: Early Examples

The first examples of heterogeneous agent New Keynesian models appeared in the immediate wake of the Great Recession. These models were designed to address the origins of the crisis, its propagation, and the observed policy responses, all aspects in which household heterogeneity in terms of income, wealth, and balance sheets plays a central role. Oh and Reis (2012) study the extent to which fiscal stimulus in the form of targeted transfers to households alleviated the costs of the recession. Guerrieri and Lorenzoni (2017) examine the impact of a tightening of household borrowing constraints on aggregate demand and output. McKay and Reis (2016) investigate the role of automatic stabilizers in dampening macroeconomic fluctuations when monetary policy is active and when it is constrained by the zero lower bound. Similarly, Krueger, Mitman, and Peri (2016) examine the effectiveness of unemployment insurance in mitigating the fall in aggregate expenditures during the crisis. McKay, Nakamura, and Steinsson (2016) and Werning (2015) study the effectiveness of various forms of monetary policy including forward guidance, an instrument used by central banks to stimulate aggregate demand when the zero lower bound is binding. We also study this in Kaplan, Moll, and Violante (2016). Den Haan, Rendahl, and Riegler (2017) and Bayer, Lütticke, Pham-Dao, and Tjaden (2017) argue that the precautionary saving response to an increase in labor market risk causes households to substitute away from consumption expenditures into nonproductive, safe assets (such as government bonds), which can trigger a demand-driven recession.

These models differ in many important details, but they are all HANK models: they combine New Keynesian-style nominal rigidities with household heterogeneity and market incompleteness.

HANK: Central Elements

In the remainder of the paper, we focus on a version of HANK we developed with Benjamin Moll (Kaplan, Moll, and Violante 2018).[2] This formulation is distinctive in that it allows households to hold two assets: 1) a low-return liquid asset that represents holdings of cash, bank accounts, and government bonds, and 2) a high-return illiquid asset that is subject to a transaction cost and represents equities (which are mostly held in not-so-liquid retirement accounts), privately-owned businesses, and housing net worth. The household block of the model is based on Kaplan and Violante (2014). Households make decisions about labor supply, consumption, and savings. They face idiosyncratic labor productivity risk, which together with incomplete markets generate a precautionary saving motive.

Households can borrow in liquid assets up to an exogenous limit at an interest rate that is higher than the interest rate on liquid saving. We interpret this spread as an exogenous cost of financial intermediation. Inflows into liquid assets are after-tax labor earnings, interest payments on liquid assets, and lump-sum government transfers. Outflows from liquid assets are net deposits into the illiquid account, transaction costs, and consumption expenditures. Illiquid assets increase due to interest payments plus net deposits.

A trade-off between the two assets emerges endogenously. The low-return asset is ideal for consumption-smoothing (because of its liquidity properties), whereas the illiquid asset is preferred for long-term wealth accumulation (because of its high return).

The firm block of the model consists of a representative final-good producer that purchases a continuum of intermediate-goods in monopolistically competitive markets. The intermediate goods require capital and labor, which are rented from households in competitive input markets. Intermediate producers set prices to maximize their profits subject to convex costs of changing their price (as in Rotemberg 1982), which makes the price-level sticky. The illiquid asset held by households

[2] Here we provide only an intuitive description of the most important components of the model. In a companion working paper version, Kaplan and Violante (2018), we provide a more detailed description of the model, full details of computations presented in the following sections, and a number of additional analyses.

consists of both capital and shares that are claims to the equity of an aggregate portfolio of intermediate firms.[3]

The government raises revenue through a proportional tax on labor income. It uses the revenue to finance purchases of final goods, to pay lump-sum transfers to households, and to pay interest on its outstanding real debt. Through debt issuance, the government is the only provider of liquid assets in the economy. The monetary authority sets the nominal interest rate on liquid assets in accordance with a Taylor rule dictating that nominal rates rise when inflation rises, and fall when inflation falls.

The three equilibrium prices in this economy (the wage along with the returns on the liquid and illiquid assets) are determined by relevant market clearing conditions. In equilibrium, the return on illiquid assets is higher than the return on liquid assets in order to compensate households for the costs of transacting in the illiquid asset.

Several modeling choices that are inconsequential in RANK models can matter tremendously for the behavior of HANK models. In HANK, because of borrowing constraints and heterogeneity in marginal propensities to consume, both the timing and distribution of the fiscal transfers that are needed to balance the government budget constraint in the wake of a shock will matter. In RANK, because of Ricardian equivalence, the choice of fiscal rule does not matter. Similarly, the distribution of claims to firm profits, both across households and between liquid and illiquid assets, matters in HANK, whereas in RANK, profits are simply rebated to the representative household.[4] This also implies that in RANK models there is a unique stochastic discount factor for firms to use when setting prices, but in HANK models there is no unique discount factor. Also, in HANK, an assumption is needed about the extent to which fluctuations in labor demand are concentrated among different households, whereas in RANK no such assumption is necessary. Finally, because of the precautionary saving motive and occasionally binding borrowing constraint, in HANK the cyclicality of idiosyncratic uncertainty and access to liquidity are important determinants of the effects of aggregate shocks to household consumption (Acharya and Dogra 2018).

On the one hand, the sensitivity of HANK to these assumptions complicates the analysis and highlights important areas where micro data must be confronted. On the other hand, the assumptions about all these issues implicit in RANK models have little empirical support.[5]

Role of the Two Assets for Consumption Behavior

Virtually all of the existing HANK literature uses models with a single asset. However, we adopt the two-asset model because it is more successful at capturing key features of microeconomic consumption behavior.

[3] We assume that, within the illiquid account, resources can be freely moved between capital and equity, an assumption which allows us to reduce the dimensionality of the asset space.

[4] Broer, Hansen, Krussell, and Öberg (2016) discuss how the New Keynesian transmission mechanism is influenced by the assumptions that determine how profits get distributed across households.

[5] See the companion working paper, Kaplan and Violante (2018), for details on the specific assumptions we made in our baseline HANK model.

The coexistence of a low-return liquid asset and a high-return illiquid asset creates the conditions for the emergence of wealthy hand-to-mouth households (who hold little or no liquid wealth despite owning sizable amounts of illiquid assets) alongside poor hand-to-mouth households (who hold little net worth). The model is able to replicate the observation that around one-third of US households are hand-to-mouth with high marginal propensities to consume and, among these, around two-thirds are wealthy hand-to-mouth and one-third are poor hand-to-mouth (Kaplan, Violante, and Weidner 2014). The remaining households hold sufficient liquid wealth that their consumption dynamics are similar to those of the representative agent.

This existence of both types of hand-to-mouth households improves the fit of the model with respect to the responsiveness of consumption to interest rates and transitory income shocks. The two-asset model generates an average quarterly MPC out of small income windfalls of around 15 to 20 percent, as well as substantial heterogeneity in MPCs driven by heterogeneity in liquid wealth holdings across households. This level and distribution of MPCs is in line with the large body of evidence discussed earlier, as well as with more recent evidence in the context of the Great Recession (Mian, Rao, and Su 2013).

For comparison, the average MPC in an otherwise similar representative agent model is approximately equal to the discount rate, which is around 0.5 percent quarterly. When parameterized to match the same ratio of net worth to average income as in the data (and as in the two-asset model), the average quarterly MPC in the one-asset model is around 4 percent, which is eight times higher than in the representative agent model, but still much lower than empirical estimates.

Researchers have proposed modifications to the one-asset model to increase the average MPC to empirically realistic levels. One approach is to ignore all illiquid wealth and choose the household discount factor to generate the same ratio of *liquid wealth* to average income as in the data. Besides grossly misrepresenting observed household balance sheets, this approach also precludes the model from including capital—which is a crucial ingredient when analyzing macroeconomic dynamics in general equilibrium. A second approach used in (Carroll, Slacalek, Tokuoka, and White 2017; Krueger, Mitman, and Perri 2016) is to introduce enough heterogeneity in discount factors so that there are some very patient households that drive capital accumulation, together with some very impatient households that have a high MPC (although, even with heterogeneity in discount factors, a low-wealth calibration is usually required in order to generate a high aggregate MPC).

A problem with both these approaches is that, in order to generate realistic MPCs, the one-asset models feature many more *poor* hand-to-mouth households than are in the data. By abstracting from the illiquid assets held by the wealthy hand-to-mouth, these models also miss potentially important exposure of household consumption to fluctuations in returns to illiquid assets.

Comparison Between RANK and HANK

In this section, we compare the responses of representative agent and heterogeneous agent New Keynesian models to a series of aggregate shocks that are common in the study of business cycles. To allow for a clean comparison, we adopt a RANK model with the same two-asset structure, the same functional forms for preferences, technology, transaction costs, and price adjustment costs, and the same production side, government, and monetary authority as in HANK. The only important departure from HANK is the absence of any form of household heterogeneity.

We assume that each economy is initially in its steady state and is then hit by a one-time, unanticipated shock that is persistent and mean reverting. After the shock, the economies eventually return to their original steady states. Because the two models differ only on the household side, we focus our attention on the impulse response of aggregate consumption.

We start by analyzing three canonical sources of business cycles: demand, productivity, and monetary shocks. For consistency, we consider contractionary shocks whose size and persistence are chosen to generate a similar drop in aggregate consumption in the RANK model over the first quarter. For additional details of this comparison and the calibration of the two models, see Kaplan and Violante (2018).

Notions of Equivalence Between RANK and HANK

We define three notions of equivalence between RANK and HANK with respect to a given shock. The two models are *nonequivalent* when the impulse response function of consumption to a shock are different. They are *weakly equivalent* when the impulse responses are the same but the transmission mechanisms of the shock are different. They are *strongly equivalent* when both the impulse responses and the transmission mechanisms are the same. In other words, RANK and HANK are strongly equivalent in response to a given shock only if they produce the same impulse response function to the shock, for the same reasons.

Comparing impulse response functions across models, and hence identifying nonequivalence, is straightforward. Comparing transmission mechanisms, which is needed to distinguish between weak and strong equivalence, is open to some interpretation and various methods could be used. Here, we mostly emphasize a decomposition of the consumption impulse response function into the effects of all equilibrium objects that enter into the household consumption problem. These include wages, interest rates, asset prices, fiscal policy and the shock itself. A similar transmission mechanism requires this decomposition to be similar in the two models.

