Research Statement

Matthew Rognlie, Northwestern University, August 2024

I am a macroeconomist specializing in the aggregate implications of heterogeneity. My work focuses on policy-relevant questions—such as inflation dynamics, the transmission of fiscal and monetary policy, and the long-term effects of population aging on the natural rate of interest—and how answers to these questions are shaped by micro-level behavior.

Macro models with heterogeneity can be difficult to solve, and it is not always clear what aspects of heterogeneity drive the aggregate results. My work addresses these challenges in two ways. First, it uses theory to narrow in on particular moments of the data that matter for aggregate outcomes, such as intertemporal MPCs for fiscal policy and compositional effects for population aging. Second, it develops new, powerful "sequence-space" solution methods that make it simpler and faster to solve models with extensive heterogeneity. These methods expand the set of models that are feasible to compute, and also provide an intuitive way to work with existing models.

In the following I describe my work grouped into three categories: "Heterogeneity and its short-run macro consequences", "Heterogeneity in the long run: secular trends and policy", and "Sequence-space solution methods".

Heterogeneity and its short-run macro consequences. My first line of work studies the aggregate implications of heterogeneity for classic short-run macro questions, such as the effects of shocks to fiscal policy, monetary policy, and exchange rates. A major theme is that when households have high average marginal propensities to consume (MPCs), macro transmission works differently, with a greater role for the feedback from real income to consumption. My work emphasizes how we can generalize MPCs—by looking at intertemporal MPCs, marginal propensities to earn (MPEs), and marginal propensities to save in different assets—to better understand these aggregate dynamics.

Fiscal policy. High MPCs have long been understood to matter for the transmission of fiscal policy, since feedback from income to consumption amplifies the direct effects of government spending. Traditionally, this process has been described using the Keynesian cross. In "The Intertemporal Keynesian Cross" [1] (with Adrien Auclert and Ludwig Straub, forthcoming at the *Journal of Political Economy*), we show that an intertemporal version of the Keynesian cross is present in modern, microfounded models, and that it is characterized not just by MPCs but by a new set of moments we call iMPCs ("intertemporal Marginal Propensities to Consume"). These iMPCs measure the response of household consumption to income received or expected in other periods.

We point out that iMPCs in the data follow a distinctive pattern: household spending spikes immediately after receiving a one-time transfer, and then remains elevated for several years. Matching these iMPCs rules out not only representative-agent models but also the two-agent

models ("TANK") that are often used to match MPCs. Instead, the data favors heterogeneous-agent models with limited liquidity. We show that this has important macro consequences: conditional on matching the same MPCs, models that also match iMPCs feature larger multipliers from deficit spending than previously thought.

In "Excess Savings and Twin Deficits: The Transmission of Fiscal Stimulus in Open Economies" [6] (with Rishabh Aggarwal, Auclert, and Straub, *NBER Macro Annual 2022*), we extend this analysis to the open economy. We show that persistent increases in government debt—such as those experienced worldwide during the pandemic—first cause surges in "excess savings", and eventually lead to trade deficits in countries that disproportionately increased their debt. There is also a distributional dimension: since the richest households have lower MPCs, they spend less out of their excess savings, and in equilibrium savings "trickle up" the wealth distribution. We further illustrate this mechanism in "The Trickling Up of Excess Savings" [5] (*AEA P&P*).

Monetary policy and business cycles. The heterogeneous-agent New Keynesian ("HANK") literature has recently revisited traditional macro questions, such as the propagation of monetary policy, with new models that better match important features of the micro data, like high MPCs and income and wealth inequality. Thus far, however, this work has been inconsistent with the macro time series evidence emphasized by an earlier literature (such as Christiano, Eichenbaum, and Evans), which featured inertial, hump-shaped impulse responses to shocks. In "Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model" [14] (with Auclert and Straub, R&R at the *American Economic Review*), we reconcile these two approaches for the first time, matching both micro and macro facts by allowing for slow household updating of expectations. Our estimated model shows that investment plays a decisive role in both the monetary transmission mechanism and business cycles more generally, since its direct effect on aggregate demand is amplified by iMPCs.

