Heterogeneous Agents In Developed and Developing Countries

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I study whether an economy's response to aggregate shocks depends on its level of development. Empirically, I find that across countries there is an inverted U-shaped relationship between how much output reacts to monetary shocks and the share of hand-to-mouth agents. Theoretically, I show that this novel moment cannot be reconciled with representative agent models. Matching this relationship requires a heterogenous agent model with one key feature: countercyclical inequality and income risk. This creates amplifying income effects by shifting towards constrained households the additional aggregate demand generated by unconstrained households' substitution effects. Amplification peaks when there is a considerable share of hand-to-mouth agents, but also enough households that can intertemporally substitute. These results have implications for aggregate demand stabilization policies and the welfare costs of business cycles.

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1 Introduction

How do economies at different stages of development respond to aggregate shocks? Addressing this question would help us understand whether business cycles are different between developed and developing countries, and whether we are in need of country-specific aggregate demand stabilization policies. However, our understanding of this cross-country relationship is limited, with most estimates coming from high-income economies. This should come as no surprise, as such enterprise faces not one, but two identification challenges: the lack of exogenous shocks in macroeconomics and the fact that data availability is endogenous to development.

Neither is there a conclusive theoretical answer to such question, despite borrowing constraints being pervasive in developing countries and the distinctive feature of incomplete markets models. One illuminating case comes from monetary policy. Partial equilibrium logic would point to a larger share of the population being excluded from credit markets, stripping interest rates from their ability to stimulate aggregate demand. But powerful general equilibrium forces could be unleashed if this additional aggregate demand relaxes borrowing constraints, pushing output in the opposite direction. These effects might even cancel each other out, making the incomplete markets structure of second order.

To shed light on the empirical relationship and distinguish between those theoretical predictions, I introduce a new moment that consists of an inverted U-shaped relationship between output responses to monetary shocks and the hand-to-mouth share of households in an economy. Consider three countries: Belgium with a hand-to-mouth share of 20%, Croatia with around 50%, and South Africa with nearly 80%. I find that output's reaction to the same monetary shock is five times as big in Croatia than what it is in Belgium and South Africa. This heterogeneity in response to shocks among the development path favors a heterogeneous agent new keynesian (HANK) model over a representative agent (RANK) one. In particular, a one-asset HANK model with countercyclical inequality and income risk is required to match this moment.

I try to address the dual empirical challenge outlined above in section 2. To deal with the endogeneity of macroeconomic shocks, I estimate country-specific Proxy SVAR (see Stock and Watson 2018) output impulse response functions to high frequency identified monetary shocks. The external instrument is based on exchange rates futures (see Witheridge 2024) and I use these estimates as a measure of aggregate shocks. I overcome the data constraints by assembling a household level dataset with information on assets, income and consumption coming from surveys of countries across the development spectrum like Austria and Thailand. I apply Kaplan et al. (2014)'s methodology to calculate hand-to-mouth shares to this micro data, which I use as a measure of development. Pulling together these two measures gives way to the inverted U-shaped relationship.

I discipline the theoretical predictions with this novel moment in section 3. A RANK model fails to account for such a fact since it predicts that the output response will be the same independently of which is the share of hand-to-mouth agents in the economy. Instead, I demonstrate that a one-asset HANK model where countercyclicality of inequality and income risk is introduced in an ad-hoc fashion can match the inverted U-shape. I then bring in fiscal policy and investment and find that, as long as they are not introduced in a

countercyclical way, they cannot explain the empirical fact. Along the way I provide micro data validation for all of this: the one-asset HANK model also matches MPC estimates coming from Havranek and Sokolova (2020) and the household finance's dataset supports countercyclicality.

How cyclicality is specified turns out to be critical since it determines whether shocks get amplified by borrowing constraints. It does so by controlling how the income distribution moves with aggregate income, with an expansive monetary shock concentrating agents' incomes after an aggregate demand increase under the countercyclical case. This relaxes the borrowing constraints of low-income, high-MPC households by redistributing towards them the extra aggregate demand (countercyclical inequality) and reduces their savings due to precautionary motives (countercyclical income risk). Both mechanisms amplify through constrained households' income effects the initial unconstrained households' substitution effects.

The empirical moment's inverted U-shape is a result of the interaction between such amplification mechanism and how the hand-to-mouth share of agents changes across the development spectrum. In high-income countries, the majority of the population can intertemporally substitute. This gets amplified by the income effect that countercyclicality generates when redistributing towards constrained households. In middle-income countries, the share of agents on their Euler equation is smaller, but still enough to have a significant direct impact on aggregate demand. Given that the share of constrained agents is larger, this triggers an even stronger indirect effect. In low-income countries, there are so few agents who have access to credit markets that the initial partial equilibrium response is not meaningful. Hence, there are no large general equilibrium effects despite the large mass of constrained agents.

Coming back to the initial question posed, this paper argues that aggregates' reaction to shocks do differ along the development path. Though I provide an answer in the context of monetary shocks, this has broader business cycle implications. Similar mechanisms (that not necessarily transmit into the same response) could be at play for productivity and fiscal policy shocks. Optimal aggregate demand stabilization policies will also need to be different across countries as a consequence. The higher potency of monetary policy in middle-income countries could be a blessing, but also a curse if not administered correctly. In terms of welfare, the incomplete market structure by itself augments the costs of business cycles. They might be massive in non-developed countries if, as this paper tries to show, a higher share of hand-to-mouth agents makes aggregate demand more volatile.

Literature. The present paper relates to the large literature that investigates business cycles through the lens of heterogeneous agents models.[1] The empirical support of these papers comes from developed countries evidence. This paper instead picks its moments from the cross-section of high, middle and low-income countries. A theoretical exception is Werning (2015), who finds that aggregates in incomplete markets models react as in a representative agent model for any level of liquidity.[2] This neutrality result resembles

[1] A non-comprehensive list is McKay et al. (2016), Auclert et al. (2018), Auclert (2019), Wong et al. (2019), Auclert et al. (2020), Ottonello and Winberry (2020), Auclert et al. (2021b), Guerreiro (2023).

[2] This is true under assumptions like acyclicality of income risk. Werning (2015) also studies deviations from these assumptions and shows how countercyclical income risk can amplify monetary shocks.

others as Krusell and Smith (1998) and goes in line with Berger et al. (2023), who empirically find that deviations from complete markets account for only 7% of U.S. output volatility. In comparison, I present evidence that favors HANK over RANK models. The different conclusions with respect to those papers steam from the complementarity between borrowing countries and countercyclicality that leads to considerable amplification in middle-income countries. Another strand of the literature to which Werning (2015) is also close to, sheds light into HANK mechanisms by imposing assumptions that allow them to derive analytical results (see Acharya and Dogra 2020, Ravn and Sterk 2021, Bilbiie 2024). They also find that countercyclical inequality and income risk are the key amplification devices. This paper aims to better understand the mechanisms at play by taking an empirical route instead of aiming for tractability.

A converse set of papers explore macroeconomic fluctuations across countries, but abstaining from modeling any kind of heterogeneity. The present paper builds on Almgren et al. (2022), who study how responses to interest rate shocks differ across countries within a monetary union and on Witheridge (2024), who studies monetary-fiscal interactions in emerging markets. Bolhuis et al. (2024) and Checo et al. (2024) also construct high-frequency monetary policy shocks series for emerging markets. What bring us to the large literature coming out from Neumeyer and Perri (2005) and Aguiar and Gopinath (2007) that revolves around the excessive volatility of consumption and investment that these economies exhibit.[3] Relative to the middle-income economies that are their object of study, this paper brings in country-specific estimates for both low and high income economies, with hand-to-mouth shares that range from around 10% for Austria to 80% for South Africa. Pulling together all of them under the same methodology, I show that emerging markets are an special case where the HANK mechanisms are at play in their most extreme form. Moreover, this paper suggests that the incomplete markets structure may offer a complementary explanation to the excess volatility puzzle, similar to the role financial frictions play in Garcia-Cicco et al. (2010) and Mendoza (2010).

The intersection between these literatures are papers that empirically exploit cross-sectional variation and theoretically model heterogeneity. Herreño and Pedemonte (2022)'s TANK model generates a positive relation between employment and prices after a monetary shock. Moreover, they find that low-income U.S. regions have a higher sensitivity. Hong (2020) can explain emerging markets' excess volatility by feeding transitory productivity and financial shocks to an small open economy HANK model. This is true when the model is calibrated to match Peruvian MPCs from Hong (2023), but not when calibrated to U.S. MPCs. Conversely, Guntin et al. (2023) find that permanent TFP shocks to their small open economy heterogeneous agents model can rationalize the large consumption adjustments that they observe along the income distribution. This occurs after large recessions in Italy, México, Perú and Spain.[4] Relative to those papers, empirically I add cross-country variation that turns out to be crucial to uncover the inverted U-shape between aggregates' responses to shocks and development. Theoretically, I isolate countercyclical inequality and income risk as the key mechanism that makes the incomplete market structure have amplifying effects.[5]

[3] A non-exhaustive list is Arellano (2008), Schmitt-Grohé and Uribe (2016) and Casal and Guntin (2023).

[4] Hong (2020) and Guntin et al. (2023) findings can be reconciled if one thinks of garden-variety recessions as transitory TFP shocks and crises as permanent TFP shocks.

[5] Herreño and Pedemonte (2022) implicitly get amplification by making labor supply countercyclical. Hong (2020) by introducing financial frictions shocks.

2 Empirics

In this empirical section I first present the data and methodologies to measure both sides of the relationship between aggregate responses to shocks and development. I display the estimates of such methods and the resulting relationship afterwards. Lastly, I discuss alternative methods and how robust results are.

2.1 Baseline Methods

In order to uncover the relationship between aggregate shocks and development, I need to proceed in two steps. In the first step I set the baseline Proxy SVAR empirical strategy used to estimate output responses to monetary shocks. In the second step I outline how to calculate hand-to-mouth shares, my baseline measure of borrowing constraints.