We also discuss two complementary approaches for comparing transmission mechanisms. First, we decompose the difference between the consumption responses in HANK and RANK into a general equilibrium discrepancy (due to different equilibrium price dynamics across models) and a partial equilibrium discrepancy (due to different sensitivity to the same price movements). A similar transmission mechanism requires both these discrepancies to be small in absolute value. Second, we compare the impulse response in HANK under alternative assumptions about the fiscal rule that balances the government budget constraint in the wake of the shock. In our baseline, changes in the stock of debt adjust to balance the budget in the short run and transfers adjust far in the future. Alternative fiscal rules imply different choices about the timing of the necessary adjustment in transfers. As explained earlier, in RANK, due to Ricardian equivalence, the choice of this fiscal rule has no effect on the impulse response function. Hence a similar transmission mechanism requires the timing of transfers to also have virtually no impact in HANK.

Demand Shocks: Strong Equivalence

Figure 1 compares the consumption response in HANK and RANK to a negative demand disturbance, modeled as a shock to households' marginal utility of consumption. Panel A shows that the impulse response functions for aggregate consumption are almost identical. In panels B and C, we plot the impulse response function decompositions for HANK and RANK, respectively. The decompositions are very similar in the two models, in the sense that by far the largest component of the decline in expenditures is the demand shock itself (the dash-dot line labeled "Pref"): expenditures fall because households become more patient and so postpone consumption. In Kaplan and Violante (2018), we show that the partial and general equilibrium discrepancies are both tiny, and that the aggregate consumption response is not affected by the fiscal rule.

Thus, the demand shock offers a clear-cut example of strong equivalence: both the aggregate response to the shock and its transmission mechanism are very similar in HANK and RANK.

Total Factor Productivity Shocks: Weak Equivalence

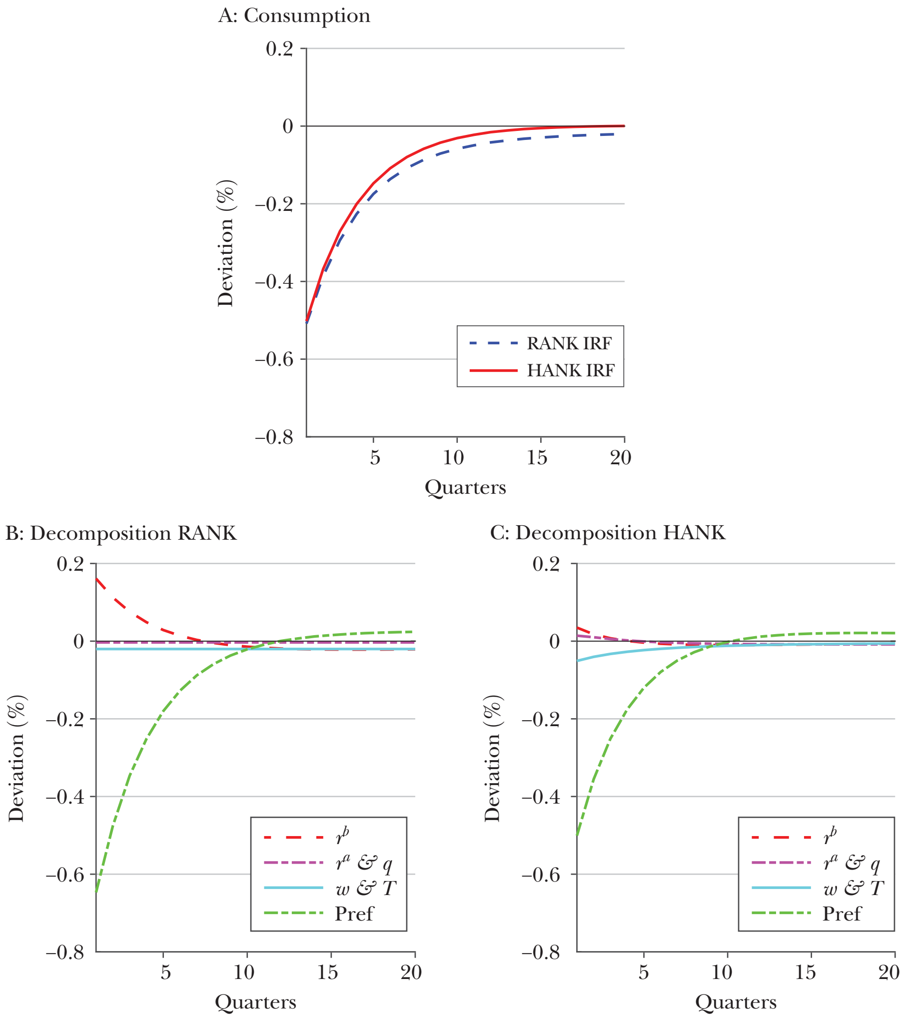
Figure 2 compares the consumption response in HANK and RANK to a negative technology shock, modeled as an unexpected drop in total factor productivity. As with the demand shock, panel A shows that the impulse response functions for the two models lie almost on top of each other.

However, here the transmission mechanisms are very different across models. The drop in productivity raises marginal costs and inflation, to which the central bank reacts by tightening monetary policy. The representative household responds to the higher interest rate by increasing liquid savings and postponing consumption. Thus, in RANK (panel B), the fall in consumption is driven entirely by intertemporal substitution in response to the higher interest rate. In HANK (panel C), the change in interest rates accounts for less than half of the fall in consumption. Instead, consumption falls mostly because disposable household income falls and the MPC out of a change in transitory income is large in HANK.[6] The productivity shock is thus an example of weak equivalence between HANK and RANK models. In

[6]As explained in Gali (1999), in RANK models, wages and hours rise in response to a contractionary shock to total factor productivity. This feature of New Keynesian models remains present in HANK. The fall in disposable household income accrues because of the fall in firm profits.

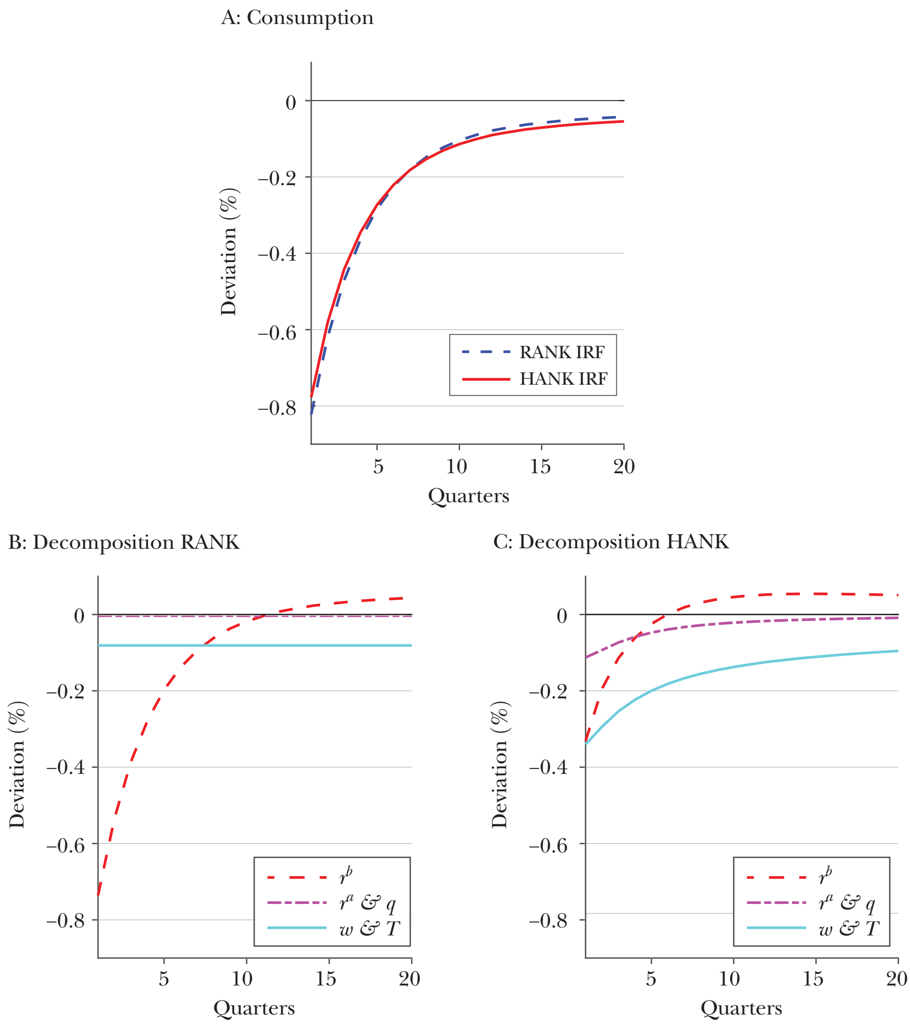
Figure 1

Negative Demand Shock in HANK and RANK: Impulse Response Functions (IRFs) for Consumption and their Decomposition



Note: Figure 1A shows the impulse response function for consumption in the two models HANK and RANK, while B and C present impulse response function decompositions. The line labeled "Pref" indicates the component of the impulse response due only to the preference shift, with all prices and transfers fixed at steady state values. The lines labeled r^b indicate the component of the impulse response due to the liquid rate changing, with all other prices, transfers, and the shock fixed at steady state values. Similarly, the lines labeled "r^a & q" indicate the component of the impulse response due to only the illiquid rate r^a and the equity price q changing, and the lines labeled "w & T" indicate the component of the impulse response due to only the wage w and lump-sum transfers T changing.