Exchange rates and energy shocks. In standard open-economy New Keynesian models, exchange rate depreciations generally boost aggregate demand through *expenditure switching*: agents reallocate their spending toward domestically produced goods. Empirically, however, the expansionary effects of depreciation are contested. In "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel" [12] (with Auclert, Martin Souchier, and Straub, R&R at the *American Economic Review*), we quantify the opposite *real income channel*: depreciations lower households' real incomes by raising the prices of imported goods, causing them to spend less on domestic goods as well. In an open-economy heterogeneous-agent model calibrated to match evidence on MPCs, we find that when short-run trade elasticities are realistically low, the real income channel can dominate, so that the net effect of depreciation is contractionary. In "Managing an Energy Shock: Fiscal and Monetary Policy" [2] (with Auclert, Hugo Monnery, and Straub, forthcoming in the *Proceedings of the Annual Conference of the Central Bank of Chile*), we show that a similar channel makes energy shocks more contractionary, which is important in understanding the effects of the 2021–22 energy price increase in Europe.

Marginal propensities to earn and save. Although much of my work focuses on the importance of marginal propensities to consume, I have also explored the role of other key moments in heterogeneous-agent models. In "MPCs, MPEs, and Multipliers: a Trilemma for New Keynesian Models" [4] (with Auclert and Bence Bardóczy, *Review of Economics and Statistics*), we study marginal propensities to earn (MPEs), which measure how much households reduce their earned income in response to a one-time transfer. We show that in models that match MPCs and have a flexible labor margin, MPEs are far too high compared to the data. This can be fixed by making consumption and labor complements in utility, but that implies unrealistically high fiscal multipliers; altogether, we have a "trilemma" where with flexible labor, it is impossible to match data on MPCs, MPEs, and multipliers at the same time. We show that one simple solution is to take agents off their labor supply curves by assuming sticky wages. This paper has helped shift the HANK literature away from its early assumptions of sticky prices and flexible labor supply.

In "Inelastic Asset Markets and Aggregate Demand" [18] (work in progress with Auclert, Straub, and Lingxuan Wu), we show that when assets are imperfectly substitutable, marginal propensities to save in particular assets matter. For instance, if a household chooses to invest in stocks rather than short-term bonds, aggregate demand will increase, since stock prices will rise and some households will consume out of the capital gains. We generalize the Keynesian cross to account for these potentially quite rich asset-market feedbacks.

Aggregate implications of micro price dynamics. While most of my work focuses on the aggregate implications of household heterogeneity, a similar approach is useful for other questions, like aggregate price dynamics. In "New Pricing Models, Same Old Phillips Curves?" [3] (with Auclert, Rodolfo Rigato, and Straub, *Quarterly Journal of Economics*), we study a widely-used class of state-dependent pricing models that can be used to fit micro-level price behavior. For the canonical model in this class, we prove a sharp equivalence result, showing that its first-order dynamics are exactly equivalent to a mixture of two time-dependent models, which reflect the extensive and intensive margins of adjustment. We show how this can be generalized to more complex models. Quantitatively, however, these mixtures turn out to be very similar to a simple Calvo model. In practice, therefore, we still have the standard New Keynesian Phillips curve—with a higher slope that reflects the well-known "selection effect" in price-setting, but an identical functional form.

This paper advances the literature by introducing new tools to derive aggregate inflation dynamics from micro-level price behavior. We show that these tools can be used directly within an otherwise standard New Keynesian model—going beyond the existing literature, which focuses on one-time permanent shocks to the money supply. At the same time, our results pose a challenge to existing models: since they deliver effectively the same Phillips curve, these models cannot solve the New Keynesian Phillips curve's widely acknowledged weaknesses, such as its lack of inertia and limited discounting of future shocks.

Other work on short-run dynamics and policy. Most of my work on short-run dynamics involves heterogeneous-agent models, but I have also worked with other models for related questions. In "Investment Hangover and the Great Recession" [8] (with Andrei Shleifer and Alp Simsek, *AEJ Macro*), we argue that a "hangover" from overbuilding can lead to recession, and show that ex-ante it can be optimal to restrict investment, although ex-post after a crash it is optimal to stimulate investment. In "What Lower Bound? Monetary Policy with Negative Interest Rates" [17], I study optimal monetary policy when the negative rates are possible, identifying the central tradeoff as being between demand stabilization and a distortionary subsidy to paper currency. Finally, in "Unique Equilibrium in the Eaton-Gersovitz Model of Sovereign Debt" [10] (with Auclert, *Journal of Monetary Economics*), we rule out the possibility of self-fulfilling crises in the canonical sovereign debt model—showing that other forces are needed to generate multiplicity. This model resembles the standard model of heterogeneous households in my other work, but heterogeneity is across countries instead, and the option to default adds complexity.