Measuring Output Responses to Monetary Shocks

In this first step, I measure cross-country aggregates responses to shocks as output reactions to monetary shocks at the country-level. I start by describing the aggregate data I utilize, then proceed to present Stock and Watson (2018)'s Proxy SVAR framework used as empirical strategy and finally describe the high frequency monetary shocks based on exchange rates futures exploited as external instrument (see Bianchi et al. 2023 and Witheridge 2024).

Data. For the SVAR, I assemble a panel of 25 countries with variables at a monthly frequency. The sample of countries consists of Austria, Belgium, Croatia, Cyprus, Czechia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Russia, Slovakia, Slovenia, South Africa, Spain and Thailand. Variables included are interest rate, seasonally adjusted industrial production in logs, CPI in logs and unemployment rate, which mostly come from *IMF IFS*. Exceptions come from interest rates. In particular, I use 12-month central bank reported interbank rates. *PRIBOR* for Czechia, *BUBOR* for Hungary, *MIACR* for Russia, *Jibar* for South Africa, *BIBOR* for Thailand and *Euribor* for countries that have adopted the Euro. The period covered in the sample spans the months from January 2009 to December 2019.

For the proxys, I also create a panel, with the caveat that its composed of instruments from 6 currencies instead of 25 countries. This is because estimates for countries in the Euro area will be exploiting the same instrument. The frequency is monthly and the period covered is January 2009 - December 2020 too.[6] The instruments are calculated using spot and 12-month forward exchange rates from *Bloomberg*. In particular, USD/EUR for countries that have adopted the Euro and USD/CZK for Czechia, USD/HUF for Hungary, USD/RUB for Russia, USD/ZAR for South Africa and USD/THB for Thailand. Central bank policy meeting dates are also needed and they come from *Bloomberg Calendar*, *Central Bank News* and from central banks themselves.

[6]Nothing theoretically prevents the variables included in the VAR to cover a larger sample than the proxy. In fact, this would produce more precise estimates. However, for some countries, interest rates are not available going further back than 2009. This determines the lower bound of the sample. The upper bound is set by the start of the COVID-19 pandemic.

Proxy SVAR. Consider the reduced-form order 3 VAR

$$\mathbf{y}_t = \mathbf{b} + \sum_{l=1}^{3} \mathbf{B}_l \mathbf{y}_{t-l} + \mathbf{u}_t,$$

where $\mathbf{y}_t$ is a vector of endogenous variables. In particular, $\mathbf{y}_t = [r_t, ip_t, p_t, ur_t]$, where r_t is monthly interest rate, ip_t is monthly seasonally adjusted industrial production in logs, p_t is monthly CPI in logs and ur_t is monthly unemployment rate. $\mathbf{b}$ is a vector of constants, $\mathbf{B}_l$ $\mathbf{B}_1, \ldots, \mathbf{B}_L$ are matrices of coefficient and $\mathbf{u}_t$ is a vector of residuals with covariance matrix σ. $\mathbf{u}_t$ is the linear transformation of the vector of structural shocks $\epsilon_t = [\epsilon_{r,t}, \epsilon_{ip,t}, \epsilon_{p,t}, \epsilon_{ur,t}]$, which have covariance matrix $\mathbf{I}$, generated by the matrix $\mathbf{S}$

$$\mathbf{u}_t = \mathbf{S}\epsilon_t,$$

with $\mathbf{S}$ coming from $\mathbf{SIS}' = \mathbf{\Sigma}$. This is, of course, satisfied by infinitely many matrices $\mathbf{S}$, which is the usual identification challenge from VAR. A well-known approach is to proceed with a Cholesky decomposition, but is also well-known that it implies strong assumptions.

An alternative way to proceed is with external instruments. For identification to be successful, the first column of $\mathbf{S}$, $\mathbf{s}_1$, needs to be identified. This corresponds to the variable to be shocked in the SVAR, namely, r_t. Therefore, if one counts with a proxy $\mathbf{z}$ that satisfies

$$\mathbb{E}[z_t \epsilon_{r,t}] \neq 0$$
$$\mathbb{E}[z_t \epsilon_{ip,t}] = \mathbb{E}[z_t \epsilon_{p,t}] = \mathbb{E}[z_t \epsilon_{ur,t}] = 0,$$

where $\epsilon_{r,t}$ is the shock corresponding to $\mathbf{s}_1$, and $\epsilon_{2:n,t}$ represents the rest structural shocks, one would achieve identification of $\mathbf{s}_1$ up to sign and scale.[7]

External Instrument. Bianchi et al. (2023) and Witheridge (2024) construct high frequency monetary shocks from exchange rates futures exploiting the Covered Interest Parity (CIP)[8]

$$f_{t,t+1} - e_t = r^i_{t,t+1} - r_{t,t+1},$$

where $f_{t,t+1}$ is the log of the forward exchange rate between country's i currency and the U.S. dollar, e_t is the log of the spot exchange rate between country's i currency and the U.S. dollar, $r^i_{t,t+1}$ is country's i interest rate and $r_{t,t+1}$ is U.S. interest rate. During the narrow window in which monetary policy announcement of country i takes place, $r_{t,t+1}$ remains plausibly constant. Then, high frequency monetary shocks can be measured as

$$\Delta fp_{t,t+1} = \Delta r^i_t,$$

where $\Delta fp_{t,t+1}$ is the change in the forward premium $fp_{t,t+1} = f_{t,t+1} - e_t$ and Δr^i_t, is the change in country's i interest rate during such window. That is, changes in the forward premium capture changes in rates that are purely due to monetary announcements.[9]

[7] The scale was determined when setting the covariance matrix of structural shocks ϵ_t equal to $\mathbf{I}$, giving way to the following interpretation: an additional unit of $\epsilon_{1,t}$ has an effect of one standard deviation on $\mathbf{y}_{1,t}$.

[8] Not all countries have interest rates' future markets to construct shocks in the tradition of Romer and Romer (1989), Gertler and Karadi (2015), Nakamura and Steinsson (2018) and Bauer and Swanson (2023).

[9] Since the Great Recession, a gap has opened in the CIP (see Du and Schreger 2022). Appendix A shows that the instrument is robust to such deviations as long as they remain constant during the narrow window.

Measuring Hand-to-Mouth Shares

In this second step, I describe the micro data coming from household finance surveys to which I apply Kaplan et al. (2014)'s methodology to measure borrowing constraints, which I also briefly describe. Combining the hand-to-mouth shares coming out from this approach with the cross-country output responses to monetary policy shocks presented above results in next section's empirical moment.

Data. For the bulk of countries, which are European, I recur to European Central Bank's *Household Finance and Consumption Survey* (*HCFS*), which collects data at the household level on sociodemographics, consumption and financial positions. This is the exact same source that Kaplan et al. (2014) use to obtain their estimates for France, Germany, Italy and Spain, and that Almgren et al. (2022) exploit to obtain their estimates for 19 countries. In relative terms, I count with 22 countries, since I use *HCFS* latest wave conducted during 2020 and 2022, while they restore to 2010 and 2014 waves respectively. For non-European countries, I recur to their respective household finances surveys, Russia's *All-Russian Survey of Consumer Finances* (*RUS*)'s 2018 wave, South Africa's *National Income Dynamics Study* (*NIDS*)'s 2014/2015 wave and Thailand (*THH*)'s *Household Annual Resurvey*'s 2012 wave.[10] All of these surveys are designed based on United States' *Survey of Consumer Finances*.

Methodology. Questions are not exactly the same across surveys, but are similar enough to create "buckets" of assets and liabilities, which can themselves be grouped into liquid and illiquid wealth. Following Kaplan et al. (2014), the former includes cash, stocks, bonds, checking and saving accounts, net of credit card debts. The latter includes real state and pensions plans net of mortgages and insurance plans. Kaplan et al. (2014) classify household i at time t as poor hand-to-mouth if

$$b_{it} \leq 0, \quad \text{and} \quad 0 \leq a_{it} \leq \underline{a}$$

and as wealthy hand-to-mouth if

$$b_{it} > 0, \quad \text{and} \quad 0 \leq a_{it} \leq \underline{a}$$

where b_{it} is net illiquid wealth, a_{it} is net liquid wealth and $\underline{a}$ is the borrowing constraint, that they set to be half monthly labor income.[11] Therefore, a household is classified as hand-to-mouth if it was classified as poor hand-to-mouth or wealthy hand-to-mouth. That is, a household is hand-to-mouth when it does not count with enough net liquid wealth to offer as collateral for a credit that would allow for consumption smoothing. The key difference with previous measures that did not distinguish between liquidity types is that now households with positive illiquid wealth $b_{it} > 0$ are considered hand-to-mouth too, ramping up the number of constrained households. Previous hand-to-mouth shares measures were lower bounds since net wealth included illiquid assets $0 \leq a_{it} + b_{it} \leq \underline{a}$. For all purposes, wealthy hand-to-mouth households behave as poor hand-to-mouth. Ignoring them would understate the prevalence of borrowing constraints, leaving variation in the distribution of MPCs unexplained.

[10] Thailand's survey comes from an effort lead by Robert Townsend (see Townsend 2016).

[11] The "half" comes from resources being consumed at a constant rate in Kaplan et al. (2014)'s model.

2.2 Results

The methodologies outlined above measure aggregate shocks and development at the country level. I validate these methods and show estimates coming from them.

