

# Research Statement

Daniel Greenwald\*

March, 2022

My research agenda lies at the intersection of macroeconomics and finance, incorporating realistic financial features into general equilibrium models to derive quantitative results and policy implications. While empirical research has provided a huge amount of insight into economic and financial phenomena over the years, important questions remain that cannot be answered through reduced form analysis alone. Importantly, while purely empirical work excels at identifying cross-sectional differences, it is often impossible to directly measure the drivers of aggregate effects. Moreover, when considering new or counterfactual policies, the existing data typically cannot capture how the data generating process itself would change in a new environment. In my research, I work to address these gaps, using structural models to evaluate the sources of aggregate changes and the implied effects of alternative policies.

For a prime example of the value of this general equilibrium approach, consider the impact of loosening payment-to-income limits in the mortgage market. In the cross-section, payment-to-income ratios have been found to be poor predictors of default.<sup>1</sup> Seeing this cross-sectional pattern, the mortgage giants Fannie Mae and Freddie Mac began to relax their thresholds for these limits in the 1990s.<sup>2</sup> Importantly, however, this relationship holds in a *partial equilibrium* analysis holding house prices fixed. As my research has shown, relaxing payment-to-income limits was a key contributor to the massive boom and bust in house prices that followed, thereby contributing indirectly to the vast number of subsequent loan defaults and foreclosures. In this case, failure to consider the general equilibrium implications led to unexpected and ultimately catastrophic effects of a change in policy.

My research program can be divided into three main avenues. First, I demonstrate and quantify how the structure of mortgage markets influences the dynamics of house prices and the broader macroeconomy. In this work, I construct theoretical frameworks that capture important but understudied features of mortgage markets, and show that

---

\*Sloan School of Management, MIT, 100 Main Street, Cambridge, MA, 02142, [dlg@mit.edu](mailto:dlg@mit.edu).

<sup>1</sup>See e.g., DeFusco, Johnson, and Mondragon (2020).

<sup>2</sup>See Johnson (2020) for details of this change.

they are first-order for understanding the sources of the recent housing boom and bust, the effectiveness of macroprudential policies, and the implications of alternative mortgage designs.

Second, I propose new theories of how the structure of corporate debt shapes the macroeconomy. In one line of research, I show that standard interest coverage covenants observed on bank loans imply a novel channel through which interest rates can drive corporate borrowing and investment — one that is strong when rates are high, but negligible when rates are close to zero. In further work, I demonstrate that credit lines, which offer bank credit to firms at prenegotiated prices and quantities, allow vast amounts of credit to flow to large, profitable firms in bad times, but divert these resources to smaller, financially constrained firms. As a result, credit lines can generate larger recessions despite boosting corporate lending growth in the aggregate.

Third, I reveal the links between asset prices and inequality. I begin with the stock market, providing evidence that redistribution between labor compensation and profits has been a leading contributor to movements in stock prices at long horizons, and explains most of the abnormally large growth in stock prices since the 1989. Additional work conversely studies the effect of asset prices on inequality. Using household-level portfolio data, we find that heterogeneity in the revaluations caused by falling rates has been strong enough to explain all of the rise in financial wealth inequality since the 1980s. We show that these revaluations do not merely occur “on paper” but have major effects on household’s consumption possibilities, with younger, less wealthy cohorts losing, and older wealthier cohorts gaining.

## **Research: Housing and Mortgage Markets in the Macroeconomy.**

The bulk of my housing and mortgage research concerns if and how changes in credit conditions, such as the limits imposed by underwriters on new mortgages, influence house prices, with a particular focus on the housing boom and bust of the 2000s. While a substantial prior literature exists in this field, these papers have traditionally focused on the role played by loan-to-value (LTV) limits, which cap the size of a new loan as a fraction of the value of the property (i.e., minimum down payments).<sup>3</sup> These works have often pointed to a loosening of LTV limits as an important driver of the housing boom.

In “**The Mortgage Credit Channel of Macroeconomic Transmission,**” under revision at the *Journal of Political Economy*, I propose a new explanation, arguing that a relaxation of a second and much less studied limit was essential to the boom and bust, while changes in LTV limits played a minimal role. This alternative limit is the “payment-to-income”

---

<sup>3</sup>See e.g., Iacoviello (2005), Liu, Wang, and Zha (2013), and Favilukis, Ludvigson, and Van Nieuwerburgh (2017), among many others.