Heterogeneity in the long run: secular trends and policy. My next line of work studies major long-term questions that involve heterogeneity. This includes structural work that models the effects of secular trends, such as population aging and rising inequality, and also empirical work that hones our understanding of other trends, such as the evolving capital-labor split in income. I also use new theoretical methods to solve for long-run optimal policy in the presence of heterogeneity.

Effects of population aging and inequality. Due to rapidly falling fertility and longer lifespans, the world age distribution will shift upward throughout the 21st century. Since the old own more assets but work less than the rest of the population, this shift will have major macro consequences. In "Demographics, Wealth, and Global Imbalances in the Twenty-First Century" [13] (with Auclert, Hannes Malmberg, and Frederic Martenet, R&R at the *Review of Economic Studies*), we show that the macro effects of population aging can be captured by a simple statistic we call the "compositional effect", which rolls forward the forecasted shift in age distribution against fixed age profiles of assets and labor income. Combining this effect with sufficient statistics for the aggregate elasticities of asset supply and demand, we can derive general equilibrium changes in interest rates, wealth, and net foreign asset positions across countries.

Using harmonized micro-level wealth and income data for 25 countries, we apply this method and predict a continued fall in global real interest rates of 125 basis points through 2100. This refutes the influential "great demographic reversal" hypothesis, which holds that interest rates will ultimately rise as the baby boom generation retires and draws down savings. The reason for our finding is two-fold. First, in the data, the old do not draw down savings nearly as much as many life-cycle models would imply—instead, assets plateau at a relatively high level. Second, from a flow perspective, even though an older population has lower savings, slower population growth also implies lower net investment demand—so that the overall pressure on real interest

rates is still negative.

In "Inequality and Aggregate Demand" [16] (with Auclert), we perform a similar analysis of the effects of another secular trend: the rise in inequality. We show that high inequality can push down long-term interest rates and output, but only if it is driven by greater labor market risk (a point we also develop in a special case in [9]). If, on the other hand, inequality arises from a falling labor share, then long-term rates can actually increase.

Secular trends in income distribution and investment prices. In "Deciphering the Fall and Rise in the Net Capital Share: Accumulation or Scarcity?" [11] (*Brookings Papers on Economic Activity*), I document two main facts about the aggregate split between capital and labor income in the US and other major developed countries. First, the net long-term rise in the capital share is driven mostly by rising rental income in the housing sector. Second, once housing is removed, the remaining trend is U-shaped—with a postwar fall and more recent rise—and difficult to explain with returns on measured capital. Both facts cast doubt on the influential narrative by Piketty, which emphasizes capital accumulation as the cause of rising capital income.

This paper anticipated subsequent work in several ways. First, housing has proven to be an important driver of the factor income distribution—even, as Gutierrez and Piton (AER Insights 2020) have now shown, for the "corporate" sector in many countries. Second, I pointed out the importance of distinguishing between gross and net income shares, since gross shares are heavily influenced by the capitalization of fast-depreciating products like software—as described by Koh, Santaeulàlia-Llopis, and Zheng (Econometrica 2020). Finally, I argued that with housing removed, there was little connection between net capital income and measured capital, and that the residual could potentially be interpreted as a time-varying markup—anticipating in part the large subsequent literature on rising market power.

In "Capital Heterogeneity and Investment Prices: How Much Are Investment Prices Declining?" [19] (work in progress with François Gourio and Tom Holden), we tackle another major macro trend: the widely cited decline in the relative price of investment goods vs. consumption. We point out that the aggregate decline masks substantial heterogeneity: a few short-lived goods like computers have experienced large relative price declines, while many other investment goods, such as most structures, have actually seen relative price increases. The usual way to aggregate these prices, weighting by investment flows, is not correct for most economic questions and overstates the relevant price decline. With the correct weighting, the recent growth contribution of investment-specific technological change falls to nearly zero, and low net investment becomes much easier to explain.

