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Is Monetary Policy Neutral? The Effectiveness of Monetary Policy Transmission across the Income Distribution

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Abstract

This paper analyzes the role of the interest rate channel of monetary policy on household consumption sensitivities across the income distribution. To study this, I build a heterogenous agent model where households experience interest rate shocks as a proxy for monetary policy in addition to income shocks. I find that the poorest quintile increases consumption by about 4.5% in response to a recessionary interest rate cut, with this effect weakening for each additional quintile. When interest rate shocks differ by income group, the poorest lose about 3.6% of consumption and monetary policy's effect on aggregate consumption weakens. When the income distribution skews more toward the upper quintiles, these effects amplify. If agents lose income in recessions, the effect of an interest rate cut is greatly dependent on whether households are subject to disparate rate policy. My results suggest that the traditional interest rate channel might be less effective at stimulating demand for high income individuals than as intended by policy makers.

[1] I would like to thank Professor Kathrin Ellieroth, who advised me throughout this academic year. Your guidance and insight (especially on the quantitative side) made this process most rewarding for me. I would also like to thank Professor Michael Donihue, who kept all of us motivated throughout the year and provided great feedback throughout. I thank Professor Samara Gunter, who encouraged me to undertake this research at the end of my junior year. Finally, I'd like to thank my family and friends, who encouraged me throughout this experience and made my time at Colby better than I could have ever asked for.

Introduction & Motivations

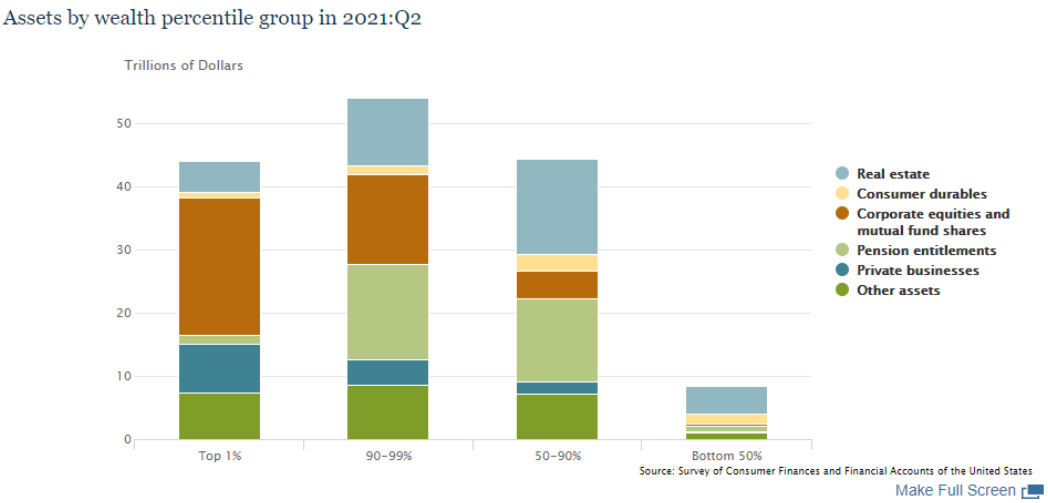
The current monetary policy stance has affected individual outcomes in the macroeconomy with varying strength. In this paper, I analyze the effect of the monetary transmission mechanism and its central interest rate channel, where a central bank influences the economy through a change in short-term nominal interest rates. Most macroeconomic models study the effects of monetary policy using a single representative household. Conversely, I incorporate income and interest rate heterogeneity to study how monetary policy affects households at different levels of the income distribution. Most importantly, I attempt to answer whether monetary policy has distributional effects that could worsen inequality. I find that interest rate shocks influence agent's consumption changes at different levels.

Following the Great Recession, Federal Reserve policy has come under heightened scrutiny from economists of differing schools of thought, as well as politicians across the aisle.[2] Major concerns often cite the current regime of low interest rates and unconventional monetary policy being unable to influence demand as well as perpetuating inequality. Some have even called for the Fed to incorporate an inequality component to their dual mandate. By any measure, income and wealth inequality have increased steadily since 1980, and the rate of this increased has heightened throughout the recovery from the Great Recession.[3]

Figure 1 shows the distribution of asset ownership across certain wealth percentiles as of 2021:2. The startling reality in the United States is that the top 1% own an almost identical

[2] Notable political critiques include Ron Paul's, *End the Fed*. Economist critiques include Selgin and Lastrapes (2012) as well as John Taylor in the years following the recession. Recently, former Treasury Secretary Lawrence Summers criticized the Powell Fed for being "behind the curve" regarding the current bout of inflation beginning in 2021.

[3] Both the Gini coefficient and income shares of the wealthiest cohorts have indicated worsening inequality, and these are expected to accelerate following the COVID-19 Pandemic.



Wealth component	Top 1% (US$ Trillions)	90-99% (US$ Trillions)	50-90% (US$ Trillions)	Bottom 50% (US$ Trillions)
Real estate	4.96	10.62	14.97	4.33
Consumer durables	0.84	1.43	2.78	1.64
Corporate equities and mutual fund shares	21.71	14.16	4.24	0.26
Pension entitlements	1.46	15.22	13.31	0.96
Private businesses	7.67	4.02	1.85	0.16
Other assets	7.41	8.56	7.22	1.03

Note: *Distributions by generation are defined by birth year as follows: Silent and Earlier=born before 1946, Baby Boomer=born 1946-1964, Gen X=born 1965-1980, and Millennial=born 1981-1996.*