(PTI) limit, which caps a borrower’s mortgage payment as a fraction of his or her income. Although these limits are mainstays of the US mortgage system, this paper to my knowledge marks their first appearance in a general equilibrium model with endogenous house prices. The key economic mechanism is that when PTI limits are imposed alongside LTV limits, shifts in PTI limits can cause large movements in house prices — a phenomenon that I label the *constraint switching effect*.

To understand how this effect works, picture a borrower who is exactly limited by both constraints, so that a loan equal to 80% of the value of her target property (her LTV limit) would carry a mortgage payment equal to 36% of her income (her PTI limit).<sup>4</sup> Before finalizing the loan, however, the loan officer informs this borrower that the bank is now willing to approve her loans up to a 50% PTI ratio, corresponding to a much larger maximum loan balance. For a borrower who prefers to finance housing with credit rather than cash, this expansion of credit access is good news, but it comes with a catch: the property this borrower had originally chosen is not sufficiently valuable to collateralize the new, larger loan while satisfying her LTV limit. As a result, this borrower can obtain more credit, but only if she instead chooses to buy a larger, more valuable property.<sup>5</sup> When PTI limits loosen for many borrowers in parallel, this force can cause a large increase in housing demand and house prices at equilibrium.

I next apply this insight to investigate the sources of the 2000s housing boom. I show in loan-level data that PTI limits were massively loosened over this period, and use the model to argue that this relaxation was essential to the events that unfolded. Specifically, I find that a PTI liberalization of the magnitude observed in the data would by itself have generated a sizable boom, accounting for one-third of the actual rise in house prices and debt over this period. Moreover, I find that loose PTI limits allowed other forces (low interest rates and unrealistic house price expectations) to drive the remaining two-thirds of the boom, amplifying their influence by roughly 50%. In sharp contrast, I demonstrate that loosening LTV limits — the typical focus of the existing literature — cannot produce a large boom when PTI limits are enforced at historical levels, and, perhaps surprisingly, can even cause house prices to *fall*. As a result, I conclude that a regulatory cap on PTI ratios is a highly effective macroprudential policy that could have dramatically dampened the boom-bust cycle had it been in place, while a similar cap on LTV ratios would have been ineffective at slowing the boom.

In “**Managing a Housing Boom**,” joint with Jason Allen of the Bank of Canada, we refine the theory in Greenwald (2018) to provide theoretical guidance for policymakers concerned about rising property values. We augment the base theory with a key feature

---

<sup>4</sup>While this example is provided for intuition, the credit limit structure in fact strongly incentives borrowers to target a house price that satisfies these conditions.

<sup>5</sup>Equivalently, more expensive properties that would have previously needed to be financed largely by cash can now have a much larger share financed by credit, making them more appealing to this buyer.

prevalent in the US as well as many countries around the globe: a segmented mortgage market, with different debt limits in each submarket. We focus on Canada, where this takes the form of a government-insured sector that imposes tight PTI limits but low down payments, and an uninsured sector with the reverse pattern (loose PTI limits but large down payments).

While this segmentation might seem like a minor detail, it has far-reaching economic and policy consequences. First, a segmented market allows for much larger housing booms following an increase in household optimism, since PTI limits in the insured sector that would severely limit borrowing in a boom can be evaded by switching into the uninsured sector. Second, while tightening PTI limits across the board is highly effective at dampening house price growth, tightening these limits in the insured sector only can counterproductively *accelerate* the boom. Third, the effectiveness of down payment regulation depends crucially on the submarket in which it is imposed, with large effects on house prices but minimal effects on overall credit when applied in one submarket, and the reverse pattern in the other.

In “**Do Credit Conditions Move House Prices?**” joint with Adam Guren of Boston University, and revise and resubmit at the *American Economic Review*, we seek to address another key debate in this macro-housing literature. Although more than a decade has passed since the 2000s boom and bust, the field is far from consensus on the overall role played by credit in this episode. To date, prominent papers have produced widely divergent estimates of the contribution of credit to the rise in house prices, with some arguing that credit drove most of the cycle, while others have asserted that credit had virtually no effect on house prices over this period.<sup>6</sup> In this paper, we explain the source of these disparate results, and provide a methodology to reconcile them.