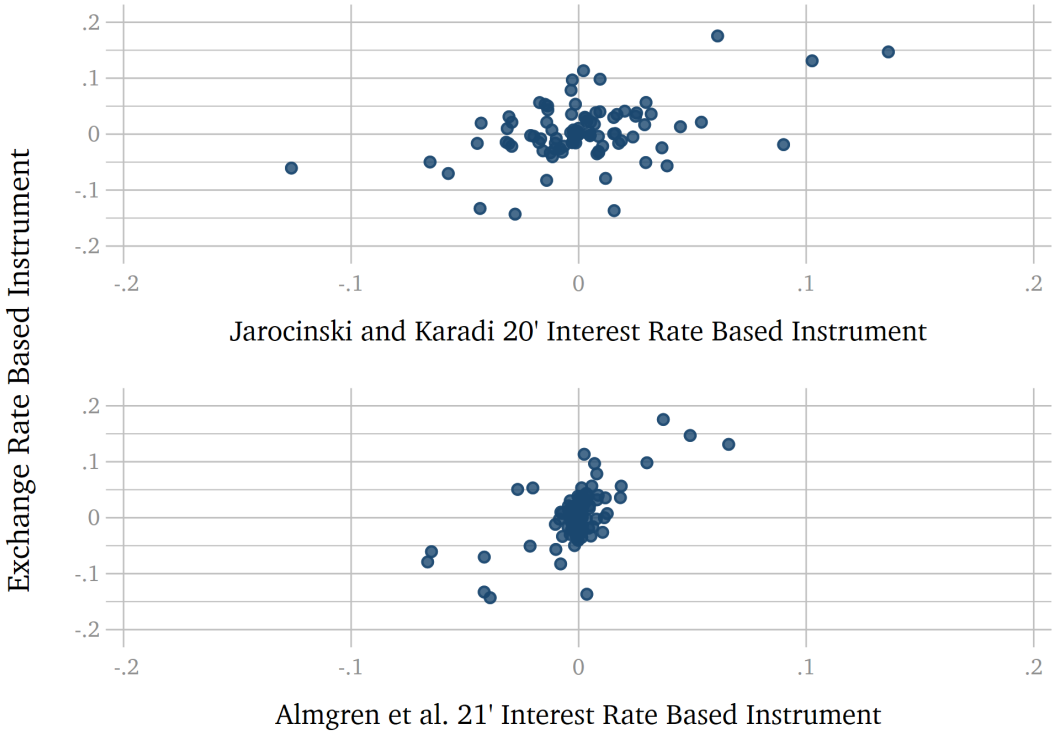
Validation

I provide checks for the identification strategy before delving into its results.

External Instrument. A virtue of the exchange rate futures based instrument is that one can construct shocks for countries that do not count with interest rates futures. To validate this proxy, I take advantage of the fact that both types of markets exist for the Euro. Figure 1 shows that the instrument constructed from Euro forward and spot exchange rates correlates strongly with instruments constructed from Euro interest rates futures.

Relevance and exogeneity are sufficient for identification. However, they are not enough for inference. The correlation between the proxy and the variable to be instrumented not only needs to be different from zero, but also strong. Table 1 shows the results from such first stage for all the countries in the sample. Montiel Olea et al. (2021) recommend the F-test to be above 10 as a rule of thumb for Proxy SVAR estimates, which is the case for most of the countries in my sample.

Figure 1: Exchange Rate Based and Interest Rate Based Instruments



Notes. Upper panel shows a correlation of 0.7 between Jarociński and Karadi (2020)'s changes in European Central Bank (ECB) interest rates futures around monetary policy announcements and the changes in Euro exchange rates futures around ECB announcements. Lower panel shows a correlation of 2 with Almgren et al. (2022) instrument.

Table 1: First Stage of Interest Rates on Exchange Rate Based Instruments

Country	F-stat	Coefficient	p-value	R^2	Adj. R^2
Austria	19.078	0.307	0.000	0.131	0.124
Belgium	20.788	0.315	0.000	0.141	0.134
Croatia	22.064	0.342	0.000	0.148	0.141
Cyprus	18.123	0.316	0.000	0.125	0.118
Czechia	18.990	-4.430	0.000	0.130	0.123
Estonia	21.509	0.338	0.000	0.145	0.138
Finland	19.736	0.321	0.000	0.134	0.128
France	18.393	0.313	0.000	0.127	0.120
Germany	25.033	0.368	0.000	0.165	0.158
Greece	19.713	0.329	0.000	0.134	0.128
Hungary	13.510	-61.537	0.000	0.096	0.089
Ireland	24.407	0.347	0.000	0.161	0.155
Italy	17.920	0.312	0.000	0.124	0.117
Latvia	25.678	0.367	0.000	0.168	0.162
Lithuania	18.074	0.299	0.000	0.125	0.118
Luxembourg	21.798	0.339	0.000	0.146	0.140
Malta	28.580	0.373	0.000	0.184	0.177
Netherlands	23.995	0.348	0.000	0.159	0.152
Portugal	20.629	0.331	0.000	0.140	0.133
Russia	10.030	-0.718	0.002	0.093	0.084
Slovakia	23.424	0.347	0.000	0.156	0.149
Slovenia	25.099	0.367	0.000	0.165	0.158
South Africa	39.172	-1.083	0.000	0.236	0.230
Spain	20.955	0.334	0.000	0.141	0.134
Thailand	2.053	77.302	0.155	0.018	0.009

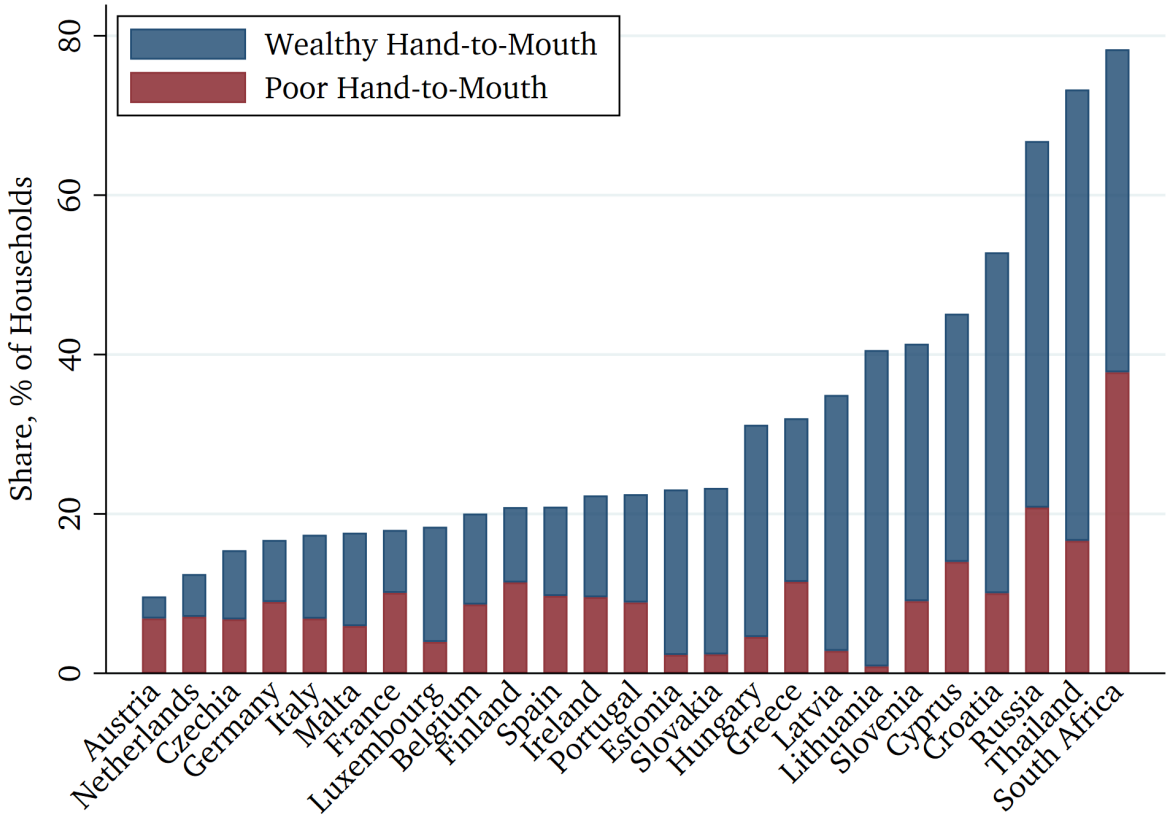
Notes. Results of country-specific regressions between variable to be instrumented (interest rate) and external instrument (changes in exchange rates futures around monetary policy announcements). Above 10 F-stat recommended by Montiel Olea et al. (2021) for Proxy SVAR.

Baseline Estimates

Having validated these methodologies, I proceed to show the relationship between aggregates responses to shocks and development. Towards that end, I display before the cross-country hand-to-mouth shares calculations and the Proxy SVAR estimated output reactions to monetary shocks.