Figure 1. Asset ownership by wealth percentile in the US, source: FED Quarterly SCF

amount of the total assets as the top 50-90% and nearly six times the amount that the bottom 50% of households own. When extrapolated to just the stock market, the results appear even more disproportionate: the top 1% and top 10% of households own 54% and 89% of stocks, respectively. The basic theory behind this contribution to inequality is simple: higher income households can both save and invest more, and low interest rates (yields) for fixed income securities led to massive capital inflows into equities, which returned a compounded 252.96% for the decade following the Great Recession.[4]

To study the effectiveness of monetary transmission through the interest rate channel, I model the effects of interest rate shocks on heterogenous households within a dynamic partial-equilibrium. In my model, agents choose each period between current consumption and

[4] Damodaran, A. "Historical Returns on Stocks, Bonds and Bills: 1928-2020." (2021).

borrowing in a one-period debt. I employ stochastic monetary policy shocks that affect the consumption patterns of forward-looking households endowed with disparate exogenous income. Then, simulate an economy that contains an income distribution with five quintiles that mirrors the current distributional picture in the US. In addition, I observe the relative sensitivities of households to interest rate shocks.

I find that interest rate cuts in recessions stimulate consumption by about 4.5% for the lowest income quintile. The highest income quintile is much less responsive, increasing consumption by about 0.2%. In relative terms, the poor are more sensitive to interest rate shocks than high income households by a ratio of more than 20. When agents are shocked with different interest rate policies, this ratio widens and the poorest lose consumption because of the interest rate channel transmission. Regarding the income distribution, I observe that the current levels of inequality may diminish the intended effects of monetary policy transmission. In addition, when agents lose income in recessions, monetary policy becomes much less effective at stimulating consumption. This effect varies significantly depending on the interest rate environment, both for each income quintile and in the aggregate.

The rest of the paper is laid out as follows, part two includes a significant review of the literature discussing monetary policy transmission, and part three outlines the quantitative model framework and calibration. Part four covers empirical data and part five presents the main results. Finally, part six analyzes the key findings of my analyses and part seven concludes.

II - Literature Review

Contemporary Macroeconomic Modeling

Modern macroeconomic models have aimed to replicate stylized facts whilst being rooted in microfoundations. These models are known as Dynamic Stochastic General Equilibrium

(DSGE) models and are used for policy analysis in both the private and public sector.[5] Sbordone et. al, (2010) explains DSGE models and their use, highlighting the interactions between a demand, supply, and monetary policy block. These models are dynamic in that agents' expectations about future periods affect today's choices, stochastic in that random events shock the economy, disrupting steady state conditions for both households and firms, and achieve general equilibrium in that each of the interacting markets clear for every period in the model.

A major reason for the acceptance of DSGE models is their microfoundations, which generally render them Lucas Critique robust. Building off prior work which theorized rational expectations among agents, Lucas (1976) contended that large scale macroeconometric models were unfit for policy analysis, due to their lack of microfounded parameters.[6] Essentially, the historical relationships of these models reflected only the monetary or fiscal policy regimes that were present throughout the early 20th century. The Lucas Critique came at an inflection point in economic history where the Phillips curve's traditional interpretive relationship began to break down.[7] This real-world event served as evidence backing Lucas, especially his idea of policy invariance, which implied that the predictive power of the Phillips curve extended to only the monetary regimes and data of the early 20th century.

The Monetary Transmission Mechanism

Important to this paper's analysis is an understanding of the empirical and theoretical backing behind the monetary transmission mechanism. The most basic theory contends that monetary authorities can use their policy variable to directly affect the overall cost of

[5] Such models have been adapted at a central bank level. Notable uses include Smet and Wouters (2007) at the ECB and the Federal Reserve Board's comprehensive model *FRB.US* includes over 100 endogenous variables and 50 stochastic identities.
[6] Muth (1961) outlines the idea of rational expectations as agents making use of all pertinent information within a model in order to form expectations on the future.
[7] There occurred both high unemployment and inflation in the mid-1970s.

capital/borrowing in the economy, which then influences the real economy through spending and investment. In addition, the policy variable has direct intertemporal substitution and wealth effects on consumption. This is known as the interest rate channel. While the literature body suggests that interest rate channel has remained the core channel of transmission, some empirics indicate that the interest rate view appears to have weak effects on the cost of capital variable.

Bernanke and Gertler (1995) argue for the credit view of monetary transmission, which states that frictions create an external finance premium, which represents the spread between firms internal and external cost of capital and additionally induces lenders to take on risk.[8] They explain two of mechanisms through which the credit channel transmits: the balance sheet channel and the bank lending channel. The balance sheet channel posits that a borrower's external finance premium is decided by their net worth, and their cost of capital should have an inverse relationship with their financial standing. Thus, changes in borrower's balance sheets should theoretically affect their financial decision-making, which is supported by Bernanke and Gertler's connections between balance sheet metrics to firms' fixed investment and inventories. In addition, there are links between the household balance sheet and durable goods expenditures.

The bank lending channel simply describes the effect of monetary policy on the supply of intermediated credit. For example, a reduction in the supply of loanable funds should increase a borrower's external finance premium and in turn decrease real economic activity. Later research by Boivin, et. al (2010) found within a DSGE framework that the external finance premium may serve as an exogenous shock that drives aggregate fluctuations, rather than an endogenous parameter within the credit view.

[8] Frictions include imperfect information among market participants, or strong regulations.

Heterogenous Agent Models

In order to study the responses of disparately endowed agents in response to economic shocks, quantitative macroeconomists have turned to HANK (Heterogenous Agent New Keynesian) models. These models introduce idiosyncratic risk into standard New Keynesian models that are now widely used in monetary policy analysis. HANK model research often contends that the heterogeneity incorporated in such models brings into question many policy issues, such as monetary transmission.