Figure 2
Negative Total Factor Productivity (TFP) Shock in HANK and RANK: Impulse Response Functions (IRFs) for Consumption and their Decomposition

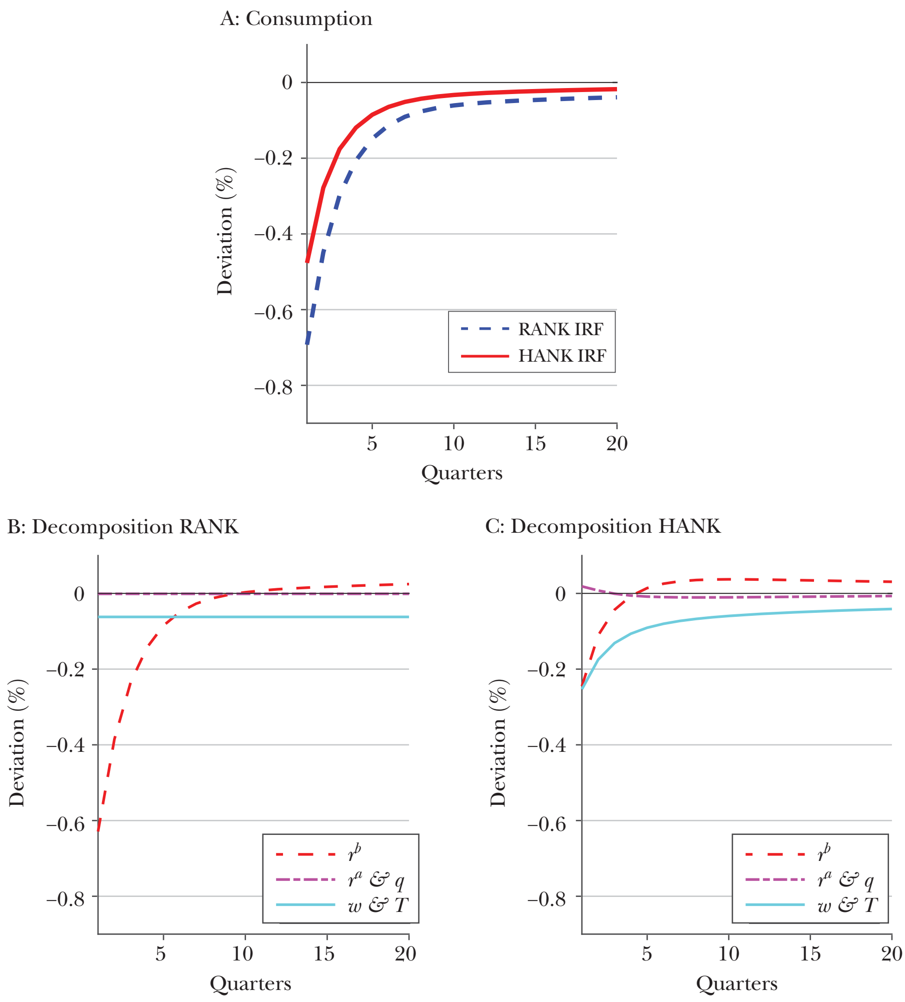


Note: Figure 2A shows the impulse response function (IRF) for consumption in the two models HANK and RANK, while B and C present impulse response function decompositions. The lines labeled r^b indicate the component of the impulse response due to the liquid rate changing, with all other prices and transfers fixed at steady state values. Similarly, the lines labeled "r^a & q" indicate the component of the impulse response due to only the illiquid rate r^a and the equity price q changing, and the lines labeled "w & T" indicate the component of the impulse response due to only the wage w and lump-sum transfers T changing.

Kaplan and Violante (2018), we show that both alternative approaches also suggest weak equivalence. In all three approaches, the differences in transmission mechanisms can be traced to the two hallmarks of the two-asset heterogeneous agent model that we discussed earlier: a high aggregate marginal propensity to consume out of income and a low sensitivity to interest rates.

Figure 3

Negative Monetary Shock (Positive Innovation to the Taylor Rule) in HANK and RANK: Impulse Response Functions (IRFs) for Consumption and their Decomposition



Note: Figure 3A shows the impulse response function for consumption in the two models HANK and RANK, while B and C present impulse response function (IRF) decompositions. The lines labeled r^b indicate the component of the impulse response due to the liquid rate changing (the shock), with all other prices and transfers fixed at steady state values. Similarly, the lines labeled "r^a & q" indicate the component of the impulse response due to only the illiquid rate r^a and the equity price q changing, and the lines labeled "w & T" indicate the component of the impulse response due to only the wage w and lump-sum transfers T changing.

Monetary Shock: Nonequivalence

Figure 3 compares the consumption response to a monetary policy shock in HANK and RANK, modeled as an innovation in the Taylor rule. Panel A shows that in the first quarter after the shock, consumption drops by roughly 50 percent more in RANK than in HANK. The transmission mechanism for monetary policy is different in the two models. In RANK (panel B), the direct intertemporal substitution channel due to the rise in the real liquid rate accounts for the whole effect. In HANK (panel C), the drop in consumption due to the fall in disposable income plays a role that is at least as important as the substitution channel. In Kaplan and Violante (2018), we spell out this difference in detail, and also show that the aggregate response is particularly sensitive to the choice of fiscal rule.[7] The monetary shock is thus an example of nonequivalence. Again, different sensitivities of household consumption to wages and interest rates are at the heart of the gap between the two impulse response functions.

Our result may appear to contrast with Werning (2015), who finds weak equivalence between the representative and heterogeneous agent model for the response of aggregate consumption to a monetary shock, but our findings are in fact consistent. His benchmark heterogeneous agent model is purposefully constructed so that the impulse response function for consumption following a change in the real rate is exactly the same as in RANK: the smaller partial equilibrium intertemporal substitution response to the change in interest rates in the heterogeneous agent model is exactly offset by the stronger aggregate demand response in general equilibrium. Werning illustrates how departures from his "as if" benchmark can lead to a larger or smaller aggregate consumption response to the monetary shock in HANK relative to RANK. Our version of HANK features several such departures, which explains why in our calibrated economy monetary shocks are examples of nonequivalence.

Fiscal Stimulus Shocks: Stark Nonequivalence

The large fiscal stimulus implemented by many governments in response to the Great Recession spurred a new wave of studies that made use of the emerging HANK framework (Oh and Reis 2012; McKay and Reis 2016; Hagadorn, Manovskii, and Mitman 2018). In this section, we show that fiscal stimulus is a stark example of nonequivalence between HANK and RANK models.

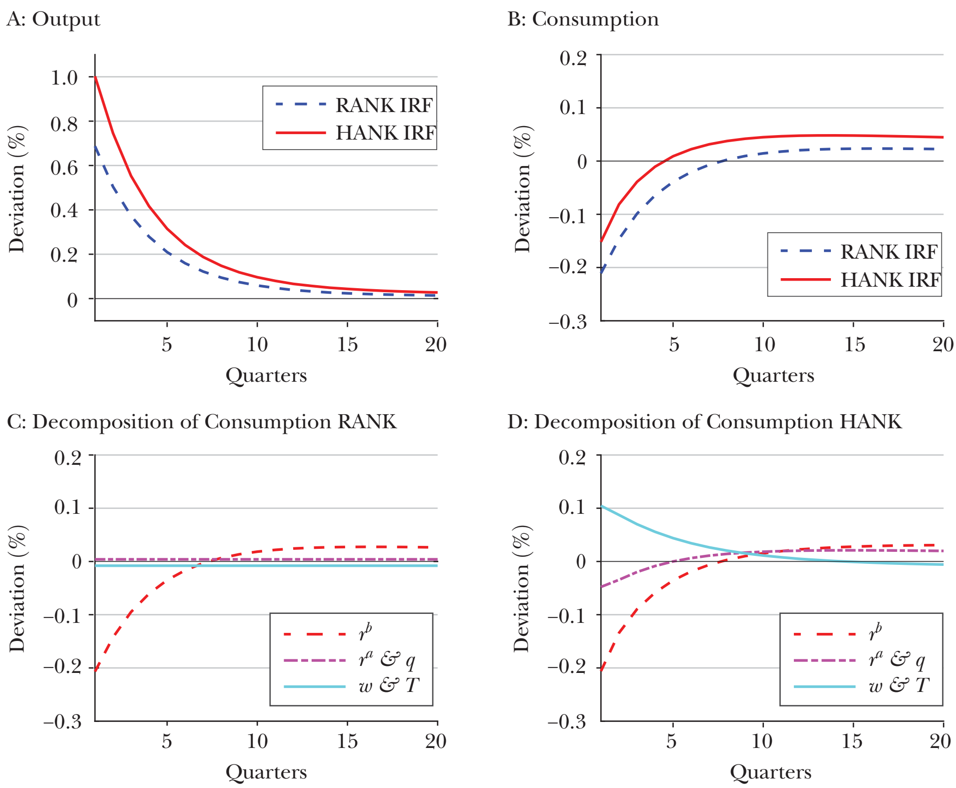
Figure 4 illustrates the effects of a deficit-financed temporary increase in government expenditures. Panel A shows that the expansionary effects on output are much stronger in HANK than in RANK, and panel B illustrates that the reason is the weaker crowding-out of private consumption. Crowding-out occurs because, in order to induce households to hold the additional debt issued by the government, the interest rate must rise. This puts downward pressure on private consumption.

The discrepancy between the two models in the transmission mechanism of the government expenditure shock can be seen in panels C and D. In RANK (panel C), the decline in aggregate consumption is entirely accounted for by the rise in the real interest rate (dashed line). In HANK (panel D), this decline is offset by the

[7] This result is especially stark for forward guidance shocks, as illustrated in Kaplan, Moll, and Violante (2016).

Figure 4

Fiscal Stimulus (Rise in Government Expenditures) in HANK and RANK: Impulse Response Functions (IRFs) for Output and Consumption and Decompositions for Consumption

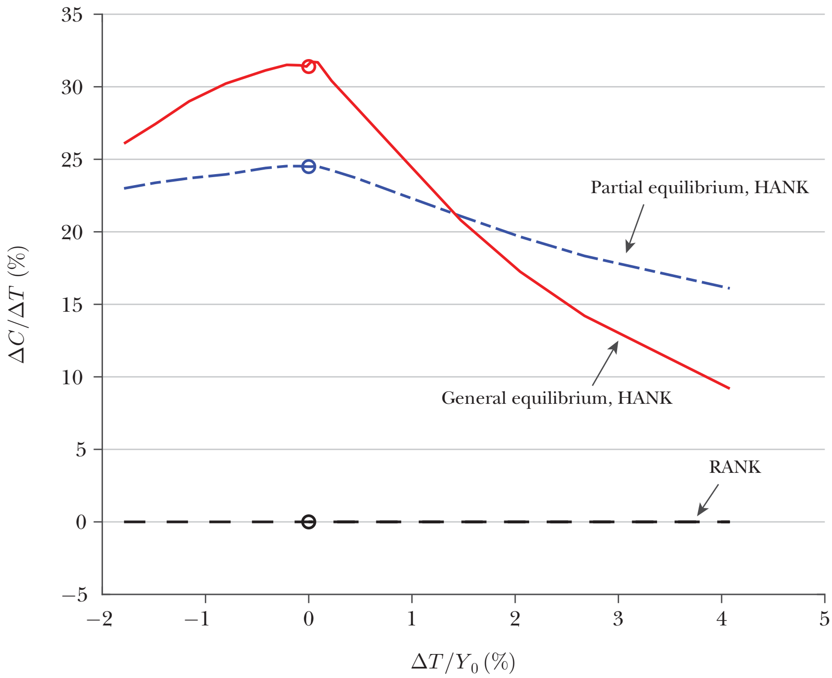


Note: Figure 4A and B show the impulse response functions (IRFs) for output and consumption in the two models HANK and RANK, while C and D present IRF decompositions for consumption. The lines labeled r^b indicate the component of the impulse response function due to the liquid rate changing, with all other prices and transfers fixed at the steady state values. Similarly, the lines labeled "r^a & q" indicate the component of the impulse response due to only the illiquid rate r^a and the equity price q changing, and the lines labeled "w & T" indicate the component of the impulse response due to only the wage w and lump-sum transfers T changing.

increase in labor demand and wages (solid line), which transmits strongly to household consumption through the high aggregate marginal propensity to consume.