We show this discrepancy in results is, perhaps surprisingly, due to the way the market for rental housing is modeled, with papers to date making one of two “polar” assumptions. At one extreme lie papers that assume that rental markets do not exist, which find that credit expansions drive large house price appreciations. At the other extreme, papers that assume that deep-pocketed landlords can frictionlessly convert properties between owner-occupied and rented status find that any increased demand is completely absorbed by these landlords, who use arbitrage to keep the price of housing equal to the present value of rents, preventing any rise in prices.

We argue that both assumptions are too extreme: while households can switch from renting to owning, and vice versa, important frictions remain in rental markets, such as variation in the suitability of properties for renting, that prevent house prices from being

---

<sup>6</sup>Papers finding strong effects include Favilukis et al. (2017), as well as Greenwald (2018), described above. In contrast, Kaplan, Mitman, and Violante (2019) find close to zero influence of credit standards on house prices over this period.

fully arbitrated to rents. To capture this, we augment the model in Greenwald (2018) with a new rental market structure that can accommodate any intermediate level of frictions, while nesting these polar cases. We then demonstrate that the strength of these frictions can be pinned down by a new empirical moment: the change in house prices relative to the change in homeownership following a shock to credit. We estimate this moment in the data, use it to calibrate the model, and simulate a realistic boom-bust scenario to measure the effect of credit changes over this period. We find that the relaxation of credit standards played a major role, explaining between 34% and 55% of the rise in house prices. Our results are consistent with strong frictions, but are quantitatively distinct from either polar model, demonstrating the importance of allowing for intermediate degrees of segmentation.

The last portion of this line of research concerns the design of mortgage contracts. Following the destructive wave of foreclosures during the housing crash, some researchers and policymakers have begun to advocate for Shared Appreciation Mortgage (SAM) contracts that aim to prevent defaults by reducing the mortgage balance, mortgage payment, or both, when house prices fall. The drawback of such a contract is, of course, that it does not eliminate house price risk, but instead transfers it to the financial sector, which will now incur losses from reduced contractual repayments if house prices fall. These contracts therefore pose a potential threat to the health of the financial system that could offset or reverse the risk-sharing gains to households.

In “**Financial Fragility with SAM?**”, a *Journal of Finance* publication joint with Tim Landvoigt and Stijn Van Nieuwerburgh, we seek to evaluate the net benefit of these proposed contracts by testing them in a quantitative general equilibrium model of the intermediated mortgage market, in which house prices, mortgage rates, borrower default, and bank failure are all endogenous. We find that typical SAM implementations would indeed greatly increase financial fragility. The key to this result is accurately capturing the financial position of banks, who are on average much more levered than households, and finance themselves with potentially unstable short-term deposits. As a result, shifting house price risk from households to banks — which includes a large national component that is difficult to diversify — causes a much higher rate of bank failures and credit market disruptions following a national housing decline.

At the same time, our result does not rule out improvement over standard contracts. In particular, we find large possible gains from insuring homeowners against losses *relative* to the national average. This form of risk is much more geographically diversified, making it dramatically less risky for national banks. At the same time, this relief is highly efficient at reducing foreclosures, since it allocates debt forgiveness directly to borrowers in areas with the highest default rates. We hope these insights can help innovators in the policy and fintech space develop contracts to effectively reduce the harms associated

with foreclosure without destabilizing the financial system.

## **Research: Corporate Debt in the Macroeconomy**

Following my work in mortgage markets, I have applied a similar focus on institutional features of debt to the market for corporate credit.