Acharya and Dogra (2018) examine the consequences of heterogeneity in the macroeconomy, specifically a household's marginal propensity to consume (MPC). They find that heterogeneity and imperfect markets have significant effects on the standard New Keynesian framework, in that the cyclicality of risk greatly changes the effectiveness of monetary policy. Such models can study heterogenous sensitivities of income shocks in recessionary periods and are able to determine which representative households lose the most as well as how they are affected by monetary policy measures.

(Kaplan et al., 2018) examine the monetary transmission mechanism's effect on household consumption under a HANK framework. Their model allows households to invest their savings in two assets that vary in liquidity and return. The authors find that the indirect effects of interest rate shocks (expansion of labor demand, which improves labor incomes) on consumption comprise a great deal of their model's empirical results, in contrast to direct effects which concern the household's intertemporal substitution problem. This contrasts with the standard New Keynesian model, where the majority of consumption effects are direct.

Distributional Effects of Unconventional Monetary Policy

The Federal Reserve's (and peer central bank) employment of aggressive unconventional monetary policy measures has brought about many questions, especially with regard to distribution of incomes and risk throughout the economy and financial system. At the same time, both wealth and income equality have increased greatly by nearly every measure in the United States since 1980, and these disparities have accelerated in the expansionary period following the Great Recession. Despite these trends, many policy makers have been quick to dispel speculation concerning the relationship between recent monetary policy and inequality, with former Fed chairman Ben Bernanke stating he had "doubts" about such a relationship as recently as 2016.

Aside from public opinion and financial market commentary, there is a burgeoning literature on this topic. This body of research identifies a relatively novel channel of monetary transmission known as the redistribution channel. Auclert (2019) decomposes the redistribution channel, finding that both capital gains and losses have a stated effect on monetary policy transmission. Importantly, Auclert asserts that lower real rates benefit low MPC asset owners and can diminish the effectiveness of nominal interest rate cuts as a tool to stimulate demand. Essentially describing the macroeconomic environment of the last 13 years, this finding has serious implications for monetary policy. Albert, et. al (2019) examine the redistributive effects of unconventional monetary policy in the US, finding that there were significant undesirable distributional outcomes transmitted through the portfolio channel.[9]

Other research examines how monetary shocks can affect different ends of the distribution. Amberg, et. al (2021) study distributional consequences of monetary shocks using Swedish data, finding that the income redistributive effects are U-shaped. Specifically, income

[9] The portfolio channel of monetary policy transmission essentially states that low yields will induce investors to rebalance their holdings to assets with higher expected returns (generally fixed income to equities).

shocks are much greater for low- and high-income individuals relative to the middle class. Perhaps this finding can be one explanation for the shrinking middle class, as well as monetary policy's inability to affect demand at the margin. Gornemann, et. al (2016) similarly find that low-income households are most sensitive to monetary shocks – introducing heterogeneity into the standard NK model increases volatility of consumption by more than 10% and GDP by around 4%.

The effect of the declining neutral rate of interest (r*) has also come into the view of researchers. As a result, many economists have raised the questioned whether declining interest rates have a direct causal effect on inequality, or if the two have worked in tandem. Mian, et. al (2021) observed that rising income inequality is a significant factor explaining the decline in r* over the last forty years, contrary to the view that demographic changes have led the decline.[10] Also important is the author's observation that inequality should become a key parameter in large-scale macroeconomic models that inform policy making.

Monetary Policy and Nonbanks

As nonbank intermediaries take a larger position within both corporate and household credit markets, the question of whether monetary policy effectively transmits to these entities has arisen.[11] While the literature clearly indicates that traditional banks' supply of credit works countercyclically to monetary policy, it is unclear whether nonbanks augment the strength of the credit view of monetary policy.

[10] The standard view contends that the aging of the baby boomers (who have high saving rates) has caused the decline in the natural rate of interest. However, Mian, et. al find that there were no major shifts in income across age groups. Instead, the increase in income shares of high earners and subsequent increased levels of saving are likely to have a greater effect.

[11] Nonbank intermediaries include financial institutions such as hedge and other pooled investment funds, private equity and venture capital firms, and broker dealers. In addition to these, insurance firms, pawn shops, payday lending services, and other lending operations are considered nonbank intermediaries due to their lack of national or international regulation.

Elliot et. al (2019) find that nonbank credit supply expands relative to banks as a result of contractionary monetary policy, and this liquidity likely shifts from banks to nonbanks. Nonbanks can then increase their lending, which weakens monetary policy transmission by offsetting the reduction in the credit supply by nonbanks. This effect is stronger in consumer credit markets, especially auto lending where nonbanks increase their credit supply by 10% following a hike in the policy rate. Most importantly, the increasing presence of nonbank lenders within credit markets may hinder the Fed's ability to properly counteract future shocks in these markets. Despite the growing share of nonbanks throughout global financial markets, there is a distinct lack of research on this topic.

The effect of nonbanks is likely to extend to mortgage markets. Leu and Robertson (2021) observe that following the Fed's first two rounds of quantitative easing and subsequent attempt to reduce the MBS holdings on their balance sheet, nonbanks were able to fill gaps in mortgage lending left by banks. Lacking the regulatory burden that traditional banks face, nonbanks receive funding to originate MBS and have been in a stronger financial position than banks since the Great Recession. Fed policy is likely to have a role in this phenomenon, especially due to government conservatorship of Freddie Mac and Fannie Mae as well as LSAPs which included the purchase of nearly $40 billion each month in agency MBS at the height of the response to the COVID-19 pandemic. This government backstopping is believed to drive both liquidity and demand for these securities, creating a high-yielding investment with relatively low risk.