Oh and Reis (2012) document that in the wake of the Great Recession, deficit-financed transfers were by far the largest component of fiscal stimulus in the United States. Figure 5 illustrates the effects of alternative temporary changes in lump-sum transfers (of different signs and sizes). The flat dashed line reminds us that, because of Ricardian neutrality, in RANK the consumption response is always zero. Thus, representative agent models are particularly ill suited for analyzing deficit-financed transfers. The dot-dash line shows the partial

Figure 5
Consumption Response to Change in Transfers in HANK and RANK



Note: The figure shows first quarter change in aggregate consumption (C) relative to first-quarter change in lump-sum transfers (T) in RANK and and in partial and general equilbirum HANK models. Y_0 is initial aggregate income.

equilibrium dynamics of aggregate consumption in the HANK model, which is simply the sum of the individual consumption responses, holding prices fixed at their steady-state levels. For expansionary transfer policies, the aggregate MPC falls with size because a larger fraction of the transfers is saved. For contractionary policies, the size-dependence is weaker (the line is flatter to the left of zero) since smoothing the fall in income for many households would now require tapping into expensive credit. These predictions are in line with the evidence discussed earlier both qualitatively (in terms of size-dependence and sign asymmetries) and quantitatively (the quarterly aggregate MPC is around 20 percent).

The solid line illustrates that in the full HANK model, for a wide range of values, the general equilibrium response is stronger due to the aggregate demand effects. However, since the model features an active Taylor rule, a very large stimulus can be so inflationary that the monetary authority raises interest rates to a point that it overcompensates for the expansionary effects of fiscal policy.

Simpler Models that Mimic HANK

We have repeatedly seen that the key differences between HANK and RANK models that lead to nonequivalence or weak equivalence can be traced back to the lower sensitivity of consumption to interest rates and higher sensitivity to disposable income. A natural question that arises is whether some simple modifications to RANK could replicate these features of consumption behavior and thus generate transmission mechanisms that are similar to those in HANK without the computational complexity of a full-blown heterogeneous agent model.

One such modification is the Two-Agent New Keynesian model (TANK), based on the spender–saver model of Campbell and Mankiw (1989). Early examples of this approach are Iacoviello (2005), Galí, López-Salido, and Vallés (2007), and Bilbiie (2008). For certain shocks, TANK can approach strong equivalence with HANK and thus offer a useful shortcut. For other questions, such as the macroeconomic impact of fiscal transfers of different sizes and signs, the two models yield different answers. In Kaplan, Moll, and Violante (2018) and Bilbiie (2017), similarities between HANK and TANK are discussed in the context of monetary policy shocks, and Debortoli and Galí (2017) extend the comparison to various other shocks and fiscal rules.

An alternative avenue for modifying RANK is to introduce liquid wealth directly into the utility function of the representative household. This shortcut captures, in a reduced-form way, the idea that in the presence of uninsurable risk, the household sector as a whole values the existence of a supply of safe, liquid assets because of its precautionary value (as in Aiyagari and McGrattan 1998). In Kaplan and Violante (2018), we show that this augmented RANK model has several other properties that bring it closer to the HANK model (see also Michaillat and Saez 2018).

Macro Questions that Require a Model with Heterogeneity

So far, we have addressed macroeconomic questions about impulse and propagation that are well-posed in both heterogeneous and representative agent models. However, some questions pertaining to macroeconomic dynamics can only be addressed in models with household heterogeneity. In this section, we provide three examples: the effects of aggregate shocks that are not well-defined in representative agent models; how different responses to aggregate shocks by households at different parts of the distribution can aid in the identification of shocks and transmission mechanisms; and the effect of aggregate shocks on household inequality.[8]

Microfoundations of a Fall in Aggregate Demand

Two salient features of the Great Recession were a deep and prolonged drop in expenditures and a sharp fall in the nominal interest rate that led to a binding zero lower bound. These features of the data are consistent with a drop in aggregate demand

[8] In Kaplan and Violante (2018), we provide more details on all these exercises and some additional figures.

as a primary driving force behind the recession. To generate a large sudden fall in aggregate demand in representative agent models, most researchers have resorted to assuming a shock to the discount factor of the representative household. This type of shock was the basis of the earlier discussion summarized in Figure 1. Macroeconomists often justify this shock as a stand-in for some unspecified deeper force that acts as if "households become more patient" (Eggertsson and Krugman 2012).

HANK models offer the possibility to generate a rise in households' desire to save through mechanisms that are both more micro-founded and consistent with aspects of micro data. One leading example is tighter credit limits that reduce borrowing capacity, leading constrained households to deleverage sharply and leading unconstrained households to increase their savings in order to avoid being constrained in the future (as in Guerrieri and Lorenzoni 2017). Another example is a surge in uninsurable labor market risk, which exacerbates the precautionary saving motive (as in Den Haan, Rendahl, and Riegler 2017; Bayer et al. 2017). In the presence of sticky prices, both types of shocks induce a fall in aggregate expenditures and a large enough drop in the real interest rate that the zero lower bound on nominal rates binds.[9]

For both of these representations of a shortfall in aggregate demand, the two-asset version of HANK offers an important advantage over its one-asset counterpart. In the aftermath of the shock, the additional household savings are channeled towards the unproductive liquid asset, which is the better asset for consumption smoothing purposes, rather than towards productive illiquid capital, thus avoiding a counterfactual investment boom. Indeed, the literature that studies these shocks in one-asset HANK models typically abstracts from capital for this reason.

Heterogeneity in the Transmission Mechanism

As explained earlier, models can differ in their transmission mechanism while not differing in terms of their aggregate response to certain shocks. Hence, collecting empirical evidence on the mechanism itself is crucial in distinguishing between models. Time-series data alone might not be that useful because confounding factors abound. An alternative approach is to use cross-sectional data (as discussed by Nakamura and Steinsson in this issue). In this context, one advantage of heterogeneous agent models is that they make predictions about how the effect of an aggregate shock varies across the distribution of households. One can therefore exploit rich micro data to gather support for a specific model or mechanism.

For example, in our two-asset version of HANK, the consumption drop in response to a contractionary monetary shock differs tremendously across households depending on their holdings of liquid wealth. For the mass of hand-to-mouth households with zero liquid wealth, the response is largest and is almost entirely due to the general equilibrium drop in their labor income. But for households

[9] In certain models that admit aggregation in closed form, it is possible to show that a rise in idiosyncratic uncertainty is formally equivalent to a rise in the discount factor of the pseudo-representative agent (Braun 2012).

with substantial positive liquid wealth, the direct effect of the interest rate change is larger than the effect of the drop in their labor income, because these consumers have a low marginal propensity to consume but a high sensitivity to interest rate changes. Empirical work using household panel data on consumption, income, and wealth provides some support for this pattern of cross-sectional transmission mechanism (Cloyne, Ferreira, and Surico 2016).

Examining the consumption response of aggregate shocks at different points in the distribution of households is also a promising avenue to identify the underlying sources of aggregate fluctuations. For example, the three types of aggregate demand disturbances just described—preferences, credit tightness, and income risk—all produce qualitatively similar aggregate dynamics: a large reduction in aggregate expenditures that leads to a decline in interest rates. However, the distributional response of these three shocks is very different: The discount factor shock generates consumption responses that are much more evenly distributed across the liquid wealth distribution than either the credit or risk shocks. And relative to the risk shock, the credit shock generates a consumption response that is more heavily concentrated among households with negative liquid wealth. In Kaplan and Violante (2018), we illustrate these differences.

Impact of Aggregate Shocks on Inequality

Heterogeneous agent models are not only valuable for understanding how wealth and income inequality can affect the magnitude and transmission mechanism of aggregate shocks. They are also useful when the question is turned on its head: to what extent do macroeconomic shocks affect inequality?

For example, consider the effects of a contractionary monetary shock on the distribution of consumption in the two-asset HANK model. The rise in the interest rate pushes up consumption of the very wealthy households through a positive income effect. The equilibrium fall in aggregate demand leads to a reduction in labor income, which lowers consumption most sharply for households at the bottom of the distribution. In Kaplan and Violante (2018), we illustrate the quantitative strength of these forces and conclude that the monetary shock has only a modest effect on consumption dispersion that persists as long as the shock itself does. The empirical analysis in Coibion, Gorodnichenko, Kueng, and Silvia (2017) finds some support for this finding that contractionary monetary policy has a positive, but small, impact on inequality.

Conclusions: Looking Ahead

A new macroeconomic framework is emerging. It embeds a rich representation of household consumption and portfolio choices, consistent with many aspects of microeconomic data, into a dynamic general equilibrium model of the macroeconomy that can accommodate a wide range of aggregate shocks and demand-side effects. This framework offers a coherent way to study questions that pertain to cross-sectional inequality, economic mobility, social insurance, and redistributive policies as well as traditional business cycle questions that bear on the dynamics of macroeconomic variables, propagation mechanisms of aggregate shocks, and stabilization policies.

This framework is still in its infancy. To conclude this essay, we outline several promising directions for the development of this class of models.

New Keynesian models rely on wage and price stickiness to explain both why monetary policy can have real effects and why aggregate demand can affect real output. A promising alternative aggregate demand channel, which does not rely on price stickiness, is based on search frictions in the product market. Households vary the effort with which they hunt for bargains depending on their wealth, income, and demand for consumption. Heterogeneous agent models with search in product markets can embed this mechanism and generate aggregate demand effects either through endogenous movements in the competitiveness of product markets and markups (Kaplan and Menzio 2016) or through endogenous movements in aggregate productivity (Huo and Ríos-Rull, 2016).

In existing HANK models, labor market risk is mostly exogenous. Labor market frictions are one way to provide micro foundations for the extent and nature of idiosyncratic labor market risk. For example, Hubmer (2018) shows that skewness in earnings growth uncovered in micro data (Guvenen, Schulhofer-Wohl, Song, and Yogo 2015; Arellano, Blundell, and Bonhomme 2017) arises endogenously in a canonical frictional model of the labor market with on-the-job search. As another example, Moscarini and Postel-Vinay (2017) describe a setting where firms choose to match outside offers to retain their workers, in which case, the wage goes up without any change in productivity, generating inflation. Embedding this mechanism into a heterogeneous agent model could then generate a credible micro-foundation for the two main driving forces behind inflation dynamics: 1) aggregate demand shocks driven by the distribution of marginal propensities to consume and 2) cost-push shocks driven by the distribution of workers along the job ladder.