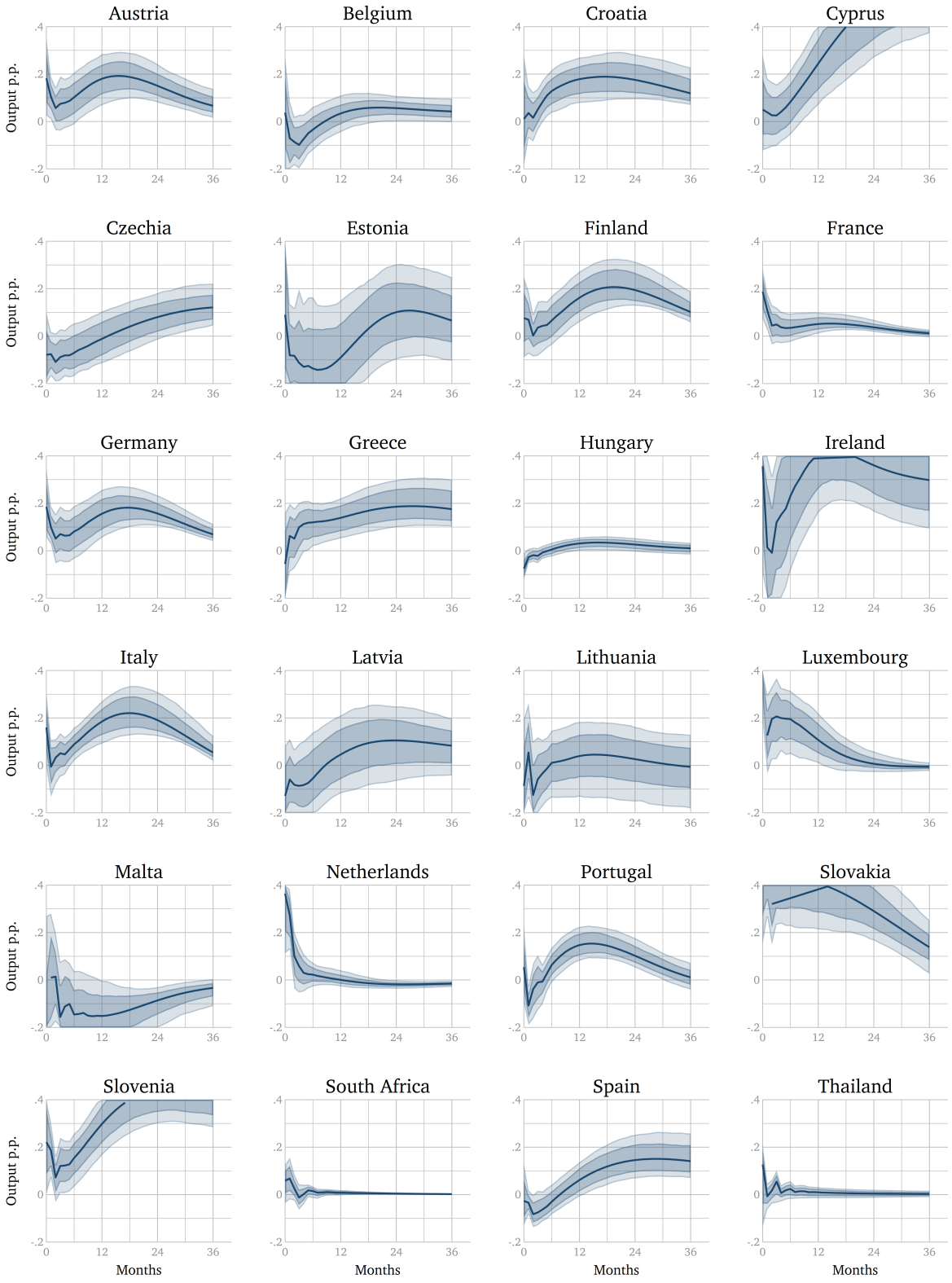
Hand-to-Mouth Shares. Figure 2 presents the poor and wealthy hand-to-mouth shares estimates. The first fact that strikes out from the picture is the large cross-country variation in hand-to-mouth shares. They go from 9.6% in Austria to 78.3% in South Africa. This covers a wider range than Kaplan et al. (2014), whose minimum and maximum shares where 20% and 30%, and Almgren et al. (2022), with 15% and 62%. Another fact that comes out from the figure is that these estimates are a strong proxy of development: a 10 p.p. increase in the hand-to-mouth share lowers per capita GDP in 7,723 dollars, a correlation significant at the 1% level. A third key fact that emerges from these calculations is the importance of taking into account wealthy hand-to-mouth households. If hand-to-mouth status was only granted to poor hand-to-mouth households, both the level and variation of borrowing constraints would be lower, ranging from 0.9% to 37.8%. Wealthy hand-to-mouth households contribute in both dimensions, ranging from 2.8% to 56.6%.

Figure 2: Hand-to-Mouth Shares



Notes. A household is classified as poor hand-to-mouth if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income and their net illiquid wealth is less or equal than zero. A household is classified as wealthy hand-to-mouth if their net illiquid wealth is larger than zero instead. The sum of the two shares makes for the share of households classified as hand-to-mouth. Source is *HCFS* for European countries, *RUS* for Russia, *NIDS* for South Africa and *THH* for Thailand.

Figure 3: Proxy SVAR Output Impulse Response Functions (IRFs) to Monetary Shock

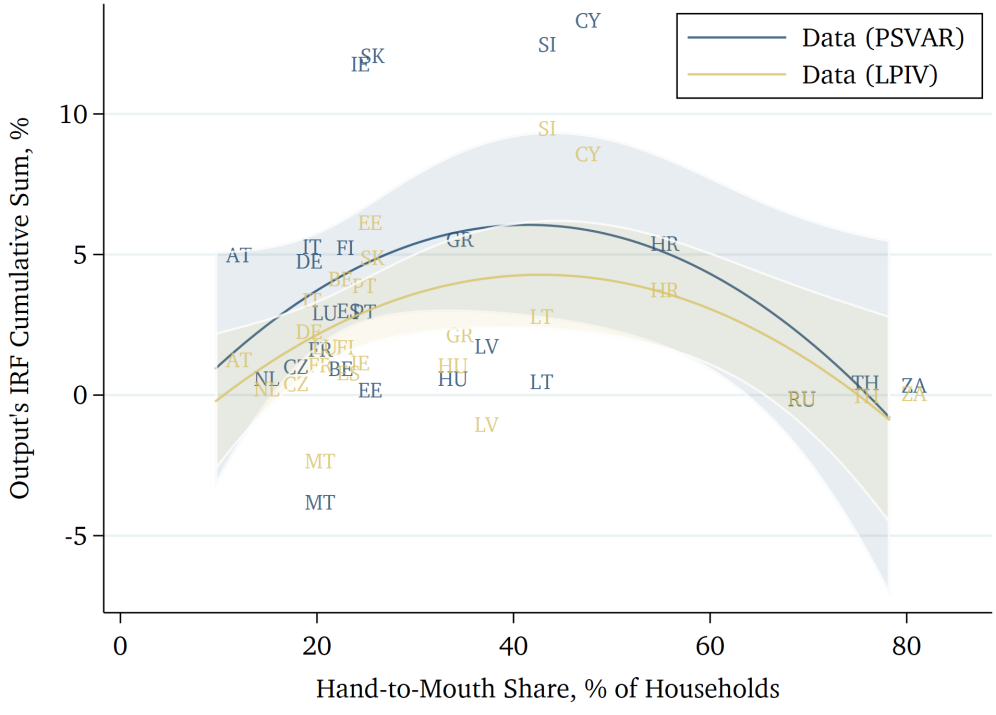


Notes. Blue lines are impulse response functions of seasonally adjusted industrial production in logs to a -1.5 p.p. interest rate shock estimated vía Proxy SVAR. External instrument is changes in exchange rates futures around monetary policy announcements. Other variables included in the VAR are: CPI in logs and unemployment rate. Source is *IMF IFS*. Blue shaded areas are 68% and 90% confidence bands coming from moving block bootstrap standard errors (see Jentsch and Lunsford 2019).

Output Responses to Monetary Shocks. Figure 3 plots impulse response functions to a -1.5 p.p. interest rate shock under the baseline Proxy SVAR method. The most northwestern and southeastern plots correspond to the smallest and second largest hand-to-mouth shares countries, Austria and Thailand respectively. The effects seem rather small and barely significant. The most southwestern and northeastern plots correspond to average hand-to-mouth share countries, Slovenia and Cyprus respectively. In contrast, the effects are significant and the hump-shaped responses extends beyond the 36 months window.

A clearer picture emerges when we calculate the cumulative sum of those IRFs and plot them against the hand-to-mouth shares computed in the above section. This results in the inverted U-shaped relationship in Figure 4 below. Although even the plain unconditional correlation measured in column 1 of Table 2 might be of interest, things other than borrowing constraints could differ across countries. Column 2 then adds controls from *World Bank Standard Indicators (WBSI)*. The quadratic relationship becomes stronger and R^2 increases. Column 3 drops Thailand, for which the F-stat is less than 10. The relationship holds. Column 4 drops the three highest hand-to-mouth share countries, Russia, Thailand and South Africa. Though not statistically significant, the coefficients still go in the same direction. The general message coming out of these regressions is that the hand-to-mouth shares work as a "sufficient statistic" to determine outputs' reaction to monetary shocks.

Figure 4: Proxy SVAR, LPIV Cumulative IRFs and Hand-to-Mouth Shares



Notes. Blue line is OLS estimated cross-country quadratic relationship between aggregates reaction to shocks and development. The former is given by the cumulative sum of impulse response functions of seasonally adjusted industrial production in logs to monetary shocks estimated vía Proxy SVAR. The latter is measured as hand-to-mouth shares, where a household is classified as such if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income. Blue shaded area are 95% confidence bands. Yellow line and shaded area correspond to Local Projections IV estimates.

Table 2: Proxy SVAR Cumulative IRFs and Hand-to-Mouth Shares

	(1) IRF Cum. Sum	(2) IRF Cum. Sum	(3) IRF Cum. Sum	(4) IRF Cum. Sum
HtM Share	41.979*	52.347*	53.953*	38.010
	(23.215)	(26.685)	(26.816)	(47.135)
HtM Share Squared	-50.626*	-57.785**	-60.474**	-26.113
	(25.050)	(26.265)	(26.791)	(68.516)
Observations	25	25	24	22
R^2	0.156	0.228	0.212	0.222
Controls	No	Yes	Yes	Yes

Robust standard errors in parentheses. All regressions include a constant.

Notes. Results of OLS estimated cross-country quadratic relationship between aggregates reaction to shocks and development. The former is given by the cumulative sum of impulse response functions of seasonally adjusted industrial production in logs to monetary shocks estimated vía Proxy SVAR. The latter is measured as hand-to-mouth shares, where a household is classified as such if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income. Controls from *WBSI* include per capita GDP, share of exports and share of savings. All regressions include a constant. Robust standard errors in parentheses.