LendingClub

LendingClub was a P2P loan platform that originated more than $20B in unsecured loans ranging from $1,000-$40,000 from 2007-2020. It was the first lender of its time to register its

loans as securities with the SEC, and these loans were traded on a secondary market.[12] LendingClub's notes generally matured after three years, and investors were able to browse loans on the website's lending platform. They could then choose to invest in specific notes whereby investors collected interest payments from the loans and LendingClub received fees from both parties.[13] LendingClub assigned a grade to each note, which was dependent on each borrower's credit profile. Grades ranged from A1 to C5 and had a corresponding interest rate. As of 2020, notes with A1 and C5 ratings yielded 6.46% and 17.74%, respectively. The interest rates varied significantly over time: for example, LendingClub was forced to hike the rates they charged on notes three times in 2016, due to an inability to generate enough institutional capital to satisfy borrower demand.[14]

III – Model

To analyze the traditional interest rate channel of monetary transmission, I consider an economy with infinitely lived agents and discrete time *t* that continues forever. In the model, exogenous shocks to income and interest rates affect the agent's choice between consumption and borrowing. Agents maximize log utility of consumption, and their value function *V* is denoted:

$$
\begin{aligned}
& V(z,a,y) = \max_{c,\, a'} [u(c) + \beta \mathbb{E} max(V'(z',a',y'), VB'(y'))] \\
\text{s.to} \quad & c + (1+zr)a = a' + y \\
& a' \geq a,\ c \geq 0 \quad y \sim i.i.d \\
& a_0\ given.
\end{aligned}
\tag{1}
$$

[12] LendingClub referred to these as Notes.
[13] Information on the borrower was given, in addition to the amount of loan, loan grade, and purpose.
[14] Michael Corkery, "As Lending Club Stumbles, Its Entire Industry Faces Skepticism," The New York Times (The New York Times, May 10, 2016), https://www.nytimes.com/2016/05/10/business/dealbook/as-lending-club-stumbles-its-entire-industry-faces-skepticism.html?_r=0.

To maximize lifetime utility captured by the value function, agents choose between current consumption *c* and future borrowing *a'* in riskless one-period debt.[15] In addition, they maximize expected value in the future, discounted by β.

The budget constraint states that consumption in the present is paid for by current period borrowing plus income. In addition, agents cannot save and are constrained in that they cannot consume negatively to balance out excess borrowing. In the present, agents experience exogenous interest rate shock *z* and income shock *y* and then must choose between staying solvent *V'*(*z'*, *a'*, *y'*) and bankruptcy *VB'*(*y'*).

Bankruptcy *VB*(*y'*), lasts for one period in the model. The bankrupt's value function is given:

$$\begin{aligned} & VB(y) = \max_{c}[u(c) + \beta \mathbb{E} max(V'(z', a', y'), VB'(y'))] \\ \text{s.to} \quad & c = y - \Theta \\ & c \geq 0 \quad y \sim i.i.d \end{aligned} \tag{2}$$

In this state, agents can no longer borrow and current period debt a_t is forgiven. Thus, bankrupts must consume out of their current income *y* subtracted by θ, which captures the bankruptcy penalty. In the next period, agents in bankruptcy must choose between solvency *V'*(*z'*, *a'*, *y'*) and remaining in bankruptcy *VB'*(*y'*).

Calibration

Interest rate shock *z* is a Markov process that serves as a proxy to monetary policy shocks. To simulate business cycles in the economy, there are two states representing normal times and a recession. For the sake of simplicity, the conditional probability of remaining in

[15] Debt market frictions are not the focus of this paper; thus, agents borrow in perfect markets.

normal times given being in normal times in the current period is equal to the conditional probability of staying in a recession in the future given being in a recession in the current period. This is captured by*:*

Pr(z' = normal times|z = normal times) = Pr(z' = recession|z = recession) = 0.91, so that a recession occurs every 11 years. The Markov process can be viewed in matrix form:

$$\begin{bmatrix} \pi_{normal|normal} & \pi_{recession|normal} \\ \pi_{normal|recession} & \pi_{recession|recession} \end{bmatrix}$$

Agents are in the model are rational and use these probabilities to form an expectation for the future, dynamically solving their optimization problem. For the baseline model simulation, I assume procyclicality of interest rate policy, where rate cuts occur during a recessionary period and vice versa.

Interest rate r is a weighted estimate of common consumer credit metrics, namely the average of mortgage rates and credit card APRs from 2010:1 – 2021:3. In each recessionary period, a 4% interest rate cut occurs, which is the average response by the Federal Reserve over the last two recessionary periods.[16]

The inclusion of exogenous income parameter y allows me to incorporate heterogeneity into the model, as well as simulate distributional income effects of the model economy. Consequently, y is an independent and identically distributed random variable that takes five states; thus, the agents have an identical chance of being endowed with each income level every period. This allows me to study income quintiles, which depict enough of the income distribution without sacrificing tractability. While the absolute level of the income parameters is unimportant, the relative level of each income quintile was found using recent SCF data. As a result, the

[16] Peak to trough.

highest quintile is endowed with a 61% share of the total income, matching distribution at present.[17]

Table 1 summarizes the 10 exogenous parameters and their targets. The discount factor of 0.99 is common in such macro models. To create a utility cost of bankruptcy, I set Θ at .3, or 30% of income, so that few agents in the model default. [18]

External Parameters			
Parameter		Value	Source
Prob. of recession	π	0.91	cycle lasts 11 years
Interest rate in normal times	r_{high}	11%	Composite estimate
Interest rate in recessions	r_{low}	8%	Average rate cut
1st income quintile	*y1*	10	SCF estimates 2019
2nd income quintile	*y2*	23	"" ""
3rd income quintile	*y3*	38	"" ""
4th income quintile	*y4*	63	"" ""
5th income quintile	*y5*	210	"" ""
Discount factor	β	0.99	Standard estimate
Bankruptcy penalty	Θ	30% of y	Exler and Tertilt (2020)

Table 1 – externally calibrated parameters

Solution and Simulation

To solve the model, I reduce the representative value function into a Bellman equation and then perform a value function iteration algorithm using MATLAB. Agents choose their borrowing over a grid of 100 evenly spaced points, which is bounded by zero and the average debt-to-income of about 20% in the US. To obtain equilibrium, I first initialize a guess for the agent's value function with large negative number. The model then iterates until the difference

[17] Calculating relative total incomes of each quantile yields almost the same result as each quintile's share of overall income in the US.
[18] Similar to the result of Exler and Tertilt (2020), who find a bankruptcy rate of less than 1%.

between the guess and the large number is less than a chosen tolerance level. Thus, the agent's optimal choice is found.