The HANK model analyzed in this essay is a model of net household asset positions rather than gross positions. In reality, many households hold highly leveraged portfolios, particularly with regards to illiquid assets, such as housing. If mortgage contracts allow for some degree of pass-through of interest rates (either because of adjustable rates or the option to refinance), then changes in interest rates can have significant cash-flow effects on expenditures for borrowers (for example, Flodén et al. 2016; Di Maggio et al. 2017; La Cava, Hughson, and Kaplan 2016). In addition, many assets and liabilities (like cash, bank accounts, government bonds, secured and unsecured debt) earn nominal returns that do not adjust instantaneously to aggregate conditions, and so surprise inflation can have redistributive effects (Doepke and Schneider 2006; Auclert 2017). And when households have long-term nominal debt contracts (as is the typically the case for mortgages), then anticipated inflation can also have redistributive effects. In a version of the model with endogenous credit limits, aggregate shocks would transmit to the real economy also by modifying the extent of credit availability (for example, Chatterjee, Corbae, Nakajima, and Ríos-Rull

2007; Agarwal, Chomsisengphet, Mahoney, and Stroebel 2015; Gross, Notowidigdo, and Nakajima 2016; Favilukis, Ludvigson, and Van Nieuwerburgh 2017).

In this first generation of HANK models, equity prices barely move in response to aggregate shocks (for example, monetary shocks), and when they do, it is often in the wrong direction. The most promising way to generate realistic asset price movements in response to macroeconomic fluctuations is through time-varying risk premia: that is, the willingness of market participants to bear risk is greater in booms than in recessions (Cochrane 2017). Future versions of these models should aim to generate large and variable risk premia, as well as to recognize that some households are much more exposed to asset price movements than are others because of the composition of their balance sheets (Mian, Rao, and Su 2013; Glover, Heathcote, Krueger, and Ríos-Rull 2017) and the nature of their labor income (Guvenen, Karahan, Ozkan, and Song 2015).

There are no banks in the baseline HANK models: liquid assets are provided directly by the fiscal authority and backed by future tax revenues. Any changes in households' demand to save in liquid assets therefore directly affect the government budget constraint, which induces a stronger link between fiscal policy and household savings behavior than in reality. Moreover, many of the prevailing accounts of the Great Recession attribute a central role to the deterioration of banks' balance sheets. Exploring this latter propagation mechanism requires an explicit model of the banking sector, along with regulatory constraints on bank balance sheets. The two-asset version of HANK lends itself naturally to the introduction of banks, since one of the key roles of financial intermediaries is transformation of assets from higher to lower liquidity (as illustrated in Kaplan, Moll, and Violante 2016).

A heterogeneous agent model could help to explore deviations from rational expectations and complete information. Some recent papers have showed how dispersed information (Angeletos and Lian 2017) or behavioral biases (Farhi and Werning 2017) can have consequences for the relative strengths of partial equilibrium versus general equilibrium effects of aggregate shocks, thus changing the incidence of shocks across the household distribution.

Finally, the analysis of optimal policy changes drastically in a heterogeneous agent economy because redistributive and social insurance implications come into play. For example, McKay and Reis (2016) show that removing automatic fiscal stabilizers would not amplify aggregate consumption fluctuations as long as monetary policy follows a standard Taylor rule, but could lead to large welfare costs because of the decrease in social insurance. Gornemann, Kuester, and Nakajima (2016) argue that a monetary policy rule that emphasizes price stability redistributes towards rich households, while one that stresses output stability redistributes towards poor households who are more exposed to unemployment risk, and that the median household prefers output stability. An emerging literature is making progress towards characterizing optimal policies in this class of models (for example, Le Grand and Ragot 2017; Nuño and Thomas 2016; Bhandari, Evans, Golosov, and Sargent 2017).

■ *We are grateful to Felipe Alves for outstanding research assistance and to Mark Gertler, David Lopez-Salido, Virgiliu Midrigan, Ben Moll, Matt Rognlie, Tom Sargent, and Christian Wolf for comments.*

References

Acharya, Sushant, and Keshav Dogra. 2018. "Understanding HANK: Insights from a PRANK." Federal Reserve Bank of New York Staff Report 835. February.

Agarwal, Sumit, Souphala Chomsisengphet, Neale Mahoney, and Johannes Stroebel. 2015. "Regulating Consumer Financial Products: Evidence from Credit Cards." *Quarterly Journal of Economics* 130(1): 111–64.

Ahn, SeHyoun, Greg Kaplan, Benjamin Moll, Thomas Winberry, and Christian Wolf. 2017. "When Inequality Matters for Macro and Macro Matters for Inequality." Chap. 1 in *NBER Macroeconomics Annual 2017*, vol. 32. University of Chicago Press.

Aiyagari, S. Rao. 1994. "Uninsured Idiosyncratic Risk and Aggregate Saving." *Quarterly Journal of Economics* 109(3): 659–84.

Aiyagari, S. Rao, and Ellen R. McGrattan. 1998. "The Optimum Quantity of Debt." *Journal of Monetary Economics* 42(3): 447–69.

Angeletos, George-Marios, and Chen Lian. 2017. "Dampening General Equilibrium: From Micro to Macro." NBER Working Paper 23379.

Arellano, Manuel, Richard Blundell, and Stéphane Bonhomme. 2017. "Earnings and Consumption Dynamics: A Nonlinear Panel Data Framework." *Econometrica* 85(3): 693–734.

Attanasio, Orazio, and Steven J. Davis. 1996. "Relative Wage Movements and the Distribution of Consumption." *Journal of Political Economy* 104(6): 1227–62.

Auclert, Adrien. 2017. "Monetary Policy and the Redistribution Channel." NBER Working Paper 23451.

Baker, Scott. Forthcoming. "Debt and the Response to Household Income Shocks: Validation and Application of Linked Financial Account Data." *Journal of Political Economy*.

Bayer, Christian, Ralph Lütticke, Lien Pham-Dao, and Volker Tjaden. 2017. "Precautionary Savings, Illiquid Assets, and the Aggregate Consequences of Shocks to Household Income Risk." Working Paper, University of Bonn.

Benhabib, Jess, and Alberto Bisin. Forthcoming. "Skewed Wealth Distributions: Theory and Empirics." *Journal of Economic Literature*.

Bewley, Truman. 1983. "A Difficulty with the Optimum Quantity of Money." *Econometrica* 51(5): 1485–1504.

Bhandari, Anmol, David Evans, Mikhail Golosov, and Thomas J. Sargent. 2017. "Inequality, Business Cycles and Monetary-Fiscal." Working Paper, University of Minnesota.

Bilbiie, Florin O. 2008. "Limited Asset Markets Participation, Monetary Policy and (Inverted) Aggregate Demand Logic." *Journal of Economic Theory* 140(1): 162–96.

Bilbiie, Florin Ovidiu. 2017. "The New Keynesian Cross: Understanding Monetary Policy with Hand-to-Mouth Households." CEPR Discussion Paper no. DP11989. Available at SSRN: https://ssrn.com/abstract=2957528.

Blundell, Richard, Luigi Pistaferri, and Ian Preston. 2008. "Consumption Inequality and Partial Insurance." *American Economic Review* 98(5): 1887–1921.

Boppart, Timo, Per Krusell, and Kurt Mitman. 2017. "Exploiting MIT Shocks in Heterogeneous-Agent Economies: The Impulse Response as a Numerical Derivative." NBER Working Paper 24138.

Braun, Anton, and Tomoyuki Nakajima. 2012. "Uninsured Countercyclical Risk: An Aggregation Result and Application to Optimal Monetary Policy." *Journal of the European Economic Association* 10(6): 1450–74.

Broda, Christian, and Jonathan A. Parker. 2014. "The Economic Stimulus Payments of 2008 and the Aggregate Demand for Consumption." *Journal of Monetary Economics* 68(S): 20–36.

Broer, Tobias, Niels-Jakob H. Hansen, Per Krusell, and Erik Öberg. 2016. "The New Keynesian Transmission Mechanism:

A Heterogeneous-Agent Perspective." NBER Working Paper 22418.

Browning, Martin, and Thomas F. Crossley. 2001. "The Life-Cycle Model of Consumption and Saving." *Journal of Economic Perspectives* 15(3): 3–22.

Brumm, Johannes, and Simon Scheidegger. 2017. "Using Adaptive Sparse Grids to Solve High-Dimensional Dynamic Models." *Econometrica* 85(5): 1575–1612.

Caballero, Ricardo J. 1999. "Aggregate Investment." Chap. 12 in *Handbook of Macroeconomics*, vol. 1B," edited by John B. Taylor and Michael Woodford. North Holland.

Campbell, John Y., and N. Gregory Mankiw. 1989. "Consumption, Income and Interest Rates: Reinterpreting the Time Series Evidence." In *NBER Macroeconomics Annual,* vol. 4, 185–246, edited by Olivier Jean Blanchard and Stanley Fischer. MIT Press.

Canzoneri, Matthew B., Robert E. Cumby, and Behzad T. Diba. 2007. "Euler Equations and Money Market Interest Rates: A Challenge for Monetary Policy Models." *Journal of Monetary Economics* 54(7): 1863 –81.

Carroll, Christopher D. 1997. "Buffer-Stock Saving and the Life Cycle/Permanent Income Hypothesis." *Quarterly Journal of Economics* 112(1): 1–55.

Carroll, Christopher, Jiri Slacalek, Kiichi Tokuoka, and Matthew N. White. 2017. "The Distribution of Wealth and the Marginal Propensity to Consume." *Quantitative Economics* 8(3): 977–1020.

Chatterjee, Satyajit, Dean Corbae, Makoto Nakajima, and José-Víctor Ríos-Rull. 2007. "A Quantitative Theory of Unsecured Consumer Credit with Risk of Default." *Econometrica* 75(6): 1525–89.

Christelis, Dimitris, Dimitris Georgarakos, Tullio Jappelli, Luigi Pistaferri, and Maarten van Rooij. 2017. "Asymmetric Consumption Effects of Transitory Income Shocks." Working Paper 467, Centre for Studies in Economics and Finance (CSEF).

Clarida, Richard, Jordi Gali, and Mark Gertler. 1999."The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 37(4): 1661–1707.

Cloyne, James, Clodomiro Ferreira, and Paolo Surico. 2016. "Monetary Policy When Households Have Debt: New Evidence on the Transmission Mechanism." Bank of England Working Paper 589. Available at SSRN https://ssrn.com/abstract=2765415.