My first entry fits into a decades-long effort by macroeconomic researchers to understand how changes in interest rates can influence firm output and investment through changes in firm debt limits. Historically, these limits have been modeled as caps on a firm's debt as a fraction of the market value of its assets, following Kiyotaki and Moore (1997). More recently, however, a new literature has begun to challenge this convention, noting that the actual debt limits written into credit agreements — often in the form of *debt covenants* — typically limit firm borrowing relative to earnings or EBITDA, rather than asset value, with potentially important economic implications.<sup>7</sup>

In “**Firm Debt Covenants and the Macroeconomy: The Interest Coverage Channel,**” I focus on interest coverage covenants, which limit the ratio of a firm's *interest payments*, rather than its debt balance, to a fraction of firm EBITDA. Although these covenants are extremely common, appearing in over 80% of syndicated loan agreements that contain financial covenants, they are new to this macroeconomic literature. Using a structural model, I demonstrate that the debt limits implied by these covenants are highly sensitive to movements in interest rates, creating a novel channel of amplification from interest rates into firm borrowing and investment. I confirm this hypothesis in firm-level data, finding that firms with interest coverage covenants increase their assets by nearly 10% in the 8Q following a 100bp drop in interest rates relative to similar firms with alternative covenant types.

Of central policy importance, however, my work implies that this new channel of interest rate transmission is *state dependent*. The key to this result is that the typical firm with debt covenants has both an interest coverage limit and a separate covenant limiting the *level* of its debt relative to its earnings. Because interest coverage limits are much more sensitive to interest rates, this channel will be stronger when more firms find interest coverage to be their tightest covenant. Since this occurs when interest rates are high, the model implies that this channel should be strong in high-rate environments, but have virtually no effect when rates are close to zero. Returning to the data, I find that following the same 100bp drop in interest rates, firms with both covenants increase their 8Q investment by an extra 2% for each additional percentage point in the initial interest rate, while firms with limits on the level of debt only show no evidence of state dependence.

In a second work on corporate credit titled “**The Credit Line Channel,**” joint with

---

<sup>7</sup>See e.g., Lian and Ma (2021) and Drechsel (2022).

John Krainer and Pascal Paul, and currently under review, we use highly detailed data to study the role of credit lines in firm debt dynamics. Our paper is motivated by the vast literature on financial frictions in macroeconomics, which is by and large concerned that in bad times, lenders will ration loans to firms or charge high spreads, starving firms of credit, and worsening the impact on investment and output. In this paper, however, we focus on a form of bank credit that is largely immune to these forces: credit lines. Because credit line facilities feature committed amounts and spreads that are negotiated in advance, they offer a source of guaranteed credit at reasonable rates in bad times, potentially neutralizing this credit crunch effect.

To test this, we use administrative Y14 data that provide a quarterly panel for virtually all corporate loans made by large US banks, and contains measures of credit line commitments and utilization not available from alternative sources. We find that undrawn credit line commitments are vast, in fact 40% larger than all used bank-firm credit from both credit lines and term loans *combined*. Moreover, they are used aggressively following negative economic events, explaining essentially all of the explosive rise of bank-firm credit following the outbreak of COVID-19, as well as the flow of credit following monetary policy shocks. Credit lines thus ensure a steady flow of total credit in bad times.

Importantly, however, we show that credit line capacity is highly concentrated among the largest, most profitable, and least financially constrained firms in the economy, leading this group to dominate bank borrowing in bad times. We further find that banks facing larger drawdowns on their credit lines cut credit to smaller firms without credit lines — an important spillover that appears driven by regulatory requirements. Because credit lines direct credit to large firms with a low propensity to invest, while crowding out firms with a high propensity to invest, our structural model implies that the drop in investment following a negative shock like COVID-19 may be *larger* due to the existence of credit lines, despite much larger growth in total corporate lending.

## **Research: Inequality and Asset Prices**

The final branch of my research studies the links between asset prices and inequality.

I begin with work on the fundamental drivers of the value of the stock market in **“How the Wealth was Won: Factor Shares as Market Fundamentals,”** joint with Martin Lettau and Sydney Ludvigson, which supersedes the earlier paper **“Origins of Stock Market Fluctuations.”** Our paper is motivated by a perhaps puzzling disconnect: while the real value of the stock market grew much faster over the 1989 - 2017 period (7.5% per annum) than the preceding 1966 - 1988 period (1.6% per annum), growth in real corporate output displays the exact opposite pattern, averaging 2.6% per annum from 1989 - 2017 compared to 3.9% per annum from 1966 - 1988.