2.3 Alternative Methods

In spite of being a widely used method, Proxy SVAR results could be sensible to model specification (see Coibion 2012, Ramey 2016). VAR methods get the benefit of considerably reducing variance by imposing a particular structure. However, this comes at the cost of potentially introducing bias (see Stock and Watson 2018). To address these concerns, Local Projections identification and Bayesian estimation methods estimates are presented as robustness checks. In particular, Figure 5 also shows the cumulative sum coming from Local Projections IV IRFs. Table 3 replicates the exercise in column 3 of Table 2 above, but with the cumulative sum of Local Projections IV, Proxy SVAR Local Projections, Bayesian Local Projections and Bayesian Proxy SVAR IRFs as outcomes. Results are broadly similar to the ones obtained with the baseline Proxy SVAR method.[12]

Table 3: Alternative Methods Cumulative IRFs and Hand-to-Mouth Shares

Method	HtM Share [95% CI]	HtM Share Sq. [95% CI]
Proxy SVAR	53.953 [1.394; 106.512]	–60.474 [–112.983; –7.964]
Local Projections IV	61.057 [–17.437; 139.551]	–60.755 [–141.666; 20.156]
Proxy SVAR Local Projections	35.378 [3.084; 67.671]	–41.561 [–75.715; –7.408]
Bayesian Local Projections	32.204 [–4.069; 68.477]	–34.767 [–70.737; 1.203]
Bayesian Proxy SVAR	47.324 [0.575; 94.073]	–51.303 [–98.056; –4.550]

Notes. Results of OLS estimated cross-country quadratic relationship between aggregates reaction to shocks and development. The former is given by the cumulative sum of impulse response functions of seasonally adjusted industrial production in logs to monetary shocks estimated vía Proxy SVAR, LPIV, Proxy SVAR LP, Bayesian LP and Bayesian Proxy SVAR. The latter is measured as hand-to-mouth shares, where a household is classified as such if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income. Controls from *WBSI* include per capita GDP, share of exports and share of savings. All regressions include a constant. 95% CI from robust standard errors.

[12]Further discussion of the particular advantages, disadvantages, assumptions, specifications and results of these alternative methods can be found in Appendix B.

3 Theory

An inverted U-shaped relationship between output responses to monetary shocks and hand-to-mouth shares was the main result of the empirical section. In this theoretical section, I use that moment to discriminate between models and find that it can only be matched by a one-asset HANK model featuring countercyclical inequality and income risk. The intuition is that countercyclicality is an amplification mechanism that complements with the incomplete markets structure in developed countries, but they substitute each other in developing countries. I first lay down the one-asset HANK model with countercyclicality. Then, I show that the inverted U-shape can be generated by changing the parameter that controls borrowing constraints. Finally, I demonstrate that other features like fiscal policy or investment cannot by themselves deliver such result.

3.1 Baseline Model

In this sub-section I establish a minimalistic combination between an heterogeneous agent model in the tradition of Bewley (1986), Aiyagari (1994) and, specially, Huggett (1993) with a textbook new keynesian model. Then I explain the calibration strategy and how the steady-state and transitional dynamics are computed.

One-Asset HANK Model

Environment and Behavior. The economy is populated by a unit continuum of infinitely lived ex-ante identical households, who face idiosyncratic but not aggregate risk

$$\begin{aligned}
&\max_{c_{it}} \mathbb{E}_{\mathrm{O}} \sum_{t=0}^{\infty} \beta^t u\left(c_{it}\right) \\
&c_{it} + a_{it} \leq \left(1 + r_t\right) a_{it-1} + e_{it} n_{it} \\
&a_{it} \geq \underline{a},
\end{aligned}$$

where c_{it} is consumption of household i at period t. Households are endowed with productivities e_{it} that follow a Markov process with transition matrix Π. To insure against such idiosyncratic risk, households can borrow against each other up to $\underline{a}$ in an asset a_{it} that pays interest r_t.[13] Income is given by $y_{it} = \frac{W_t}{P_t} e_{it} n_{it}$, but since the production side of this economy is given by a representative firm with a production function

$$Y_t = N_t,$$

real wages are given by $\frac{W_t}{P_t} = 1$ with flexible prices. Nominal wages are sticky instead. This can be microfounded with unions as in Erceg et al. (2000), but I will assume an ad-hoc labor allocation rule as in Auclert and Rognlie (2018)[14]

$$n_{it} = Y_t \frac{\left(e_{it}\right)^{\zeta \log Y_t}}{\mathbb{E}\left[e_i^{1+\zeta \log Y_t}\right]} \equiv Y_t \Gamma\left(e_{it}, Y_t\right),$$

[13] The current model abstains from specifying other sources of liquidity like government issued bonds, so liquidity is solely provided by the private agents of this Hugget economy.

[14] Two reasons justify these assumptions. First, because there is no disutility from working, labor needs to be rationed in some way. Second, sticky prices imply that there are profits that need to be distributed, what could implicitly assume some form of cyclicality of inequality and income risk.

what provides a parsimonious way to control the cyclicality of inequality and income risk.[15] Inequality and income risk will be procyclical when $\zeta > 0$, acyclical when $\zeta = 0$ and countercyclical when $\zeta < 0$. In particular, the standard deviation of household income y_{it} goes up as aggregate income Y_t increases when $\zeta > 0$, the standard deviation of y_{it} remains constant as Y_t increases when $\zeta = 0$ and the standard deviation of y_{it} goes down as Y_t increases when $\zeta < 0$.[16]

The path of interest rates follows a real rate rule

$$r_{t+1} = r + \epsilon_t.$$

Which is no other thing than a Taylor rule with coefficient equal to 1

$$i_t = r + \pi_{t+1} + \epsilon_t,$$

where r is the steady state real interest rate, ϵ_t is a monetary shock and π_t is price inflation. Since $\frac{W_t}{P_t} = 1$, price inflation is equal to wage inflation π_t^W. The latter is given by

$$\pi_{t+1}^W = 0,$$

an ad-hoc Phillips Curve that closes the model by specifying a supply side.

Equilibrium. Given an exogenous sequence for interest rates r_t, an initial nominal wage W_0, an initial price level P_0 and an initial distribution of households $\mathcal{D}_0$ over state variables e and a, a competitive equilibrium is given by sequences of prices $\{P_t, W_t, \pi_t, \pi_t^W\}$ and quantities $\{Y_t, C_t, N_t, A_t\}$ and a distribution of households $\mathcal{D}_t(e, a)$ such that households optimize, the representative firm optimizes and goods and assets markets clear

$$C_t \equiv \int c_{it} di = Y_t = N_t = \int n_{it} di$$
$$A_t \equiv \int a_{it} di = 0.$$

Calibration and Computation

I calibrate the model to standard parameters from the literature except for one: the borrowing constraint $\underline{a}$. I will vary this according to the hand-to-mouth shares calculated in empirical section 2. β will be calibrated internally by targeting asset market clearing (with goods market being cleared by Walras' law). The key untargeted moment is the inverted U-shaped relationship between cumulative responses to monetary shocks and hand-to-mouth shares. A positive relationship between MPCs and hand-to-mouth shares is also an untargeted moment. However, this micro fact is of second order importance relative to the aforementioned macro fact, given that it will not allow us to discriminate between different specifications of ciclicality. Table 4 displays the parametrization.

[15] It is well understood (see Acharya and Dogra 2020, Ravn and Sterk 2021 and Bilbiie 2024) that the cyclicality of inequality goes hand in hand with the cyclicality of income risk. The difference between the two is that the former has to do *current* shocks, while the latter with *future* shocks.

[16] This model nests the so-called "canonical" HANK model (see Auclert et al. 2024): under the $\zeta = 0$ acyclical case the labor allocation rule collapses to $n_{it} = Nt$.

Table 4: Calibration of One-Asset HANK Model

Parameter		Value	Reason/Moment	Target
A. Externally calibrated				
σ	IES	0.5	Literature	0.5
ρ_e	Prod. shocks persist.	0.92	Floden and Lindé (2001)	0.9136
ρ_e	Prod. shocks std. dev.	0.92	-	-
n_e	Income grid	11	-	-
Y	Aggregate income	1	Normalization	-
ζ	Cyclicality	-1.1	Validation	-1.1
$\underline{a}$	Borrowing constraint	[-2.99, -1.5, -0.1]	Hand-to-mouth shares	[0.17, 0.41, 0.78]
r	Interest rate	0.01	Annual real interest rate	0.04
B. Internally calibrated				
β	Discount rate	-	Asset market clearing	0

Households have CES utility over consumption $u(c) = \frac{c^{1-\sigma^{-1}}-1}{1-\sigma^{-1}}$. The intertemporal elasticity of substitution (IES) σ is set to 0.5.[17] Floden and Lindé (2001) estimated an autorregresive coefficient for residualized wages of 0.9136. Hence our calibration of ρ_e to 0.92. We also set the standard deviation of such income process to $\sigma_e = 0.92$. With these parameters in hand we discretize the income process into a 11-point Markov chain n_e with Rouwenhorst method. Aggregate income Y is normalized to one.

The only parameters left to be set are the cyclicality ζ and the borrowing constraint $\underline{a}$. Although I will show results for the three cyclicality scenarios, the baseline will be the countercyclical case ($\zeta = -1.1$, the empirically relevant according to Guvenen 2009 and the validation below). Borrowing constraints are informed by the average ratio of household's net liquid wealth to annual labor income, from which hand-to-mouth shares were calculated in section 2. In particular, $\underline{a}$ will take three values: -2.99, -1.5 and -0.1. They correspond to the ratio's maximum, average and minimum values, which themselves correspond to Italy (17% hand-to-mouth share), Hungary (41%, approximately) and South Africa (78%). The steady-state interest rate r is set to 0.01.