Cochrane, John H. 1991. "A Simple Test of Consumption Insurance." *Journal of Political Economy* 99(5): 957–76.

Cochrane, John. 2015. "Whither Inflation." *Grumpy Economist* blog, August 31. https://johnhcochrane.blogspot.com/2015/08/whither-inflation.html.

Cochrane, John H. 2017. "Macro-Finance." *Review of Finance* 21(3): 945–85.

Coibion, Olivier, Yuriy Gorodnichenko, Lorenz Kueng, and John Silvia. 2017. "Innocent Bystanders? Monetary Policy and Inequality." *Journal of Monetary Economics* 88: 70–89.

Costancio, Vitor. 2017. "Inequality and Macroeconomic Policies." Speech at the Annual Congress of the European Economic Association, Lisbon, Portugal, August 22. https://www.ecb.europa.eu/press/key/date/2017/html/ecb.sp170822.en.html.

Deaton, Angus. 1987. "Life-cycle Models of Consumption: Is the Evidence Consistent with the Theory?" Chap. 14 in *Advances in Econometrics:* Vol. 2: *Fifth World Congress,* edited by Truman F. Bewley. Cambridge University Press.

Debortoli, Davide, and Jordi Galí. 2017. "Monetary Policy with Heterogeneous Agents: Insights from TANK Models." Technical Report.

De Nardi, Mariacristina, and Giulio Fella. 2017. "Saving and Wealth Inequality." *Review of Economic Dynamics* 26: 280–300.

Den Haan, Wouter J., Pontus Rendahl, and Markus Riegler. 2017. "Unemployment (Fears) and Deflationary Spirals." *Journal of the European Economic Association,* advance article, https://doi.org/10.1093/jeea/jvx040.

Di Maggio, Marco, Amir Kermani, Benjamin J. Keys, Tomasz Piskorski, Rodney Ramcharan, Amit Seru, and Vincent Yao. 2017. "Interest Rate Pass-Through: Mortgage Rates, Household Consumption, and Voluntary Deleveraging." *American Economic Review* 107(11): 3550–88.

Doepke, Matthias, and Martin Schneider. 2006. "Inflation and the Redistribution of Nominal Wealth." *Journal of Political Economy* 114(6): 1069–97.

Duarte, Victor. 2018. "Machine Learning for Continuous-Time Economics." Available at SSRN: https://ssrn.com/abstract=3012602.

Eggertsson, Gauti B., and Paul Krugman. 2012. "Debt, Deleveraging, and the Liquidity Trap: A Fisher–Minsky–Koo Approach." *Quarterly Journal of Economics* 127(3): 1469–1513.

Fagereng, Andreas, Martin Holm, and Gisle Natvik. 2016. "MPC Heterogeneity and Household Balance Sheets." Discussion Paper 852, Statistics Norway.

Farhi, Emmanuel, and Iván Werning. 2017. "Monetary Policy, Bounded Rationality, and Incomplete Markets." NBER Working Paper 23281.

Favilukis, Jack, Sydney C. Ludvigson, and Stijn

Van Nieuwerburgh. 2017. "The Macroeconomic Effects of Housing Wealth, Housing Finance, and Limited Risk Sharing in General Equilibrium." *Journal of Political Economy* 125(1): 140–223.

Fernández-Villaverde, Jesús, Samuel Hurtado, and Galo Nuño. 2018. "Financial Frictions and the Wealth Distribution." https://www.sas.upenn.edu/~jesusfv/Financial_Frictions_Wealth_Distribution.pdf.

Flodén, Martin, Matilda Kilström, Jósef Sigurdsson, and Roine Vestman. 2016. "Household Debt and Monetary Policy: Revealing the Cash-Flow Channel." Swedish House of Finance Research Paper no. 16-8. Available at SSRN: https://ssrn.com/abstract=2748232.

Fuster, Andreas, Greg Kaplan, and Basit Zafar. 2018. "What Would You Do With $500? Evidence from Gains, Losses, News and Loans." Unpublished paper, University of Chicago.

Galí, Jordi. 1999. "Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?" *American Economic Review* 89(1): 249–71.

Galí, Jordi, J. David López-Salido, and Javier Vallés. 2007. "Understanding the Effects of Government Spending on Consumption." *Journal of the European Economic Association* 5(1): 227–70.

Gertler, Mark, and Simon Gilchrist. 1994. "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms." *Quarterly Journal of Economics* 109(2): 309–340.

Glover, Andrew, Jonathan Heathcote, Dirk Krueger, and José-Víctor Ríos-Rull. 2017. "Intergenerational Redistribution in the Great Recession." Working Paper, University of Texas. https://www.sas.upenn.edu/~dkrueger/research/RecessionNew.pdf.

Gornemann, Nils, Keith Kuester, and Makoto Nakajima. 2016. "Doves for the Rich, Hawks for the Poor? Distributional Consequences of Monetary Policy." International Finance Discussion Papers 1167. https://www.federalreserve.gov/econresdata/ifdp/2016/files/ifdp1167.pdf.

Gross, Tal, Matthew J. Notowidigdo, and Jialan Wang. 2016. "The Marginal Propensity to Consume over the Business Cycle." NBER Working Paper 22518.

Guerrieri, Veronica, and Guido Lorenzoni. 2017. "Credit Crises, Precautionary Savings, and the Liquidity Trap." *Quarterly Journal of Economics* 132(3): 1427–67.

Guvenen, Fatih. 2011. "Macroeconomics with Heterogeneity: A Practical Guide." *Economic Quarterly, Federal Reserve Bank of Richmond* 97(3): 255–326.

Guvenen, Fatih, Fatih Karahan, Serdar Ozkan, and Jae Song. 2015. "What Do Data on Millions of U.S. Workers Reveal about Life-Cycle Earnings Risk?" NBER Working Paper 20913.

Guvenen, Fatih, Sam Schulhofer-Wohl, Jae Song, and Motohiro Yogo. 2017. "Worker Betas: Five Facts about Systematic Earnings Risk." *American Economic Review* 107(5): 398–403.

Hagedorn, Marcus, Iourii Manovskii, and Kurt Mitman. 2018. "The Fiscal Multiplier." Working Paper, University of Oslo. https://www.sas.upenn.edu/~manovski/papers/The_Fiscal_Multiplier.pdf.

Hall, Robert. 1978. "Stochastic Implications of the Life Cycle–Permanent Income Hypothesis: Theory and Evidence." *Journal of Political Economy* 86(6): 971–987.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante. 2009. "Quantitative Macroeconomics with Heterogeneous Households." *Annual Review of Economics* 1: 319–54.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante. 2014. "Consumption and Labor Supply with Partial Insurance: An Analytical Framework." *American Economic Review* 104(7): 2075–2126.

Hubmer, Joachim. 2018. "The Job Ladder and its Implications for Earnings Risk." *Review of Economic Dynamics* 29: 172–94.

Huggett, Mark. 1993. "The Risk-Free Rate in Heterogeneous-Agent Incomplete-Insurance Economies." *Journal of Economic Dynamics and Control* 17(5–6): 953–69.

Huo, Zhen, and José Víctor Ríos-Rull. 2016. "Financial Frictions, Asset Prices, and the Great Recession." CEPR Discussion Paper DP11544. Available at SSRN: https://ssrn.com/abstract=2847078.

Iacoviello, Matteo. 2005. "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle." *American Economic Review* 95(3): 739–64.

Imrohoroğlu, Ayşe. 1989. "Cost of Business Cycles with Indivisibilities and Liquidity Constraints." *Journal of Political Economy* 97(6): 1364–83.

Jappelli, Tullio, and Luigi Pistaferri. 2010. "The Consumption Response to Income Changes." *Annual Review of Economics* 2: 479–506.

Johnson, David S., Jonathan A. Parker, and Nicholas S. Souleles. 2006. "Household Expenditure and the Income Tax Rebates of 2001." *American Economic Review* 96(5): 1589–1610.

Kaplan, Greg, and Guido Menzio. 2016. "Shopping Externalities and Self-Fullfilling Unemployment Fluctuations." *Journal of Political Economy* 124(3): 771–825.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante. 2016. "A Note on Unconventional

Monetary Policy in HANK." Technical Report, Princeton University.

Kaplan, Greg, Benjamin Moll, and Giovanni L. Violante. 2018. "Monetary Policy According to HANK." *American Economic Review* 108(3): 697–743.

Kaplan, Greg, and Giovanni L. Violante. 2014. "A Model of the Consumption Response to Fiscal Stimulus Payments." *Econometrica* 82(4): 1199–1239.

Kaplan, Greg, and Gianluca L. Violante. 2018. "Microeconomic Heterogeneity and Macroeconomic Shocks." NBER Working Paper 24734.

Kaplan, Greg, Gianluca Violante, and Justin Weidner. 2014. "The Wealthy Hand-to-Mouth." *Brookings Papers on Economic Activity*, no. 1, pp. 77–138.

Khan, Aubhik, and Julia K. Thomas. 2008. "Idiosyncratic Shocks and the Role of Nonconvexities in Plant and Aggregate Investment Dynamics." *Econometrica* 76(2): 395–436.

Krueger, Dirk, Kurt Mitman, and Fabrizio Perri. 2016. "Macroeconomics and Household Heterogeneity." Chap. 11 in *Handbook of Macroeconomics*, vol. 2A, edited by John B. Taylor and Harald Uhlig. Elsevier.

Krusell, Per, and Anthony A. Smith. 1998. "Income and Wealth Heterogeneity in the Macroeconomy." *Journal of Political Economy* 106(5): 867–96.

Kuroda, Haruiko. 2017. "Opening Remarks at the 2017 BOJ–IMES Conference Hosted by the Institute for Monetary and Economic Studies, Bank of Japan." May 24. https://www.boj.or.jp/en/announcements/press/koen_2017/ko170524a.htm.

La Cava, Gianni, Helen Hughson, and Greg Kaplan. 2016. "The Household Cash Flow Channel of Monetary Policy." Research Discussion Paper 2016-12, Reserve Bank of Australia. http://www.rba.gov.au/publications/rdp/2016/pdf/rdp2016-12.pdf.

Le Grand, François, and Xavier Ragot. 2017. "Optimal Fiscal Policy with Heterogeneous Agents and Aggregate Shocks." 2017 Meeting Paper 969, Society for Economic Dynamics.

Ljungqvist, Lars, and Thomas J. Sargent. 2004. *Recursive Macroeconomic Theory*, MIT Press Books.

