Financial Constraints and Household Heterogeneity in the Macroeconomy

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List of Abbreviations

DSGE Dynamic Stochastic General Equilibrium

EGM Endogenous Gridpoints Method

GFC Great Financial Crisis

HA Heterogeneous Agent

HANK Heterogeneous Agent New Keynesian

IOU I Owe You

NK New Keynesian

Abstract

Abstract goes here.

JEL Classification:

Keywords: Heterogeneous Households, Borrowing Limits, Household Debt, Deleveraging

1 Introduction

Households face limits to borrowing. For example, there is usually a limit to how much a credit card holder can spend with one card. Also, home buyers cannot take arbitrarily large loans for purchasing a house. Clearly, these are limits which vary across at least three dimensions: 1) household characteristics (e.g. credit-worthiness), 2) asset type (e.g. mortgage debt vs credit card debt) and 3) time.[1]

Such borrowing limits have important implications for the behaviour of households.[2]

How do borrowers and lenders interact in environments with different and time-varying borrowing limits and what do those interactions imply for the aggregate?

In the absence of complete insurance markets, the presence of borrowing limits constrains households in their ability to smooth shocks to consumption. Moreover, borrowing limits combined with idiosyncratic income risk induce precautionary savings, i.e. a build-up of assets in order to prevent running into the borrowing constraints.

Borrowing limits play an important role not only for individuals but for the aggregate economy as well.

The following question arises: how does time-variation in those limits affect the economic outcomes on aggregate and household levels? To answer this question, this thesis follows and extends the work by Guerrieri and Lorenzoni (2017) and analyses shocks to the household-level borrowing limits in a heterogeneous agent New Keynesian model (HANK).[3]

This limit to borrowing is usually much harsher than the so-called natural borrowing limit, which is commonly defined as the expected net present value of an individual's income stream.

Since at least the Great Depression economists have aknowledged the importance of debt. The Great Financial Crisis (GFC) was a vivid reminder of how developments in finance, including credit and limits to credit, affect households and the macroeconomy.

A heterogeneous-agent (HA) model naturally lends itself to the analysis of household-level borrowing limits for at least two reasons. First, models which neglect or only parsimoniously model household heterogeneity cannot speak to interactions between borrowers and lenders.

Debt is inherently connected with heterogeneity as borrowers and lenders crucially differ in their nature.

First, unlike their representative-agent counterparts, prototypical HA models explicitly incorporate borrowing limits. Second, HA models speak to the differential effect of borrowing constraints across the distribution of households.

The present model is not so much about the *origins* of financial constraints in form of borrowing limits but rather on the *effects* of changes in such limits and their differential consequences across household groups (i.e. borrowers and lenders).

[1] This is by no means meant to be a formal or sufficient description of dimensions along which borrowing limits may vary.

[2] Of course, firms and governments can be subject to borrowing constraints, too. The focus of this thesis, however, is on households.

[3] The term 'HANK' was coined by Kaplan et al. (2018).

I further include some financial constraints on the side of the firms and banks as done in Chiang and Zoch (2022).

The model and its dynamics are solved with the Python package `Econpizza` by Boehl (2023) and the methods therein.

Outline

The remainder of this thesis is structured as follows. Section 2 reviews the related literature. Section 3 lays down the macroeconomic model, the numerical implementation and calibration of which is discussed in section 5. Thereafter, section 6 presents the results and section 7 concludes.

2 Related Literature

This section reviews the two strands of the literature which this thesis is most closely related to. I focus first on the macroeconomic literature revolving around household inequality and constraints to household finance. Second, I dwell on the most prominent works on financial constraints and the macroeconomy, where constraints are usually placed in the firm or bank sectors.

2.1 Literature on Borrowing Constraints

Shocks to borrowing constrains have been considered in the literature before. This subsection reviews some of these works.

At least since Fisher (1933) macroeconomists have been thinking about debt and its influence on features and developments of the macroeconomy.

An early empirircal paper on the importance of borrowing constraints for conusmer behaviour is Gross and Souleles (2002).

HANK models fuse two basic modelling approaches in macroeconomics. The first is the incomplete-markets framework, pioneered *inter alia* by Bewley (1986), Imrohoroğlu (1989), Huggett (1993) and Aiyagari (1994).[4] The second one, pertaining to the aggregate economy in the model, is the New Keynsian dynamic stochastic and general equilibrium (DSGE) framework.