To achieve stationarity of both shock parameters, I simulate the model over 10,000 periods and 2500 heterogenous agents. This allows me to analyze relative consumption responses to monetary policy shocks across the income distribution, and in the aggregate macroeconomy.

IV - Data

Time Series Relationships of Key Interest Rates

To examine the empirical relationships that make up the interest rate channel, I use time series data on various interest rates from the FRED. Central to the analysis is the effective Federal Funds rate, which I consider exogenous with respect to the other series. I study interest rates on 48-month automobile loans, 30-year fixed-rate mortgages, 24-month personal loans, the bank prime loan rate, and an aggregated credit card rating average across all plans.[19] To match frequencies, the data is quarterly averaged, and begins in 1972:1 and runs to the present.[20] Figure 2 presents simple plots of each of the interest rates over the sample period. While the data appear to follow the path of the Fed's policy variable prior to the 2008 Financial Crisis, this effect seems to weaken in the years following (save for the prime loan rate).

LendingClub

Due to its separation from more traditional consumer credit markets, LendingClub's loan data presents a chance to examine how Fed policy affects shadow and nonbank entities. With the advent and widespread adoption of decentralized banking platforms, there is significant interest

[19] This serves as an index of the interest charged to the most creditworthy customers, while the average rating is indicative of the entire banked population that uses a credit card.
[20] The credit card data begins in 1995:1.

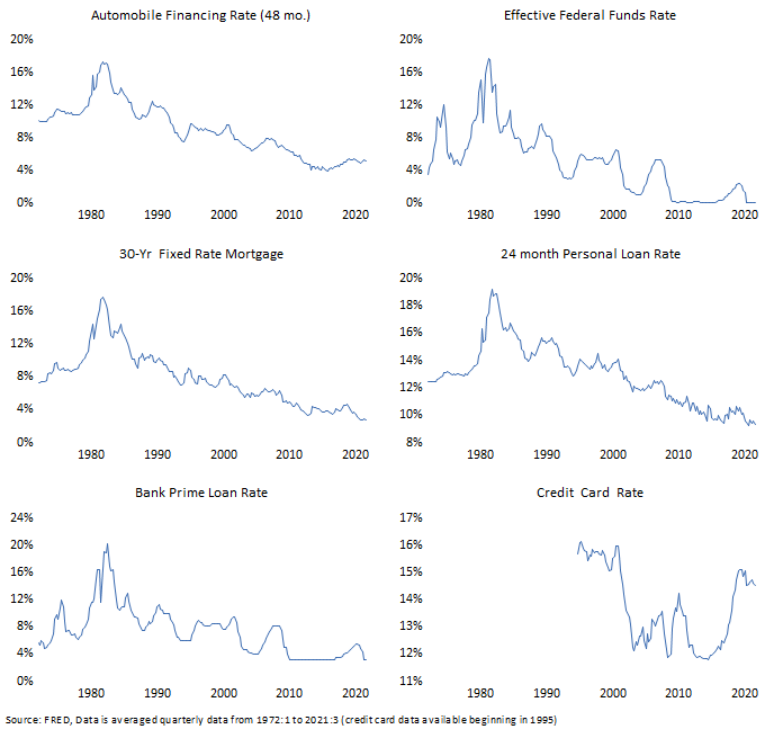


Figure 2 - plots of United States interest rate data, beginning in 1972. Source: FRED

regarding whether monetary policy can affectively transmit to institutions like LendingClub. Though not the key result of this paper, the lack of empirical analysis of the large LendingClub note dataset (more than 2.2 million loans) presented a compelling research opportunity.

V - Empirics

This section highlights my key quantitative findings and relates it to the prior sections.

Changing Influence of the Fed Funds Rate

While many factors are used to determine interest rates, the Fed Funds rate (FFR) is theoretically intended to be a major determinant. Table 2 presents the correlations between each of the interest rates studied over two samples, 1994:4 to 2008:2, and 2008:3 to 2021:3. Although simple in nature, the relationships of each of these key consumer interest rate metrics appear to break down following Great Recession and subsequent monetary response. Compared to the FFR, each of the correlations shift from strong positive to weak. Most notably, the

correlation between the FFR and the 48-month auto loan rate changes from 0.86 to 0.09, and the correlation of the mortgage rate average drops from 0.72 to 0.21.

Variable	**Fed Funds Rate**	Auto loan rate	Credit card rate	Mortgage rate	Personal loan rate
Sample: 1994Q4 2008Q2					
Fed Funds					
Auto loan rate	**0.86**				
Credit card rate	**0.79**	0.95			
Mortgage rate	**0.72**	0.88	0.87		
Personal loan rate	**0.78**	0.94	0.97	0.84	
Prime rate	**0.6**	0.69	0.67	0.56	0.61
Sample: 2008Q3 2021Q3					
Fed Funds					
Auto loan rate	**0.09**				
Credit card rate	**0.5**	0.35			
Mortgage rate	**0.21**	0.64	-0.17		
Personal loan rate	**0.06**	0.68	-0.15	0.78	
Prime rate	**0.41**	0.59	0.32	0.39	0.25

Table 2 – pairwise correlations of key interest rate data, broken down into two subsamples.
Source: FRED, author's calculations

LendingClub and Monetary Policy

To examine the FFR's predictive power on LendingClub note rates, I employ similar strategies used in prior analyses. Figure 3 shows the aggregated LendingClub note interest rates from 2007:2 to 2020:3, the entire existence of LendingClub's P2P platform.