In order to solve for the steady state of the model and compute transitional dynamics to *MIT* shocks, I utilize sequence-space Jacobians methods from Auclert et al. (2021a). The steady-state of the model is given by goods market clearing, which can be written as[18]

$$Y_t = \mathcal{C}_t\left(\{r_s, Y_s\}\right)$$

where $\mathcal{C}$ is an aggregate consumption function that maps current and future realizations of r an Y to present consumption. To study transitional dynamics, I feed a shock $\{dr_t\}$

$$dY_t = \sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t}{\partial r_s} dr_s + \sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t}{\partial Y_s} dY_s \tag{1}$$

and solve the fixed point problem by computing Jacobians $\mathcal{J}_{t,s}^{\mathbf{C},\mathbf{Y}} = \partial \mathcal{C}_t / \partial Y_s$.[19]

[17] Werning (2015) shows that, with $\sigma = 1$, the response to monetary shocks is the same for any level of liquidity in a HANK than in RANK model. This is so because he further imposes acyclicality of income risk.

[18] Asset market clears by Walras' law.

[19] For details, see Appendix C.

3.2 Results

The baseline model outlined above will answer the question of how aggregates respond to a shock at different stages of development. The answer will depend on the model's calibration, so I validate the parametrization above before delving into results.

Validation

I first try to find some support for the countercyclical calibration in the household finances' dataset. Then I check whether the calibrated model can deliver consistent micro predictions: MPCs that are increasing in borrowing constraints.

Countercyclicality. We saw above how ζ controls the cyclicality of inequality and income risk and we will see below how countercyclicality is needed to match section 2's moment. I exploit the micro data structure to empirically back up the calibration $\zeta = -1.1$, since it surveys households in different quarters throughout a year. Then, I can match households income during a particular quarter with aggregate income during that same quarter and answer whether the standard deviation of households income is positively associated with aggregate income (procyclical case), negatively associated (countercyclical case) or not associated (acyclical case).

Formally, given household income $y_{it} = e_{it}n_{it}$ and Auclert and Rognlie (2018) labor allocation rule $n_{it} = Y_t \left(e_{it}\right)^{\zeta \log Y_t} / \mathbb{E}\left[e_i^{1+\zeta \log Y_t}\right]$ one can show that

$$\operatorname{sd}\left(\log y_{it}\right) = \left(1 + \zeta \log Y_t\right) \operatorname{sd}\left(\log e_i\right),$$

which gives us a reduced-form to test[20]

$$\operatorname{sd}\left(\log y_{it}\right) = \operatorname{sd}\left(\log e_{it}\right) + \zeta \left[\operatorname{sd}\left(\log e_{it}\right) * \log Y_t\right] + \varepsilon_t.$$

Taking this equation to the micro data, $\operatorname{sd}\left(\log y_{it}\right)$ is the standard deviation of log annual labor income in quarter t, $\operatorname{sd}\left(\log e_{it}\right)$ is the standard deviation of log residualized annual labor income[21] and $\log Y_t$ is the log of aggregate income in quarter t.[22] Table 5 displays the results. The negative and statistically significant at the 1% coefficient in the first column can be considered as evidence in favor of countercyclical inequality and income risk. The spirit of the reduced form equation is at the country level, so I bring in country fixed effect to its empirical counterpart in the second column. The result remains statistically significant at the 1% and becomes even larger in magnitude. This is the preferred specifications and the coefficient on $\left[\operatorname{sd}\left(\log e_{it}\right) * \log Y_t\right]$ informs our countercyclical calibration of $\zeta = -1.1$.[23]

[20] Note that in the empirical specification below $\operatorname{sd}\left(\log e_i\right)$ has an additional t subscript with respect to its theoretical counterpart above. This is so because, in the model, the standard deviation of productivities it is fixed through time, while this is not true in the data and we will have to "control" for it.

[21] Coming from regressing log annual labor income on household head's age (both linearly and quadratically), gender, education, employment status and number of household members.

[22] Quarterly, seasonally adjusted, real gross domestic product from *IMF IFS*.

[23] No information about when the interviews were conducted was available for Germany, Hungary, Netherlands, Luxembourg, Russia, Spain and Thailand. The number of quarters for the remaining 18 countries ranges from 3 to 8.

Table 5: Standard Deviation of Household's Income and Aggregate Income

	(1) $\text{sd}(\log y_{it})$	(2) $\text{sd}(\log y_{it})$
$\text{sd}(\log e_{it})$	1.503***	2.341***
	(0.159)	(0.656)
$\text{sd}(\log e_{it}) * \log Y_t$	-0.259***	-1.141**
	(0.076)	(0.544)
Observations	64	64
R^2	0.820	0.941
Country FE	No	Yes

Notes. Results of OLS estimated relationship between the standard deviation of households's income and aggregate income. The former is given by the standard deviation of log annual labor income at quarter t. The latter is measured as the standard deviation of log residualized annual labor income at quarter t and log GDP per capita at quarter t. All regressions include a constant. Robust standard errors in parentheses.

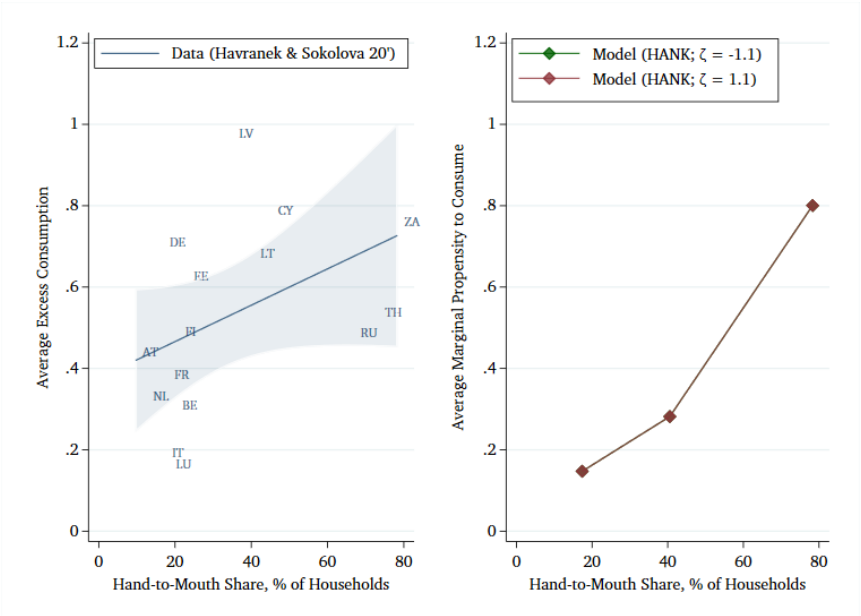
Marginal Propensities to Consume. Micro-level evidence on large propensities to consume out of wealth serves as the keystone empirical fact behind incomplete markets models, since it explicitly contradicts representative agent models' permanent income hypothesis. What this check consists of is comparing the MPCs coming out from the model against the excess consumption estimates compiled in Havranek and Sokolova (2020). They collected 3,127 estimates from the literature of how consumption reacts to anticipated or transitory shocks (which the permanent income hypothesis would predict to be close to zero). For our purposes, we kept only those that come from countries in our sample and averaged across studies (papers usually report more than one estimate) and countries. These average estimates are displayed on the left panel of Figure 5. Meanwhile, the right panel shows average MPCs for the different ζ and $\underline{a}$ calibrations of the model. Both empirically and theoretically there seems to be a positive association between borrowing constraints and propensity to consume.[24][25]

Nevertheless, however useful MPCs are to distinguish between HANK and RANK, it can also be appreciated in Figure 5 that they are not as helpful to discriminate within HANK models: under the three specifications of cyclicality the average MPC is the same. In fact, the result is even stronger: under the three scenarios the distribution of MPCs is exactly alike. This is so because MPCs are steady-state objects and the steady-state is the same under the pro, counter or acyclical cases. Cyclicality instead has to do with transitional dynamics, with how the standard deviation of household incomes change when aggregate income changes. Another way to put it is that MPCs answer the partial equilibrium question of how much would a household spend out of windfall income. And the answer to such hypothetical question does not depend on whether the household receives the actual income or not. But, in the countercyclical case for instance, the low-income, high-MPCs households are the ones that in general equilibrium actually receive the extra aggregate demand. Hence, though the model's micro implications are observationally equivalent under any of the three ciclicality cases, its macro predictions are not.

[24]Excess consumption estimates were not available for Croatia, Czechia, Greece, Hungary, Ireland, Malta, Portugal, Slovakia, Slovenia and Spain. The number of available estimates for the remaining 15 countries ranges from 5 to 96.

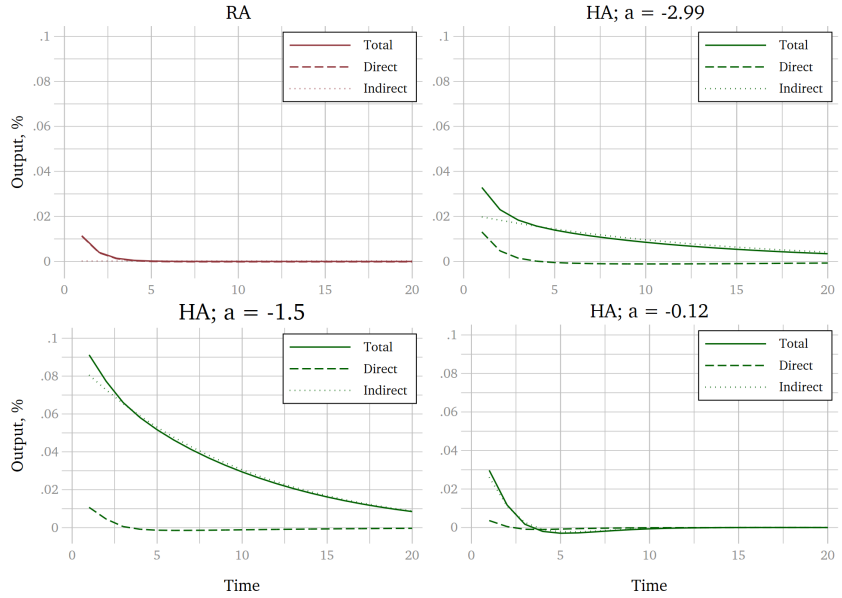
[25]One could argue that a quadratic specification would deliver a better fit or that things other than borrowing constraints are different across countries. Appendix D demonstrates that it is not the case.