Optimal long-run fiscal policy. In "Optimal Long-Run Fiscal Policy with Heterogeneous Agents" [15] (with Auclert, Michael Cai, and Straub), we study long-run fiscal policy—the optimal levels of debt, labor, and capital taxes—in a standard heterogeneous-agent model. Rather than maximizing steady-state welfare, which ignores transition costs, we seek the limiting steady state of a full Ramsey policy plan. Due to its technical difficulty, this has been rare in the heterogeneous-

agent literature. We show that the "stationarity" of these models, however, facilitates a simple characterization of the optimum, which boils down to a single scalar first-order condition.

Applying this condition, we find a surprising result: under balanced-growth preferences, a Ramsey steady state often does not exist—and when it does exist, the implied labor taxes are nearly 100%, leaving the economy close to immiseration. The primary reason for this result is that for the social planner, the Laffer curve slopes the wrong way: promising higher taxes in the future leads to higher discounted labor supply. This result calls into question the relevance of the landmark capital taxation result by Aiyagari, which assumed a Ramsey steady state for this model but never computed it. We discuss various ways in which a different model or social welfare criterion may produce a less extreme result.

Sequence-space solution methods. An important part of my research agenda has been to develop new computational methods for heterogeneous-agent economies. This has advanced in tandem with my other work: new methods make it possible to answer new economic questions, and new questions inspire new methods.

My central contribution is "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models" [7] (with Auclert, Bardóczy, and Straub, *Econometrica*). We propose obtaining first-order impulse responses as the solution to equations that are written directly in terms of *sequences* of aggregate variables. This "sequence-space" approach contrasts with the traditional "state-space" approach, which solves for a recursive law of motion of the entire economy, either to first order (the Reiter method) or globally subject to some approximations (the Krusell-Smith method). We argue that the sequence-space approach is faster and more practical for most heterogeneous-agent models, because unlike with state-space methods, the size of the sequence-space system does not scale with micro-level heterogeneity. Working directly with sequences also makes it easier to understand and decompose the mechanisms at play.

A key contribution in the paper is a fast algorithm to obtain the matrices ("sequence-space Jacobians") that form the linear system. With this algorithm, we are able to solve large heterogeneous-agent models at unprecedented speeds, and even do likelihood-based estimation for models (such as a rich two-asset model) where this had previously been out of reach—all without reducing the dimensionality of the state space, as is typically needed for state-space methods.

Our approach is rapidly growing in influence: for instance, our paper received 23 citations in 2021, 44 in 2022, and 101 in 2023. We maintain a popular code toolkit on GitHub, and also have held widely-attended workshops in the US and Europe, with code posted online, to teach sequence-space methods—work that has been supported by an NSF grant. We have further developed these methods in several other papers. For instance, in [14], we show how non-rational expectations about aggregate variables can be easily implemented by manipulating sequence-space Jacobians; in [3], we use sequence-space Jacobians to obtain a sharp characterization of

pricing models with fixed costs of adjustment; and in [15], a sequence-space representation is central to our new, tractable approach to characterizing Ramsey steady states.

Going forward, we are working to generalize the approach and overcome its current limitations, and have recently received a new NSF grant to fund this effort. For instance, although sequence-space systems efficiently represent models with vast micro-level heterogeneity, they can become impractically large in models that have many macro variables, such as large multi-region or multi-country models. In "Thinking Big: Determinacy and Large-Scale Solutions in the Sequence Space" [20] (work in progress with Auclert, Evan Majic, and Straub), we prove that the sequence-space Jacobians of stationary models have a certain "quasi-Toeplitz" structure, which we can exploit to make computation of large systems far more efficient. As an application, we solve a 177-country extension of our Intertemporal Keynesian Cross model—with heterogeneous agents in each country, and trade linkages taken from the data—in just a few seconds on a laptop. Using the same structure, we also derive criteria for determinacy and existence, providing a sequence-space counterpart to the Blanchard-Kahn conditions for state-space methods.

Another limitation is that in the presence of risk, [7] only gives first-order solutions with respect to aggregate shocks. We are currently working to overcome this limitation and extend the method to applications that require higher-order solutions. For instance, solving for the Ramsey steady state in [15] is significant in part because it is the starting point to solve for optimal policy in response to shocks. Further, in "When Do Endogenous Portfolios Matter for HANK?" [21] (work in progress with Auclert, Straub, and Tomáš Ťapák), we show how the sequence-space approach can be adapted to incorporate endogenous portfolio choice in the presence of aggregate risk, with second-order risk premia. We are optimistic that we can continue generalizing sequence-space methods—and their great benefits in handling heterogeneity—to higher-order applications.