In addition to the average interest rate, I include the note rates for those with incomes less than $50,000 and greater than $120,000, respectively.[21] There is significant volatility in note rates over the first five years of the platform, and the rate charged to those with higher incomes is higher over this entire period. This is likely due to the relatively small number of loans originated over that period. For reference, the number of loans originated in 2007 was 557; this

[21] Although splitting it up by debt-to-income would have been preferable as measure of borrower's riskiness, the LendingClub dataset was incomplete in many cases.

number had risen to over 200,000 by 2014 (the year of the platform's IPO) and peaked just short of 600,000 individual loans by 2019. By 2012, the average interest rate charged to the higher income bracket was less than that of the lower bracket and follows that trend for the rest of the platform's history.

Compared to other interest rates, the LendingClub note rates appear to have little

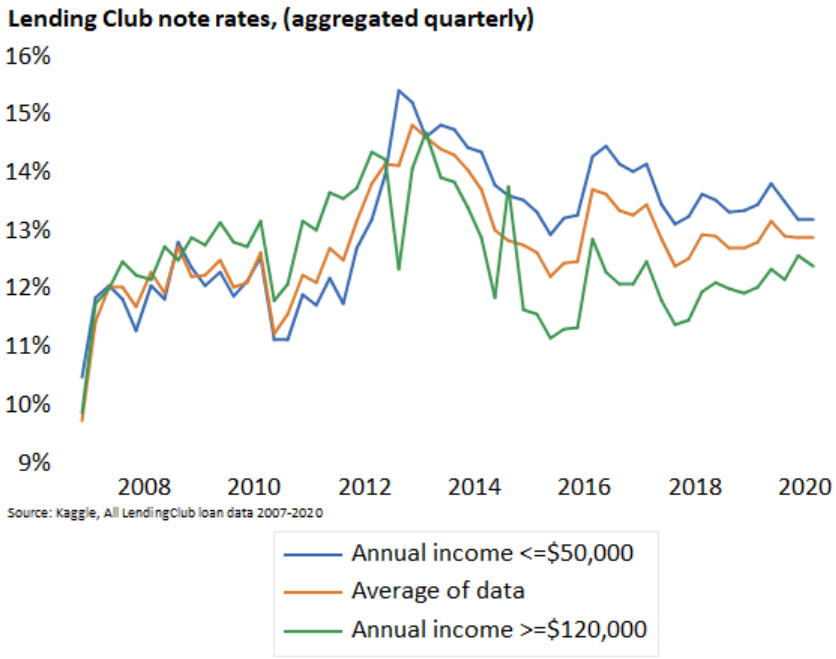


Figure 3 - plots of LendingClub note rates from 2007-2020. Source: Author's calculations

relationship with traditional monetary policy. Table 3 displays the correlations between the FFR and the LendingClub note rates disaggregated by income.[22] In order to control for a lack of data, I restrict the sample from 2014:1 to 2020:3, the end of the LendingClub P2P platform. Strikingly, there is a negative relationship between the FFR and the LendingClub interest rates. Other consumer rates such as the average credit card or mortgage rates were also negatively correlated

[22] Similar to figure 3, LC_high refers to income >=$120,000 and LC_low refers to incomes <=$50,000.

with the LendingClub rates. Finally, when regressing the LendingClub aggregates on the FFR, the

Variable	**Fed Funds Rate**	LC_high	LC_low
Fed Funds			
LC_high	**-0.28**		
LC_low	**-0.26**	0.69	

Table 3 – pairwise correlations of LendingClub note rates and the Federal Funds rate.
Source: FRED, LendingClub loan data

point estimate for the Fed rate is not statistically different than zero. Albeit surprising, the results imply that the LendingClub platform was too far removed from monetary policy, at least over the period in which it existed. To be sure, more empirical analysis of the dataset is needed to make a strong claim.

Quantitative Results

Aside from the baseline simulation, I conduct three additional simulations to examine relative consumption changes across the income distribution and in the aggregate. The first assumes more income inequality, a scenario many expect to be priced into the future. The second examines a more equal income distribution similar to that of the 1960s, and the third examines an environment where agents in the model experience income destruction in recessions.

Each simulation has two environments: the first (baseline), where agents are applied the same interest rates that are procyclical in nature, and the second environment where disparate interest rates are applied to agents depending on their income quintile. The procyclical environment, which reflects the intentions of the Fed, implies that interest rates will be cut during recessions and then increase in expansionary periods. In the second environment, some agents will experience procyclical monetary policy and others experience the opposite shock. This follows the findings of Mian and Sufi (2010) as well as Edgerton (2012), where changes in

lender's risk appetites tighten credit for some households and that financial conditions for the poorest suffer the most in recessions.

Table 4 presents the baseline result. Column 1 displays the baseline analysis, where agents' income is shocked each period and they experience the same monetary policy shock. The rows display each income quintile's percent change in consumption in response to a recessionary monetary policy shock. In other words, the results reflect consumption changes from normal times to a recession. Unsurprisingly, the lowest quintiles are the most sensitive in level terms due to their low exogenous income. The interest rate channel affects the poorest the most, simply because a four-percentage point change in the cost of borrowing represents a larger portion of their consumption.