These patterns pose a challenge to a literature that has often ascribed long-run changes in stock values to shifts in productivity. Instead, we propose an alternative source of fluctuations, arguing that changes in how output is divided between workers and owners of firms have been much more important than shocks to overall production in determining the value of the stock market over the last 60 years. Indeed, growth in real corporate *earnings* grew at a rate of 5.1% per annum over the 1989 - 2017 period, far outpacing the 1.8% growth in the 1966 - 1988 period, and matching the trend in stock prices. This divergence of corporate output and earnings was in turn made possible by opposing long-term fluctuations in labor's share of corporate output, which rose 5.4pp in the first period before declining 4.7pp in the second.

We formalize this argument by estimating a structural model of factor shares and asset prices. Our approach allows us to directly account for the roles of profit shares, interest rates, economic growth, and risk premia in driving asset prices quarter-by-quarter over the last six decades. Our main result is that 44% of the vast growth in stock wealth from 1989 to 2017 was caused by a shift in the division of output toward corporate profits, mostly at the expense of labor compensation. Economic growth accounted for less than half as much of the gains over this period (25%), while declines in risk premia (18%) and interest rates (14%) play smaller but important roles. These results contrast strongly with the 1952 - 1988 period, in which stock wealth rose by half as much, but virtually all of it was driven by economic growth.

In a follow-up paper, "**What Explains the COVID-19 Stock Market?**" joint with Josue Cox and Sydney Ludvigson, and revise and resubmit at the *Quarterly Journal of Finance*, we apply our model to the aftermath of the COVID-19 outbreak, during which the stock market lost one third of its value in less than one month, followed by a nearly full recovery in the following month. Given the vast economic dislocations at the time, it remained unclear whether the rebound was anomalous, or the initial drop was an overreaction.

Our model implies that changes in output, factor shares, and interest rates are not plausible candidates for explaining the initial drop. Given contemporaneous (and accurate) forecasts of output, and historical patterns of profit shares, expectations about cash flows should not have declined to this degree, while interest rates move the wrong direction. Instead, changes in market risk tolerance, appear to have played a dominant role. We support this explanation by showing that market movements around Federal Reserve announcements of financial market interventions explain a large share of the stock market recovery.

The final paper linking asset prices and inequality, "**Financial and Total Wealth Inequality with Declining Interest Rates,**" joint with Matteo Leombroni, Hanno Lustig, and Stijn Van Nieuwerburgh, is motivated by the very strong comovement between interest rates and financial inequality since the 1950s, with interest rates rising then falling,



and inequality displaying the opposite pattern. We first investigate whether changes in interest rates can plausibly account these changes in inequality. While it is clear that declines in interest rates can increase asset values, how those changes affect inequality depends on how the exposure of household portfolios to interest rates varies across the wealth distribution. Combining household-level data with a statistical asset pricing model, we measure the interest rate exposure of portfolios household-by-household. We find that the portfolios of the wealthy appreciate proportionally more as rates fall, worsening inequality. We estimate that this repricing effect is quantitatively powerful, fully explaining the observed rise in inequality over this period.

Because changes in interest rates can alter the valuation of the same set of cash flows, whether these changes in measured inequality reflect actual changes in consumption possibilities, or merely “paper” gains and losses, is far from obvious. To resolve this, we build a quantitative heterogeneous agents model with portfolio exposures drawn from our empirical estimates. We find that for households to afford the same consumption path they would have followed before rates fell, the top-10% financial wealth share needed to *fall* by more than 7pp, rather than rising 9pp in the data. This discrepancy implies substantial changes in consumption and welfare for households. Younger and less wealthy households lose, as they struggle to first accumulate retirement savings, then spend out of interest income once retired. In contrast, older and wealthier households benefit due to large one-time capital gains that more than offset this lost interest income.

## **Research: Additional Papers**

In “**Rare Shocks, Great Recessions,**” a *Journal of Applied Econometrics* publication joint with Vasco Cúrdia and Marco Del Negro, we estimate a macroeconomic model that departs from the typical assumption of Gaussianity to allow for rare, large shocks. We not only find strong evidence for these fat-tailed shocks in the macroeconomic data, but also show that accounting for them changes our inference about shifts in volatility over time. Specifically, models without rare large shocks appear to confuse their occurrence (or absence) with *persistent* changes in volatility, potentially overstating both the magnitude of the Great Moderation since the 1980s, as well as the likelihood of continued volatility following the Great Recession of the 2000s.