Figure 5: Marginal Propensities to Consume and Hand-to-Mouth Shares



Notes. Left panel shows a correlation of 0.6 between average excess consumption estimates compiled in Havranek and Sokolova (2020) and hand-to-mouth shares, where a household is classified as such if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income. Right panel shows the relationship between average MPCs and hand-to-mouth shares coming from calibrations of a one-asset HANK model, for different cases of ciclicality of inequality and income risk ζ.

Figure 6: RANK and One-Asset HANK Output IRFs to Monetary Shock



Notes. Solid lines are impulse response functions of output to a -1.5 p.p. interest rate shock coming from both RANK and HANK models. Dashed and dotted lines respectively decompose them into a substitution effect and an income effect. Northwestern panel shows such results for a RANK model, northeastern panel for a high-liquidity $\underline{a} = -2.99$ HANK model, southwestern panel for a mid-liquidity $\underline{a} = -1.5$ HANK model and southeastern panel for a low-liquidity $\underline{a} = -0.1$ HANK model.

Baseline Results

With the proposed calibration validated, I proceed to show the baseline model results for the relationship between aggregate responses to shocks and development. Figure 6 shows output impulse response functions to an interest rate shock[26] under four scenarios: a representative agent model benchmark and the three different $\underline{a}$ parametrizations. The general message that comes out of this figure is that while the heterogeneous agent model delivers somewhat larger responses than the representative agent model under the liquid scenario (a result that is somewhat well known, see Kaplan et al. 2018, Auclert et al. 2024), the models truly differ as we move to the less liquid cases. To understand why, the figure also breaks down the total effects into its direct and indirect effects according to equation (1) above

$$dY_t = \underbrace{\sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t}{\partial r_s} dr_s}_{\text{Direct Effect}} + \underbrace{\sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t}{\partial Y_s} dY_s}_{\text{Indirect Effect}}.$$

The first two plots are no other thing than Kaplan et al. 2018's result: while in the RA model the response is completely explained by the direct mechanism, in a (liquid) HANK model the roles are more distributed between direct and indirect effects. The last two plots shed light on this paper's novel result: with intermediate levels of liquidity the direct effects are small and the indirect effects are large, while for low levels of liquidity the direct effects are so small that the indirect effects are not large any more. Another way to put it is that there are still enough agents who intertemporally substitute in the $\underline{a} = -1.5$ case to meaningfully move aggregate demand, kicking down the general equilibrium effect of borrowing constraints being relaxed. For $\underline{a} = -0.1$ the partial equilibrium effect of the few agents on their Euler's equation is not enough to relaxes the binding borrowing constraints of most of the agents.

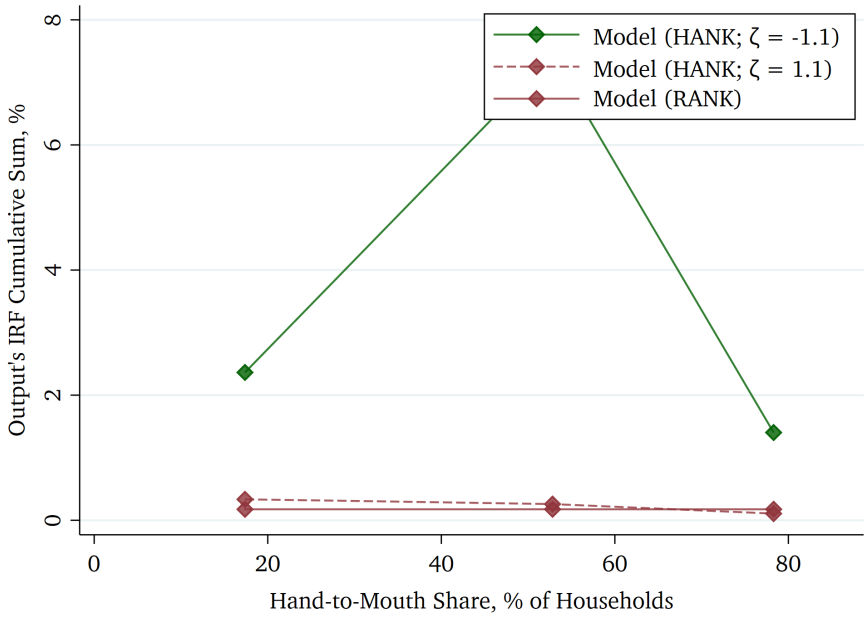
All of this can be seen more clearly in Figure 7. It calculates the cumulative sum of the impulse response functions above for the countercyclical scenario and also brings in the pro and acyclical cases. Note the different cumulative responses' levels within the highest liquidity level. Countercyclicality generates an amplifying income effect by redistributing towards constrained households the additional aggregate demand generated by the substitution effects of unconstrained households. As we move to the lower liquidity levels, this amplification mechanism first complements with the hand-to-mouth share but later they substitute each other since there is less of a direct effect to begin with. Consider instead the $\zeta = 0$ calibration. The potency of monetary policy decreases with borrowing constraints since no indirect effects counteracts the direct effects of lower liquidity.[27] In the $\zeta = 1.1$ case the direct effects get actually dampened by indirect effects since more households hit their borrowing constraints as aggregate demand increases.

Figure 8 pulls together the empirical and theoretical results. The countercyclical one-asset HANK model matches the inverted U-shaped moment coming from Proxy SVAR estimates. The cross-country relationship between output responses to monetary shocks and hand-to-mouth shares not only favors HANK over RANK, but also disciplines HANK models to feature countercyclical inequality and income risk.

[26] Particularly, a -1.5 p.p. interest rate shock with 0.35 persistence.

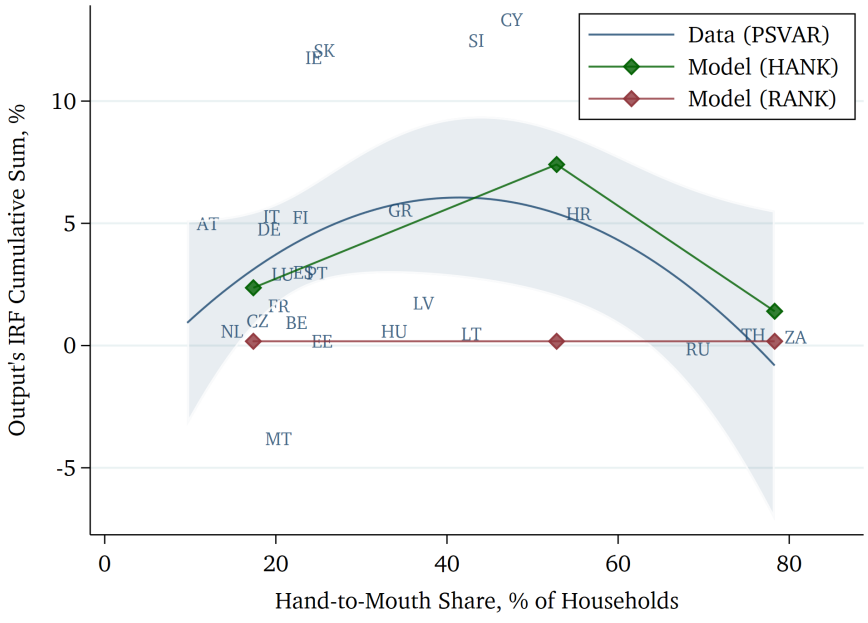
[27] Because borrowing constraints procyclical. If they were acyclical, $\zeta = 0$ would deliver a flat line.

Figure 7: RANK and One-Asset HANK Output Cumulative IRFs to Monetary Shock and Hand-to-Mouth Shares



Notes. Green line shows the relationship between the cumulative sum of impulse response functions of output to a -1.5 p.p. interest rate shock and hand-to-mouth shares coming from a countercyclical HANK model. Red dashed line replicates for a procyclical HANK and red solid line for a RANK model.

Figure 8: Proxy SVAR, RANK and One-Asset HANK Output Cumulative IRFs to Monetary Shock and Hand-to-Mouth Shares



Notes. Blue line is OLS estimated quadratic relationship between the cumulative sum of impulse response functions of seasonally adjusted industrial production in logs to monetary shocks estimated vía Proxy SVAR and hand-to-mouth shares. A household is classified as such if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income. Blue shaded area are 95% confidence bands. Green line is the theoretical counterpart of such relationship coming from a HANK model. Red line replicates for a RANK model.

3.3 Alternative Models

I showed that a one-asset HANK model with countercyclical inequality and income risk can match the inverted U-shape from section 2. In contrast with sub-section 2.3, whose objective was to show how different empirical methods gave way to the same result, the purpose of this sub-section is to show that different models do not deliver the same result. In particular, I will demonstrate that no feature other than countercyclicality can replicate the inverted U-shaped moment, unless those features are themselves defined in a countercyclical manner.