	Consumption gain/loss (%)	
Income quintile	(1)	(2)
1st	4.49%	-3.61%
2nd	1.83%	-1.40%
3rd	1.08%	0.81%
4th	0.65%	0.48%
5th	0.19%	0.14%
Total	0.63%	0.13%

Table 4 – average consumption changes in response to a recession for each income quintile under an equal and heterogenous interest rate environment.

Due to interest rate changes having very little effect on their high incomes, the top quintile responds very little to monetary shocks, which implies that the effectiveness of traditional monetary policy diminishes as you move up the income distribution. The poorest are about 23 times more sensitive to an interest rate shock relative to the richest. The second income quintile is about 9.6 times more sensitive to monetary policy shocks than the richest. Overall, the economy increases aggregate consumption by 0.63% in response to accommodative monetary policy, which indicates that monetary policy can have a stimulative effect.

Column 2 presents the disparate interest rate environment, in which interest rate policy is procyclical for the top three quintiles but is countercyclical for the two poorest. For the sake of simplicity, all agents receive either a three-percentage point hike or cut to their interest rate. This widens the risk premia in recessionary times. Overall, each quintile is less responsive to the interest rate shock than in baseline. This is likely due to the magnitude of the policy shock. However, the lowest quintiles are more sensitive to interest rate changes relative to the richest by about 25 and 10 times, respectively. In the aggregate, the whole economy is much less sensitive to interest rate shocks by about 50 basis points. In the model, aggregate consumption changes vary little across a business cycle due to positive/negative consumption shifts are balanced out across 2500 agents and 10,000 periods. This implies that monetary is less effective in stimulating consumption if agents experience disparate interest rate shocks.

	Consumption gain/loss (%)	
Income quintile	(1)	(2)
1st	5.80%	-4.55%
2nd	2.68%	-2.08%
3rd	1.91%	1.44%
4th	0.76%	0.56%
5th	0.17%	0.13%
Total	0.64%	0.12%

Table 5 – average consumption changes for each income quintile under an equal and disparate rate environment, with more income inequality.

Table 5 displays the same simulations, but with an income distribution more skewed towards the upper quintiles. In this case, the income share for the highest quintile rises from about 61% to 70%, an income share that could be seen in the future. Overall, the Table 4's baseline results are amplified as a result of increased income inequality. The poorest quintile is now more than 30 times more sensitive to interest rate shocks relative to the richest under baseline assumptions. Under both rate environments, the richest are even less responsive to

interest rate shocks. In the aggregate, however, there is very little change from baseline. This could be due to the fact that the richest comprise the majority of total consumption and are largely unaffected by interest rate cuts.

Table 6 presents the results under a more equal distribution of income, with the same interest rate shocks applied in both columns as in baseline.[23] Due to their drop in relative income share, the top two quintile become more responsive to monetary policy shocks relative to the baseline simulation. The relative consumption changes also normalize with respect to the baseline. Strikingly, the middle quintile is only about 2.25 times more responsive to the shock, as opposed to just over 5 times in the baseline economy. On aggregate terms, monetary policy transmits through interest rates much better than in baseline, increasing total consumption by nearly 1%. This implies that monetary shocks are better suited to stimulate demand from all quintiles when there is a more even distribution of incomes in the economy.

	Consumption gain/loss (%)	
Income quintile	(1)	(2)
1st	4.04%	-3.13%
2nd	1.67%	-1.26%
3rd	0.91%	0.68%
4th	0.69%	0.52%
5th	0.40%	0.30%
Total	0.89%	0.16%

Table 6 – average consumption changes for each income quintile under an equal and disparate rate environment, with a more even income distribution.

Table 7 displays the relative consumption changes when agents experience income loss during recessions. Using US Census data, I calibrate the income destruction based on the mean income percent declines for each quintile over the last three recessions. For reference, the lowest

[23] I calibrated the income quintiles relative to 1975 levels, an era where the top quintile had a 40% share of the aggregate income.

quintile lost an average of 5.11% of income while the 3rd and 5th quintile lost 1.75% and 0.67%, respectively.

	Consumption gain/loss (%)	
Income quintile	(1)	(2)
1st	-1.24%	-9.42%
2nd	-1.43%	-4.64%
3rd	-0.72%	-0.99%
4th	-0.58%	-0.74%
5th	-0.48%	-0.53%
Total	-0.57%	-1.07%

Table 7 – average consumption changes for each income quintile under an equal and disparate rate environment. All agents lose income in recessions.

When interest rate shocks are equal, the results are considerably different from the baseline in both level and relative terms. All incomes quintiles lose consumption during recessions, as monetary policy fails to counteract the income destruction that agents experience during a recession. In relative terms, the poorest are only about 2.6 times more sensitive to interest rate shocks than the rich, a result vastly different than the 23 times observed in baseline. The relative sensitivity of the third quintile to the richest drops from about 5.7 to 1.5, a 74% drop. Surprisingly, the 2nd quintile loses more consumption than the 1st quintile. This is likely because the 1st quintile's exogenous income is less affected by the income destruction of about 5% than the second quintile's 3% loss. Cumulatively, the economy loses just over 0.5% of consumption following recessions, which echoes that the interest rate cut does not fully counterbalance income destruction.

In the heterogenous interest rate environment, the results are similar in relative terms to baseline, but are worse in level terms. Similar to column 1, all quintiles consume less as the monetary policy response to recessions is seemingly not enough. The poorest are about 18 times more sensitive than the richest and consume nearly 10% less in recessions, a result nearly three

times worse than in baseline. Overall, the disparate rate environment suggests that the interest rate channel is much less effective if agents lose income as a result of recessions.

VI – Discussion

My main findings are as follows:

1. The lowest income quintiles are most sensitive to interest rate shocks in both level and relative terms.

2. Monetary policy transmission through the interest rate channel is less neutral than the Fed might believe, as there are clear differences in responses according to a household's position on the income distribution.