Guerrieri and Lorenzoni (2017) build a household-focused incomplete-markets model and find that a permanent tightening in the household-level borrowing constraint evokes deleveraging and increased precuationary savings. Combined, these two effects depress output and

[4] Imrohoroğlu (1989) compares the consumption costs of business cycles in imperfect-insurance models to the costs implied by perfect-insurance models and finds that the former exhibits higher costs than the latter in the case of no borrowing and lower costs when borrowing is permitted. Aiyagari (1994) studies asset market equilibrium where asset supply is given by households who are subject to labour income risk and asset demand by firms with a neoclassical production function. The result is that the degree by which the presence of idiosynratic risk influences aggregate savings and the equilibrium interest rate depends on the calibration of the parameters governing the desire for precautionary savings.

interest rates in the economy. The recession is aggravated and the economy falls into a liquidity trap when the model is augmented with nominal wage rigidities and the zero lower bound.

Relative to Guerrieri and Lorenzoni (2017), I add an aggregate state space, featuring production by firms, a NK Phillips Curve and monetary policy which follows the Taylor rule.

Eggertsson and Krugman (2012) analyse a permanent shock to an exogenously set debt limit in a two-agent economy with a constant fraction of borrowers and lenders. The advantage of this approach is that the authors can derive analytical results. The paper shows that reductions in the borrowing limit can significantly affect macroeconomic outcomes; for example, the economy can end up in a liquidity trap.

Importantly, Eggertsson and Krugman (2012) consider real debt, which leads to a debt-deflation spiral as in Fisher (1933).

Eggertsson and Krugman (2012) also find that a deleveraging shock can be completely undone by fiscal policy by targeting short-run tax cuts and long-run tax increases at the borrowing fraction of the population, thereby effectively using its own ability to borrow to help the borrwers who are affected by the deleveraging shock. This result, however, relies very much on the assumption that the debt limit is exogenously set.

As Eggertsson and Krugman (2012) note, it is reasonable to assume that the debt limit depends to some degree on current conditions, such as current income.

Heathcote et al. (2009) provide an overview of modelling heterogenous households in quantitative macroeconomics. See Cherrier et al. (2023) for a historical overview of the advances and different approaches towards incorporating heterogeneous agents into macroeconomic analysis in the 1980s and 1990s.

Huo and Ríos-Rull (2015) have an exogenous interest rate and two types of goods.

2.2 Further Literature on Financial Constraints and Household Heterogeneity

In the real world, it is not only households who face financial constraints. Other agents, such as firms and financial intermediaries, can be subject to limits to their borrowing capacity.

BG and BGG are among the earliest and most widely used approaches to the study of financial constraints on the firm side.

GK focus on the economy's financial intermediaries. In their framework, banks are limited in the amount of leverage they can hold because of the possibility of banks' owners to liquidate the business.

3 Model

This section puts forward the model used to analyse shocks to borrowing constraints. Time, denoted by t, is discrete and refers to quarters of a year.

3.1 Household Sector

The model allows households explicitly to lend and to borrow. This is at the heart of the present analysis. Thus, the households can issue unsecured 'I Owe You''s (IOU).

Default is not considered in this model environment.

Households i are ex-ante identical but subject to idiosyncratic, i.e. household-level, income shocks.[5] Markets are incomplete and thus, households can only self-insure by saving and borrowing in a one-period, rsik-free bond. This bond is the only asset in the economy and is perfectly liquid, i.e. there are no costs involved when purchasing or selling bonds. The bond is to be understood as unsecured borrowing.[6]

Households have utility function U, which is strictly increasing in household consumption c_i. Households choose consumption, labour and asset holdings so as to maximise their utiliy, given the prices they face in the economy.

The bond is supplied by households (i.e. when households lend to and borrow from each other) and by the government.

Thus, I use wealth always to refer to liqiud wealth, which is the only form of wealth available in this setup, while being aware that wealth in reality comprises illiquid wealth, too.

A note on the asset structure is in order. The one-asset framework seems to be in contradiction to what we find in reality, where households can choose from a variety of assets to self-insure. What is more, there is government insurance and insurance from employers, see Heathcote et al.

Kaplan et al. (2018) provide an insightful critique of the one-asset structure.

Note that in incomplete markets models it is required that the interest rate times the discount fatcor is smaller than one.

3.2 Remaining Sectors and Equilibrium

3.2.1 Firms

Firm profits bear the problem that they have to be distributed. The way this is done might matter for households and their differential consumption-savings behaviour.