## **Future Research**

As the above papers move through the publication process, I am looking ahead at a longer-term agenda constructing large data sets to apply to the topics described above. In ongoing work in the housing and mortgage side, I have acquired proprietary data from Infutor that can be merged to map the address histories of most US adults to the owner

of their residence at that time. I plan to use these data to reveal individual-level patterns of homeownership, mobility, and speculative investments, that are central to economic theories but are difficult to discern in publicly available data. On the corporate debt side, I have also begin preparations to obtain new measures of debt covenants directly from SEC filings that should go beyond the subset of corporate debt covenants available in DealScan. In both cases, these novel data should help ask and answer important questions that to date have been limited by the availability of empirical evidence.

## References

- ALLEN, J. AND D. L. GREENWALD (2022): “Managing a Housing Boom,” Working Paper, MIT Sloan School of Management.
- COX, J., D. L. GREENWALD, AND S. C. LUDVIGSON (2020): “What Explains the COVID-19 Stock Market?” NBER Working Paper No. 27784.
- CÚRDIA, V., M. DEL NEGRO, AND D. L. GREENWALD (2014): “Rare Shocks, Great Recessions,” *Journal of Applied Econometrics*, 29, 1031–1052.
- DEFUSCO, A. A., S. JOHNSON, AND J. MONDRAGON (2020): “Regulating Household Leverage,” *The Review of Economic Studies*, 87, 914–958.
- DRECHSEL, T. (2022): “Earnings-Based Borrowing Constraints and Macroeconomic Fluctuations,” Working Paper, University of Maryland.
- FAVILUKIS, J., S. C. LUDVIGSON, AND S. VAN NIEUWERBURGH (2017): “The Macroeconomic Effects of Housing Wealth, Housing Finance, and Limited Risk Sharing in General Equilibrium,” *Journal of Political Economy*, 125, 140–223.
- GREENWALD, D. L. (2018): “The Mortgage Credit Channel of Macroeconomic Transmission,” MIT Sloan Research Paper No. 5184-16.
- (2019): “Firm Debt Covenants and the Macroeconomy: The Interest Coverage Channel,” Working Paper, MIT Sloan.
- GREENWALD, D. L. AND A. GUREN (2019): “Do Credit Conditions Move House Prices?” MIT Sloan Research Paper No. 5910-19.
- GREENWALD, D. L., J. KRAINER, AND P. PAUL (2021a): “The Credit Line Channel,” Federal Reserve Bank of San Francisco.
- GREENWALD, D. L., T. LANDVOIGT, AND S. VAN NIEUWERBURGH (2021b): “Financial Fragility With SAM?” *The Journal of Finance*, 76, 651–706.
- GREENWALD, D. L., M. LEOMBRONI, H. LUSTIG, AND S. VAN NIEUWERBURGH (2022): “Financial and Total Wealth Inequality With Declining Interest Rates,” Working Paper, MIT Sloan School of Management.
- GREENWALD, D. L., M. LETTAU, AND S. C. LUDVIGSON (2016): “Origins of Stock Market Fluctuations,” Working Paper, New York University.
- (2021c): “How the Wealth Was Won: Factors Shares as Market Fundamentals,” Working Paper, MIT Sloan School of Management.

- IACOVIELLO, M. (2005): "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle," *American Economic Review*, 739–764.
- JOHNSON, S. (2020): "Mortgage Leverage and House Prices," Working Paper, Rice University.
- KAPLAN, G., K. MITMAN, AND G. L. VIOLANTE (2019): "The Housing Boom and Bust: Model Meets Evidence," *Journal of Political Economy*, Forthcoming.
- KIYOTAKI, N. AND J. MOORE (1997): "Credit Cycles," *Journal of Political Economy*, 105.
- LIAN, C. AND Y. MA (2021): "Anatomy of Corporate Borrowing Constraints," *The Quarterly Journal of Economics*, 136, 229–291.
- LIU, Z., P. WANG, AND T. ZHA (2013): "Land-Price Dynamics and Macroeconomic Fluctuations," *Econometrica*, 81, 1147–1184.