McKay, Alisdair, Emi Nakamura, and Jón Steinsson. 2016. "The Power of Forward Guidance Revisited." *American Economic Review* 106(10): 3133–58.

McKay, Alisdair, and Ricardo Reis. 2016. "The Role of Automatic Stabilizers in the U.S. Business Cycle." *Econometrica* 84(1): 141–94.

Mian, Atif, Kamalesh Rao, and Amir Su. 2013. "Household Balance Sheets, Consumption, and the Economic Slump." *Quarterly Journal of Economics* 128(4): 1687–1726.

Michaillat, Pascal, and Emmanuel Saez. 2018. "A New Keynesian Model with Wealth in the Utility Function." https://eml.berkeley.edu/~saez/michaillat-saezFeb18WUNK.pdf.

Misra, Kanishka, and Paolo Surico. 2014. "Consumption, Income Changes, and Heterogeneity: Evidence from Two Fiscal Stimulus Programs." *American Economic Journal: Macroeconomics* 6(4): 84–106.

Moscarini, Giuseppe, and Fabien Postel-Vinay. 2017. "The Job Ladder: Inflation vs. Reallocation." Working Paper, Yale University.

Nuño, Galo, and Carlos Thomas. 2016. "Optimal Monetary Policy with Heterogeneous Agents." Working Paper 1624, Bank of Spain.

Oh, Hyunseung, and Ricardo Reis. 2012. "Targeted Transfers and the Fiscal Response to the Great Recession." *Journal of Monetary Economics* 59(S): 50–64.

Ottonello, Pablo, and Thomas Winberry. 2018. "Financial Heterogeneity and the Investment Channel of Monetary Policy." NBER Working Paper 24221.

Pröhl, Elisabeth. 2017. "Approximating Equilibria with Ex-Post Heterogeneity and Aggregate Risk." Swiss Finance Institute Research Paper 17-63. Available at SSRN: https://ssrn.com/abstract=2620937.

Quadrini, Vincenzo, and José-Víctor Ríos-Rull. 2015. "Inequality in Macroeconomics." Chap. 14 in *Handbook of Income Distribution*, vol. 2B, edited by Anthony B. Atkinson and François Bourguignon, pp. 1229–1302. Elsevier.

Reiter, Michael. 2009. "Solving Heterogeneous-Agent Models by Projection and Perturbation." *Journal of Economic Dynamics and Control* 33(3): 649–65.

Ríos-Rull, José-Víctor. 1995. "Models with Heterogeneous Agents." Chap. 4 in *Frontiers of Business Cycle Research*, edited by Thomas F. Cooley. Princeton University Press.

Rotemberg, Julio J. 1982. "Sticky Prices in the United States." *Journal of Political Economy* 90(6): 1187–1211.

Sargent, Thomas J. 2015. "Robert E. Lucas Jr.'s Collected Papers on Monetary Theory." *Journal of Economic Literature* 53(1): 43–64.

Schechtman, Jack. 1976. "An Income Fluctuation Problem." *Journal of Economic Theory* 12(2): 218–41.

Shapiro, Matthew D., and Joel Slemrod. 2003. "Consumer Response to Tax Rebates." *American Economic Review* 93(1): 381–96.

Vissing-Jørgensen, Annette. 2002. "Limited Asset Market Participation and the Elasticity of

Intertemporal Substitution." *Journal of Political Economy* 110(4): 825–53.

Werning, Iván. 2015. "Incomplete Markets and Aggregate Demand." NBER Working Paper 21448.

Woodford, Michael. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton University Press.

Yellen, Janet. 2016. "Macroeconomic Research after the Crisis." Speech at the Federal Reserve Bank of Boston, Boston, Massachusetts, October 14, https://www.federalreserve.gov/newsevents/speech/yellen20161014a.htm.

Yogo, Motohiro. 2004. "Estimating the Elasticity of Intertemporal Substitution when Instruments Are Weak." *Review of Economics and Statistics* 86(3): 797–810.

This article has been cited by:

1. Stav Federman, Assaf Sarid, Meir Yaish. 2023. The intragenerational mobility of the top income earners during financial crises, a story of a cohort. *Advances in Life Course Research* **58**, 100565. [Crossref]
2. Beatrice Cherrier, Pedro Garcia Duarte, Aurélien Saïdi. 2023. Household heterogeneity in macroeconomic models: A historical perspective. *European Economic Review* **158**, 104497. [Crossref]
3. Christian K. Wolf. 2023. The Missing Intercept: A Demand Equivalence Approach. *American Economic Review* **113**:8, 2232-2269. [Abstract] [View PDF article] [PDF with links]
4. Rafael Guntin, Pablo Ottonello, Diego J. Perez. 2023. The Micro Anatomy of Macro Consumption Adjustments. *American Economic Review* **113**:8, 2201-2231. [Abstract] [View PDF article] [PDF with links]
5. Yan Ji, Songyuan Teng, Robert M. Townsend. 2023. Dynamic Bank Expansion: Spatial Growth, Financial Access, and Inequality. *Journal of Political Economy* **131**:8, 2209-2275. [Crossref]
6. Junlin Mu, Lipeng Yan, Shanshan Wu. 2023. Growing with inequality: a DSGE model with heterogeneous human capital and endogenous economic growth. *Applied Economics* **55**:32, 3689-3715. [Crossref]
7. David Berger, Luigi Bocola, Alessandro Dovis. 2023. Imperfect Risk Sharing and the Business Cycle. *The Quarterly Journal of Economics* **138**:3, 1765-1815. [Crossref]
8. Carlos Madeira, Leonardo Salazar. 2023. The impact of monetary policy on a labor market with heterogeneous workers: The case of Chile. *Latin American Journal of Central Banking* **4**:2, 100092. [Crossref]
9. Martin B. Holm. 2023. Monetary transmission with income risk*. *The Scandinavian Journal of Economics* **125**:2, 441-460. [Crossref]
10. Xing Guo, Pablo Ottonello, Diego J. Perez. 2023. Monetary Policy and Redistribution in Open Economies. *Journal of Political Economy Macroeconomics* **1**:1, 191-241. [Crossref]
11. Kiana Basiri, Babak Mahmoudi, Chenggang Zhou. 2023. Who benefits the most? Risk pooling in mortgage loan insurance: Evidence from the Canadian mortgage market. *Real Estate Economics* **51**:2, 311-337. [Crossref]
12. Sebastian Poledna, Michael Gregor Miess, Cars Hommes, Katrin Rabitsch. 2023. Economic forecasting with an agent-based model. *European Economic Review* **151**, 104306. [Crossref]
13. Laura Liu, Mikkel Plagborg-Møller. 2023. Full-information estimation of heterogeneous agent models using macro and micro data. *Quantitative Economics* **14**:1, 1-35. [Crossref]
14. Byoungchan Lee. 2023. Wealth Inequality and Endogenous Growth. *Journal of Monetary Economics* **133**, 132-148. [Crossref]
15. Jolan Mohimont, Maite De Sola Perea, Marie-Denise Zachary. 2023. Softening the Blow: Job Retention Schemes in the Pandemic. *SSRN Electronic Journal* **41**. . [Crossref]
16. Tobias Broer, Per Krusell, Erik Öberg. 2023. Fiscal multipliers: A heterogenous-agent perspective. *Quantitative Economics* **14**:3, 799-816. [Crossref]
17. P. Campoy-Muñoz, M. A. Cardenete, F. J. De Miguel-Vélez, J. Pérez-Mayo. 2022. How does fiscal austerity impact on poverty and inequality? The Spanish case. *Economia Politica* **39**:3, 715-737. [Crossref]
18. Soh Young In, Berk Manav, Clothilde M.A. Venereau, Luis Enrique Cruz R., John P. Weyant. 2022. Climate-related financial risk assessment on energy infrastructure investments. *Renewable and Sustainable Energy Reviews* **167**, 112689. [Crossref]

19. A. V. Polbin, N. D. Fokin. 2022. DSGE models with heterogeneous economic agents: A new notion at the characteristics of the functioning of the economy. *Voprosy Ekonomiki* :9, 53-72. [Crossref]

20. Margaret Rutendo Magwedere, Godfrey Marozva. 2022. Monetary Policy and Inequality Links: Should Central Banks be Concerned?. *Global Business Review* **1**, 097215092211152. [Crossref]

21. Shiou-Yen Chu. 2022. What affects the fraction of collateral-constrained households in the housing market? The case of Taiwan. *Journal of the Asia Pacific Economy* 1-28. [Crossref]

22. Jinshun Wu. 2022. Study on the Optimization of Macroeconomics Teaching Model Based on Cluster Analysis in the Context of Data. *Security and Communication Networks* **2022**, 1-9. [Crossref]

23. Ravula Padmaja, Swamikannu Nedumaran, Padmanabhan Jyosthnaa, Kasala Kavitha, Assem Abu Hatab, Carl-Johan Lagerkvist. 2022. COVID-19 Impact on Household Food Security in Urban and Peri-Urban Areas of Hyderabad, India. *Frontiers in Public Health* **10**. . [Crossref]

24. Jianguo Wang, Tongsan Wang, Yuna Shi, Diwei Xu, Yutian Chen, Jie Wu. 2022. Metaverse, SED Model, and New Theory of Value. *Complexity* **2022**, 1-26. [Crossref]

25. Gu Jin, Tao Zhu. 2022. Heterogeneity, decentralized trade, and the long-run real effects of inflation. *Journal of Economic Theory* **201**, 105439. [Crossref]

26. Francesco D'Acunto, Daniel Hoang, Michael Weber. 2022. Managing Households' Expectations with Unconventional Policies. *The Review of Financial Studies* **35**:4, 1597-1642. [Crossref]

27. Yirun Chen, Wensheng Dai. 2022. Tracking Control of the Dynamic Input-Output Economic System Based on Data Fusion. *Security and Communication Networks* **2022**, 1-12. [Crossref]

28. Dimitris Papanikolaou, Lawrence D W Schmidt. 2022. Working Remotely and the Supply-Side Impact of COVID-19. *The Review of Asset Pricing Studies* **12**:1, 53-111. [Crossref]

29. Piero Ferri, Fabio Tramontana. 2022. Autonomous demand, multiple equilibria and unemployment dynamics. *Journal of Economic Interaction and Coordination* **17**:1, 209-223. [Crossref]

30. Loretti Isabella Dobrescu, Akshay Shanker, Hazel Bateman, Ben Rhodri Newell, Susan Thorp. 2022. Retirement Eggs and Retirement Baskets. *SSRN Electronic Journal* **19**. . [Crossref]

31. Leland E. Farmer, Roger E.A. Farmer. 2022. Zoomers and Boomers: Asset Prices and Intergenerational Inequality. *SSRN Electronic Journal* **140**. . [Crossref]