3.2.2 Fiscal and Monetary Policies

The monetary authority sets the notional gross nominal interest rate according to a standard Taylor rule which features persistence and which responds to the deviations of inflation from its steady state and of output from its lagged value. The strengths of these responses are given by the parameters ϕ_π and ϕ_y, respectively. In setting the notional interest rate, the central bank is subject to the zero lower bound on nominal interest rates. Thus, equation (3.2) pins down

[5] As Cherrier et al. (2023) note, there has been a strand of the literature considering also ex-ante heterogeneity in addition to ex-post heterogeneity. Doing so is beyond the scope of the present thesis.

[6] Secured borrowing would be collateralised.

the effective nominal interest rate by selecting the maximum out of the notional gross nominal interest rate and 1:

$$R_{n,t} = (R_{n,t-1})^{\rho} \left(R_{ss} \left(\frac{\pi_t}{\pi_{ss}} \right)^{\phi_\pi} \left(\frac{y_t}{y_{t-1}} \right)^{\phi_y} \right)^{(1-\rho)} \tag{3.1}$$

$$R_t = \max \{1,\ R_{n,t}\}, \tag{3.2}$$

where ρ is the persistence in the response of the central bank.

3.2.3 Equilibrium

4 Shocks to Borrowing Constraints

This section discusses the shock to the borrowing limit that I confront the above model with and sketches some consequences for the model's dynamics one might expect.

5 Implementation and Calibration

The heterogeneous-agent block of the model is solved using the endogenous-gridpoints method (EGM) by Carroll (2006).

The grid is not allowed to change over time as this mimeo notes. Otherwise, the interpolation would be between repeatedly different grid points, making the comparison of over time inaccurate.

The purpose of the present exercise is not to accurately match all moments of the empirical data but rather to flesh out the main mechanisms by which a shock to the borrowing limit affects individual-level and aggregate behaviour.

As Auclert et al. (2021) note, it is important to calculate the transition using the Jacobian of the terminal steady state.

Note that the perfect solution implies that aggregates move deterministically and agents know this perfectly.

6 Results

Note however that the responses in Guerrieri and Lorenzoni (2017) are also not very persistent. Their model also lacks capital, hanit formation or adjustment costs.

6.1 Comparison of Steady States

Variable	Initial Steady State	Terminal Steady State	Rel. Change
B	3.0000	3.0000	0.00
beta	0.9700	0.9700	0.00
C	1.0000	1.0000	0.00
D_o_Y	0.9699	0.4819	-50.31
div	0.1000	0.1000	0.00
lower_bound_a	-2.0000	-1.0000	-50.00
MPC	0.2481	0.1143	-53.93
N	1.0000	1.0000	0.00
pi	1.0000	1.0000	0.00
R	1.0158	1.0144	-0.14
Rn	1.0158	1.0144	-0.14
Rr	1.0158	1.0144	-0.14
Rstar	1.0158	1.0144	-0.14
tax	0.0473	0.0431	-8.88
Top10A	0.8162	0.7231	-11.41
Top10C	0.1908	0.1897	-0.58
w	0.9000	0.9000	0.00
y	1.0000	1.0000	0.00
y_prod	1.0000	1.0000	0.00
z	1.0000	1.0000	0.00

6.2 Transitional Dynamics

6.2.1 Aggregate Dynamics

6.2.2 Individual-Level Dynamics

6.3 Sensitivity Analyses

7 Conclusion

Would be interesting to extend the model so that there is also borrowing by other entities, especially firms.

An interesting extension of the model would be a small open economy as then funds could potentially be obtained elsewhere.

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Appendices

A Full Model

B Description of Computer Codes

C Analogy of the Borrowing Limit Shock to an Income Risk Shock

The literature has given quite some attention to shocks to labour income risk in HANK models in order to produce fluctuations which resemble business cycles. In this appendix, I show that a permanent shock to labour income risk produces impulse responses which are similar to the ones obtained from the analysis of a permanent tightening of the borrowing limit.

Statement of Authorship

I hereby confirm that the work presented has been performed and interpreted solely by myself except for where I explicitly identified the contrary. I assure that this work has not been presented in any other form for the fulfillment of any other degree or qualification. Ideas taken from other works in letter and in spirit are identified in every single case.

Andreas Koundouros
Bonn, the 25th August 2023