Published papers (includes forthcoming)

1. "The Intertemporal Keynesian Cross" (with Adrien Auclert and Ludwig Straub), *Journal of Political Economy*, Forthcoming.

2. "Managing an Energy Shock: Fiscal and Monetary Policy" (with Adrien Auclert, Hugo Monnery, and Ludwig Straub), *Proceedings of the XXV Annual Conference of the Central Bank of Chile,* Forthcoming.

3. "New Pricing Models, Same Old Phillips Curves?" (with Adrien Auclert, Rodolfo Rigato, and Ludwig Straub), *Quarterly Journal of Economics*, February 2024, 139 (1), 121–186.

4. "MPCs, MPEs and Multipliers: a Trilemma for New Keynesian Models" (with Adrien Auclert and Bence Bardóczy*), *The Review of Economics and Statistics*, May 2023, 105(3), 700-712.

5. "The Trickling Up of Excess Savings" (with Adrien Auclert and Ludwig Straub), *American Economic Association Papers and Proceedings,* May 2023, 113, 70-75.

6. "Excess Savings and Twin Deficits: The Transmission of Fiscal Stimulus in Open Economies" (with Rishabh Aggarwal, Adrien Auclert, and Ludwig Straub), *NBER Macroeconomics Annual 2022*, May 2023, vol. 37, 325-412.

7. "Using the Sequence-Space Jacobian to Solve and Estimate Heterogeneous-Agent Models" (with Adrien Auclert, Bence Bardóczy*, and Ludwig Straub), *Econometrica*, September 2021, 89(5), 2375–2408.

8. "Investment Hangover and the Great Recession" (with Andrei Shleifer and Alp Simsek), *American Economic Journal: Macroeconomics*, April 2018, 10(2), 113–53.

9. "Aggregate Demand and the Top 1 Percent" (with Adrien Auclert), *American Economic Review: Papers and Proceedings*, May 2017, 107(5), 588–592.

10. "Unique Equilibrium in the Eaton–Gersovitz Model of Sovereign Debt" (with Adrien Auclert), *Journal of Monetary Economics*, December 2016, 84, 134–146.

11. "Deciphering the Fall and Rise in the Net Capital Share: Accumulation or Scarcity?", *Brookings Papers on Economic Activity Spring 2015*, 2016, 1–69.

* Current or former Northwestern graduate students.

Under revision

12. "Exchange Rates and Monetary Policy with Heterogeneous Agents: Sizing up the Real Income Channel" (with Adrien Auclert, Martin Souchier and Ludwig Straub), August 2024, Revise and Resubmit at the *American Economic Review.*

13. "Demographics, Wealth, and Global Imbalances in the 21st Century" (with Adrien Auclert, Hannes Malmberg, and Frédéric Martenet), November 2021, Revise and Resubmit at the *Review of Economic Studies.*

14. "Micro Jumps, Macro Humps: Monetary Policy and Business Cycles in an Estimated HANK Model" (with Adrien Auclert and Ludwig Straub), January 2020, Revise and Resubmit at the *American Economic Review.*

Working papers

15. "Optimal Long-Run Fiscal Policy with Heterogeneous Agents" (with Adrien Auclert, Michael Cai*, and Ludwig Straub), August 2024.

16. "Inequality and Aggregate Demand" (with Adrien Auclert), January 2020.

17. "What Lower Bound? Monetary Policy with Negative Interest Rates", July 2016.

Work in progress (presented at conferences / seminars)

18. "Inelastic Asset Markets and Aggregate Demand" (with Adrien Auclert, Ludwig Straub, and Lingxuan Wu).

19. "Capital Heterogeneity and Investment Prices: How Much Are Investment Prices Declining?" (with François Gourio and Tom Holden).

20. "Thinking Big: Determinacy and Large-Scale Solutions in the Sequence Space" (with Adrien Auclert, Evan Majic*, and Ludwig Straub).

21. "When Do Endogenous Portfolios Matter for HANK?" (with Adrien Auclert, Ludwig Straub, and Tomáš Ťapák).