32. Jenny Chan, Sebastian Diz, Derrick Kanngiesser. 2022. Energy Prices and Household Heterogeneity: Monetary Policy in a Gas-TANK. *SSRN Electronic Journal* **88**. . [Crossref]

33. Ulrike Neyer, Daniel Stempel. 2021. Gender discrimination, inflation, and the business cycle. *Journal of Macroeconomics* **70**, 103352. [Crossref]

34. Marius Clemens, Ulrich Eydam, Maik Heinemann. 2021. Inequality over the business cycle: the role of distributive shocks. *Macroeconomic Dynamics* **7**, 1-30. [Crossref]

35. Pierre Gosselin, Aïleen Lotz, Marc Wambst. 2021. A statistical field approach to capital accumulation. *Journal of Economic Interaction and Coordination* **16**:4, 817-908. [Crossref]

36. Jonathan Chiu, Miguel Molico. 2021. Short-run dynamics in a search-theoretic model of monetary exchange. *Review of Economic Dynamics* **42**, 133-155. [Crossref]

37. Kuhelika De, Ryan A. Compton, Daniel C. Giedeman, Gary A. Hoover. 2021. Macroeconomic shocks and racial labor market differences. *Southern Economic Journal* **88**:2, 680-704. [Crossref]

38. D. P. Kolesnik, A. A. Pestova, M. E. Mamonov. 2021. Credit supply shocks and household consumption in Russia. *Voprosy Ekonomiki* :9, 24-50. [Crossref]

39. Annalisa Cristini, Piero Ferri. 2021. Nonlinear models of the Phillips curve. *Journal of Evolutionary Economics* **31**:4, 1129-1155. [Crossref]

40. Gianni La Cava, Calvin He. 2021. The Distributional Effects of Monetary Policy: Evidence from Local Housing Markets in Australia. *Australian Economic Review* **54**:3, 387-397. [Crossref]

41. N. B. Melnikov, A. P. Gruzdev, M. G. Dalton, M. Weitzel, B. C. O'Neill. 2021. Parallel Extended Path Method for Solving Perfect Foresight Models. *Computational Economics* **58**:2, 517-534. [Crossref]
42. Emanuel Kohlscheen, Marco Lombardi, Egon Zakrajšek. 2021. Income Inequality and the depth of economic downturns. *Economics Letters* **205**, 109934. [Crossref]
43. John Foster. 2021. The US consumption function: a new perspective. *Journal of Evolutionary Economics* **31**:3, 773-798. [Crossref]
44. Matthias Aistleitner, Claudius Gräbner, Anna Hornykewycz. 2021. Theory and empirics of capability accumulation: Implications for macroeconomic modeling. *Research Policy* **50**:6, 104258. [Crossref]
45. Alistair Macaulay. 2021. The attention trap: Rational inattention, inequality, and fiscal policy. *European Economic Review* **135**, 103716. [Crossref]
46. Cristiano Cantore, Lukas B. Freund. 2021. Workers, capitalists, and the government: fiscal policy and income (re)distribution. *Journal of Monetary Economics* **119**, 58-74. [Crossref]
47. Kim Abildgren, Andreas Kuchler. 2021. Revisiting the inflation perception conundrum. *Journal of Macroeconomics* **67**, 103264. [Crossref]
48. Karl Harmenberg, Erik Öberg. 2021. Consumption dynamics under time-varying unemployment risk. *Journal of Monetary Economics* **118**, 350-365. [Crossref]
49. Enrico Sergio Levrero. 2021. Estimates of the Natural Rate of Interest and the Stance of Monetary Policies: A Critical Assessment. *International Journal of Political Economy* **50**:1, 5-27. [Crossref]
50. John Bryan Davis. 2021. The status of the concept of identity in economics. *Forum for Social Economics* **50**:1, 1-9. [Crossref]
51. Guillaume Rocheteau, Pierre-Olivier Weill, Tsz-Nga Wong. 2021. An heterogeneous-agent New-Monetarist model with an application to unemployment. *Journal of Monetary Economics* **117**, 64-90. [Crossref]
52. Ansgar Rannenberg. 2021. State-dependent fiscal multipliers with preferences over safe assets. *Journal of Monetary Economics* **117**, 1023-1040. [Crossref]
53. Laura Liu, Mikkel Plagborg-Møller. 2021. Full-Information Estimation of Heterogeneous Agent Models Using Macro and Micro Data. *SSRN Electronic Journal* . [Crossref]
54. Soh Young In, Berk Manav, Clothilde Venereau, Luis Enrique Cruz Rodriguez, John Weyant. 2021. Pricing Climate Risks of Energy Investments: A Comparative Case Study. *SSRN Electronic Journal* **32**. . [Crossref]
55. Jeppe Druedahl. 2021. High Frequency Income Dynamics. *SSRN Electronic Journal* **81**. . [Crossref]
56. Adrien Auclert, Bence Bardóczy, Matthew Rognlie, Ludwig Straub. 2021. Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models. *Econometrica* **89**:5, 2375-2408. [Crossref]
57. Yan Ji, Songyuan Teng, Robert M. Townsend. 2021. Branch Expansion versus Digital Banking: The Dynamics of Growth and Inequality in a Spatial Equilibrium Model. *SSRN Electronic Journal* **105**. . [Crossref]
58. Alex Grimaud. 2021. Precautionary saving and un-anchored expectations. *SSRN Electronic Journal* **109**. . [Crossref]
59. Jiaming Huang. 2021. Group Local Projections. *SSRN Electronic Journal* **127**. . [Crossref]
60. Seongjin Park, Arkodipta Sarkar, Nishant Vats. 2021. Political Voice and (Mortgage) Market Participation: Evidence from Minority Disenfranchisement. *SSRN Electronic Journal* **73**. . [Crossref]
61. Federico Morelli, Karl Naumann-Woleske, Michael Benzaquen, Marco Tarzia, Jean-Philippe Bouchaud. 2021. Economic Crises in a Model with Capital Scarcity and Self-Reflexive Confidence. *SSRN Electronic Journal* **56**. . [Crossref]

62. Karl Naumann-Woleske, Michael Benzaquen, Maxim Gusev, Dimitri Kroujiline. 2021. Capital Demand Driven Business Cycles: Mechanism and Effects. *SSRN Electronic Journal* **60**. . [Crossref]
63. Anindya S. Chakrabati, Abinash Mishra, Mohsen Mohaghegh. 2021. Distributional Effects of Targeted Interventions. *SSRN Electronic Journal* **92**. . [Crossref]
64. Karl Naumann-Woleske, Max Sina Knicker, Michael Benzaquen, Jean-Philippe Bouchaud. 2021. Exploration of the Parameter Space in Macroeconomic Agent-Based Models. *SSRN Electronic Journal* **6**. . [Crossref]
65. Jiequn Han, Yucheng Yang, Weinan E. 2021. DeepHAM: A Global Solution Method for Heterogeneous Agent Models with Aggregate Shocks. *SSRN Electronic Journal* **32**. . [Crossref]
66. John Muellbauer. 2020. Implications of household-level evidence for policy models: the case of macro-financial linkages. *Oxford Review of Economic Policy* **36**:3, 510-555. [Crossref]
67. Ray C Fair. 2020. Some important macro points. *Oxford Review of Economic Policy* **36**:3, 556-578. [Crossref]
68. Laura Feiveson, Nils Goernemann, Julie Hotchkiss, Karel Mertens, Jae Sim. 2020. Distributional Considerations for Monetary Policy Strategy. *Finance and Economics Discussion Series* **2020**:070, 1-27. [Crossref]
69. Donato Masciandaro, Francesco Passarelli. 2020. Populism, Political Pressure and Central Bank (in)Dependence. *Open Economies Review* **31**:3, 691-705. [Crossref]
70. Jiri Slacalek, Oreste Tristani, Giovanni L. Violante. 2020. Household balance sheet channels of monetary policy: A back of the envelope calculation for the euro area. *Journal of Economic Dynamics and Control* **115**, 103879. [Crossref]
71. Sergio de Ferra, Kurt Mitman, Federica Romei. 2020. Household heterogeneity and the transmission of foreign shocks. *Journal of International Economics* **124**, 103303. [Crossref]
72. D. N. Shults. 2020. Behavioral economics and DSGE-modeling. *Voprosy Ekonomiki* :1, 47-65. [Crossref]
73. Jeremy Kronick, Francisco G Villarreal. 2020. Monetary Policy, Income Inequality, and Inflation — What's the Link?. *SSRN Electronic Journal* . [Crossref]
74. Dimitris Papanikolaou, Lawrence Schmidt. 2020. Working Remotely and the Supply-Side Impact of COVID-19. *SSRN Electronic Journal* . [Crossref]
75. Sumit Agarwal, Yeow Hwee Chua, Pulak Ghosh, Changcheng Song. 2020. Consumption and Portfolio Rebalancing Response of Households to Monetary Policy: Evidence of the HANK Channel. *SSRN Electronic Journal* **109**. . [Crossref]
76. Mali Chivakul, Bernhard Kassner. 2019. Can Consumption Growth in China Keep Up as Investment Slows?. *Comparative Economic Studies* **61**:3, 381-412. [Crossref]
77. Xiang Deng, Xiang Cheng. 2019. Can ESG Indices Improve the Enterprises' Stock Market Performance?—An Empirical Study from China. *Sustainability* **11**:17, 4765. [Crossref]
78. Marcus Hagedorn, Jinfeng Luo, Iourii Manovskii, Kurt Mitman. 2019. Forward guidance. *Journal of Monetary Economics* **102**, 1-23. [Crossref]
79. Efrem Castelnuovo, Guay Lim. 2019. What Do We Know About the Macroeconomic Effects of Fiscal Policy? A Brief Survey of the Literature on Fiscal Multipliers. *Australian Economic Review* **52**:1, 78-93. [Crossref]
80. Philip Arestis. Critique of the New Consensus Macroeconomics and a Proposal for a More Keynesian Macroeconomic Model 1-44. [Crossref]
81. Ray C. Fair. 2019. Some Important Macro Points. *SSRN Electronic Journal* . [Crossref]

82. Jasper <!>de Jong, Emmanuel <!>de Veirman. 2019. Heterogeneity and Asymmetric Macroeconomic Effects of Changes in Loan-to-Value Limits. *SSRN Electronic Journal* . [Crossref]
83. Sebastian Poledna, Michael Gregor Miess, Cars H. Hommes. 2019. Economic Forecasting with an Agent-Based Model. *SSRN Electronic Journal* **135**. . [Crossref]