3. When agents experience income destruction, monetary policy is less effective at stimulating consumption in response to a recession.

For nearly every test, the lowest income quintile was most responsive to the monetary policy shock. In fact, the average consumption response decreases with each increasing income quintile, following the empirical and theoretical literature. This has two main implications. First, due to their high relative sensitivity to interest rate shocks, loose monetary policy in recessionary periods could theoretically help those lower income quintiles by stimulating demand.[24] Second, while higher consumption sensitivities at the lower end of the income distribution appears desirable for monetary policy makers, it is unlikely that monetary policy transmits in a perfect procyclical manner. This is backed up by the breakdown in the strong positive relationships between consumer interest rates and the FFR following the 2008 Financial Crisis. If lower income households are subjected to higher rates during periods of recession, monetary policy could fail to transmit to those individuals, or worsen outcomes through other credit channels.

[24] The section of the distribution most vulnerable to recessionary shocks as evidenced by a large body of literature.

Similarly, Gornemann, et. al (2016) observe that households would prefer to forgo a full percentage point of consumption rather than be subjected to a 25-basis point annualized nominal rate hike. Extending this to middle-class households, if interest rate policy is not sufficiently accommodative to balance out the potentiality of risk premia increases, accommodative monetary policy could have weakened effects at the margin.

The current income distribution in the United States could pose problems evidenced by both my model results and the literature. First, my model suggests that the interest rate channel has very little effect on consumption patterns for wealthy households.[25] With the top income quintile comprising just under 40% of total consumption expenditures as of 2020, their low sensitivity to traditional monetary policy might help explain why both zero interest rate policy and other unconventional monetary policy measures were only able to stimulate sluggish growth throughout the 2010s.[26] While the literature indicates that monetary policy still likely transmits through the portfolio channel by increasing the value of financial assets, low-income households are marginal participants in equity markets and are decreasing participants in the housing market as prices rise.[27] Therefore, most Americans are unable to enjoy these capital gains. If the income distribution becomes more skewed towards the top quintile, the effect of monetary policy could further weaken.

My third finding suggests that monetary policy fails to completely balance out income losses during recessions. Since I calibrate the interest rate cut to the average of the last two Fed Funds cuts, my results seem to suggest that recent monetary policy responses are not enough to

[25] The calibrated income quintiles are averaged across each bin. In terms of consumption, the top 10% and higher are likely even less responsive to interest rate changes.
[26] Data taken from 2020 Consumer Expenditure Survey.
[27] Amberg, et. al (2021) demonstrate that the vast majority of capital income gains are enjoyed by the top 10% (income gains are almost exponential approaching the top 1%).

balance out the income losses that have occurred over the last three recessions. On the contrary, if there were no interest rate cuts in recessions, consumption outcomes would likely be worse in both the model and reality. Policy makers might argue that monetary policy helps to stabilize declines in output during recessions, but my results suggest that the interest rate channel effects are not as strong as they could be. Perhaps more dramatic rate cuts would better counteract income losses that households experience, but this solution faces many roadblocks such as the current ZLB interest rate policy along with the strong possibility that Fed Funds policy does not transmit equally to consumer interest rates.

VII - Conclusion

In this paper, I present several new empirical conclusions regarding monetary policy and its effects in a heterogenous agent framework. Most importantly, I show that lower income households are most sensitive to a monetary policy shock, on the order of about 23 times more sensitive. When each income bracket receives a specific interest rate, this ratio increases to about 25 times. Also important is my finding that the highest-income households are extremely unresponsive to interest rate shocks. It could be that the wealthiest are so unaffected by the interest rate channel that the only way to properly affect their expenditures would be through the balance sheet channel or affecting their asset holdings through the portfolio channel.

In addition, I observe that the transmission of monetary policy is likely to weaken in an economy with more income inequality. This has significant policy implications, considering that inequality is not only likely to persist but amplify in the coming years. Conversely, a more even income distribution allows interest rate policy to transmit more effectively relative to today's current baseline. While it is challenging to decipher whether increasing inequality has occurred

upstream to the current monetary stance, it seems as though there is some empirical relationship between the two.

Finally, I display that interest rate channel effects weaken when agents lose a percentage of their income during recessions. Since some amount of income loss is a stylized fact of most recessions, this finding has key policy implications as well. Most importantly, it appears that the Fed's interest rate response to the last three recessions has not been enough to offset the income destruction that occurs in these. My results serve as further evidence to the conclusion that heterogenous agents respond very differently to monetary policy. Policy makers should begin to acknowledge this effect, if their preferred transmission channel is through interest rates.

My results are based off the assumption that interest rates transmit (at times both pro- and countercyclically) to all agents in the economy. However, the role of alternative nonbank lenders such as money orders and payday loans are often overlooked by policy makers. As of 2019, 5.4% of U.S. households (7.1 million) are unbanked.[28] These households have no or very little ties to traditional banks - in particular the system that monetary policy makers are able to influence. With many payday loans charging over 300% APR, an interesting research opportunity would be to further examine whether monetary policy can affect nonbanks such as payday lenders and peer-to-peer platforms like *LendingClub*.

Although my model is simple compared to most HANK models, I produce tractable results that examine the effectiveness of the traditional interest rate channel of monetary transmission. While I have engaged with a large amount of the literature regarding heterogeneity

[28] Figure taken from 2019 FDIC survey; unbanked denoting that no member of the household had a checking or savings account at a bank or credit union. In addition, 25% percent of households are *underbanked*, where despite having a checking or savings account they are forced to turn to alternative forms of financing.

in monetary policy transmission, this field has endless avenues for future research, especially concerning the distributional effects of monetary policy.

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