One-Asset HANK Model + Fiscal Policy

I augment the one-asset HANK model described above with a government subject to a budget constraint

$$B_t = (1 + r_t) B_{t-1} + G_t - T_t,$$

where B_t are government bonds uniformly bounded to prevent Ponzi schemes, G_t is government spending and $T_t = \tau_t Y_t$ is total tax revenue.[28] Total after-tax income is now given by

$$Z_t \equiv Y_t - T_t = (1 - \tau_t) Y_t,$$

while household after-tax income takes the form

$$z_{it} \equiv e_{it} Z_t = e_{it} (1 - \tau_t) Y_t$$

The rest of the model remains the same, with the caveat that we will focus on the acyclical $\zeta = 0$ case. Under such scenario the model boils down to the "canonical" HANK, with a labor allocation rule $n_{it} = N_t$.[29] Equilibrium is given by agents optimizing and markets clearing

$$C_t + G_t = Y_t = N_t$$
$$A_t = B_t$$

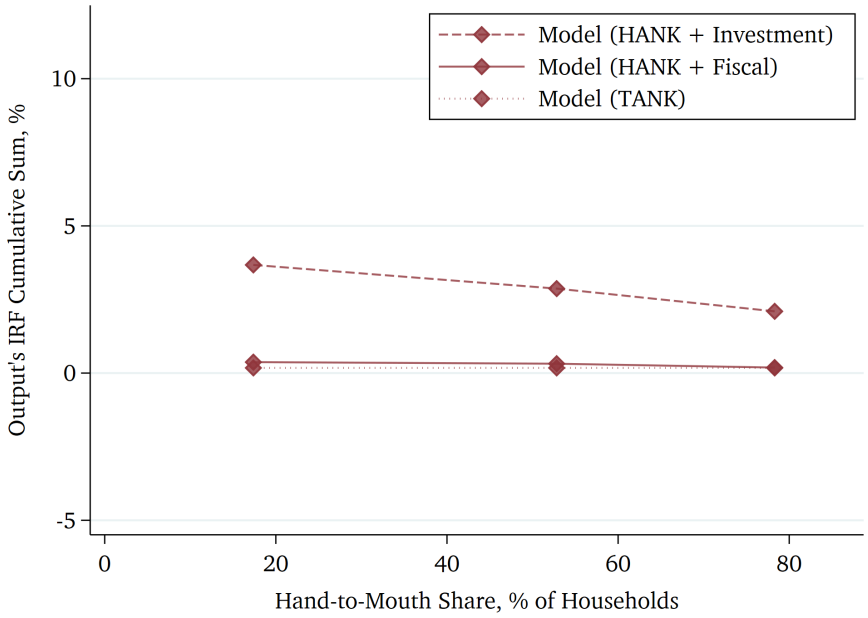
We calibrate $G = 0.2$ and $B = 0.8$ and repeat the exercise above of computing cumulative impulse response functions to a r shock for the different $\underline{a}$ levels.[30] The results are displayed in Figure 9. We can appreciate that this alternative model generates a negative relationship between the cumulative responses to monetary policy and the tightness of borrowing constraints. This is so because despite ζ being set equal to zero, the linear way in which taxes are introduced makes the standard deviation of household incomes shrink during recessions. That is, inequality and income risk are implicitly specified to be procyclical. How the cicliclality of inequality and income risk is specified remains therefore the key feature that determines the shape of the relationship between the response to aggregate shocks and development, and there is nothing in particular about fiscal policy that can match the inverted U-shape.

[28] Note that these government bonds pay the same interest rate r_t than assets A_t, so for all practical purposes this is still a one-asset model.

[29] Note that this assumption is the one that gives you the new household income in contraposition with the old one $y_{it} = e_{it} n_{it}$ since $Y_t = N_t$.

[30] Note that G is another margin to control liquidity, but I keep it constant as I change $\underline{a}$.

Figure 9: Alternative Models Output Cumulative IRFs to Monetary Shock and Hand-to-Mouth Shares



Notes. Red lines show the relationship between the cumulative sum of impulse response functions of output to a -1.5 p.p. interest rate shock and hand-to-mouth shares coming from calibrations of a one-asset HANK model with investment, a two-asset HANK model with investment and a two-agent model.

Two-Agent Model

A simpler model can be taken into consideration. Many of the features from heterogeneous agents models can be captured by two-agent models (see Bilbiie 2020). In these kind of models there is a fraction μ of agents that behaves entirely as hand-to-mouth, while a fraction $1-\mu$ behaves as a representative consumer

$$c_t^{\text{HTM}} = Y_t$$

$$c_t^{\text{RA}} = \frac{\beta^{t/\sigma} q_t^{-1/\sigma}}{\sum_{s\geq 0} \beta^{s/\sigma} q_s^{1-1/\sigma}} \left[\sum_{s\geq 0} q_s Z_s + (1+r_0)\, a_{-1} \right].$$

Aggregate consumption and output are then given by

$$C_t = \mu c_t^{\text{HTM}} + (1-\mu) c_t^{\text{RA}}.$$

I calibrate $\mu = 0.17$, $\mu = 0.41$ and $\mu = 0.78$ and redo the computations above. Figure 9 shows that the TA model predicts a constant relationship between aggregate responses and developemnt. The intuition for such result is as follows. An expansive monetary shock makes the RA agents intertemporally substitute consumption into this period. This increases aggregate demand Y, what makes HTM agents count with more income, which they fully consume. Hence, $c_t^{\text{HTM}} = c_t^{\text{RA}}$, since whatever additional consumption the RA agents make will translate one-to-one to Y and, therefore, to HTM agents consumption. Then, aggregate consumption C_t will be the same independently of μ. Since households never switch from being HTM to RA or viceversa, the model does not feature any cyclicality of inequality and income risk. Again, this feature is crucial for the inverted U-shaped relationship. There is nothing inherent to the TA model that can explain this fact.

Two-Asset HANK Model + Investment

A fully-specified model can also be take into consideration. Firms now count with capital k_{t-1} on their production functions

$$y_{jt} = k_{jt-1}^{\alpha} n_{jt}^{1-\alpha},$$

which they can choose paying a quadratic adjustment cost that gives way to a Tobin's Q-type law of motion for capital.

A representative intermediary finances that capital by investing in firm equity (and government bonds) the household's deposits. This is a two-asset HANK model since household's now count with a liquid and an illiquid account as in Kaplan et al. (2018). Illiquid assets can be converted into liquid by paying a fixed cost. The model features price as well as wage stickiness, with optimizing unions microfounding the Phillips curve. Equilibrium still involves agents optimizing and goods and assets markets clearing.

Liquid accounts are a target now and are set according to the previous three $\underline{a}$ levels. Total wealth is a new target, informed by micro data from the same countries that informed liquid accounts. Illiquid wealth is an untargeted moment.[31] I redo the computations above and the results can be appreciated in Figure 9 as well. Investment gives way to a strong output reaction for the highest liquidity level. However, the large direct effects hide indirect effects' that go in the opposite direction, due to inequality and income risk being procyciclical. Moving to the less liquid cases, the direct effects become smaller as the share of hand-to-mouth agents reduces. And there are no amplifying indirect effects from countercyclicality to compensate for these lower direct effects. The relationship between output responses to shocks and borrowing constraints ends up being convex instead of concave. Again, there is nothing in particular about investment that can explain the inverted U-shaped relationship.

[31]The rest of the model and its parametrization comes straightly from Auclert et al. (2021a) and can be found in Appendix E.

4 Conclusions

This paper studies whether the response to aggregate shocks is the same at different stages of development. If that is not the case, business cycles will be different in developed than in developing countries and aggregate demand stabilization policies should take this into account. I find that there is an inverted U-shaped relationship between output reactions to monetary shocks and the share of hand-to-mouth agents. Two empirical challenges needed to be sorted in order to answer such a question: the endogeneity of macroeconomic shocks and developing countries' data scarcity. The former was addressed by constructing high frequency monetary shocks based on exchange rates and the latter by pulling together household finance surveys from high, middle and low-income countries.

Despite the pervasiveness of borrowing constraints in developing countries, incomplete market models do not have definitive predictions on this relationship. I use the empirical moment to dissipate such theoretical ambiguity: a one-asset HANK model with countercyclical inequality and income risk matches it. For any level of development, countercyclicality generates an indirect income effect through redistributing towards low-income, high-MPCs households the additional aggregate demand generated by the direct effect of intertemporal substitution. This amplification is small when there are few constrained agents because general equilibrium effects are small and when there are few unconstrained agents because partial equilibrium effects are small. Amplification peaks instead when there is an equal distribution of constrained and unconstrained agents.

All of the above supports the idea that aggregate responses to shocks might not be the same at different stages of development. For policy shocks, the efficacy of monetary and fiscal aggregate demand stabilization might change when one moves from developed to developing countries. This paper tried to make the case that a complementarity between borrowing constraints and countercyclicality amplifies monetary policy in middle-income countries. Meanwhile, fiscal policy might be dampened in the developing world, since governments cannot finance deficits that would stabilize aggregate demand.[32]

For productivity shocks, the trend might be the the cycle: structural factors like the prevalence of credit constraints may amplify aggregate demand volatility in response to temporary productivity shocks (above and beyond whatever volatility permanent productivity shocks generate). But the cycle might be the trend too: the inverted U-shape described in this paper may explain why there exists a middle-income trap. When countries achieve average levels of development, they get stuck in a high demand volatility equilibrium from where only a combination of optimal policies and luck can take them to the quieter waters of development.

It should be clear by now that all of this matters because deviations from a representative agent benchmark amplify the welfare costs of business cycles. This paper made the case for borrowing constraints also augmenting the volatility of demand as they become more pervasive. The welfare costs of recessions could be then orders of magnitude higher in non-developed countries.

[32] Sheremirov and Spirovska (2022) estimate fiscal multipliers of 1.6 in developed countries and 0.8 in developing countries. Egger et al. (2022) estimate a multiplier of 2.5 for Kenya because they circumvent the deficit financing conundrum by providing the funds themselves.

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Appendix A

Bianchi et al. (2023) and Witheridge (2024) framework can be adapted to deal with the deviations that have opened in the CIP since the Great Recession. One simply needs to allow for a time-varying λ_t wedge

$$f_{t,t+1} - e_t = r^i_{t,t+1} - r_{t,t+1} - \lambda_t.$$

If this relationship is considered during the narrow window in which monetary policy announcement of country i take place, high frequency monetary shocks can still be measured as

$$\Delta fp_{t,t+1} = \Delta r^i_t$$

by now assuming that not only $r_{t,t+1}$ but also λ_t remain constant during such narrow window.

Appendix B

In this section we present both alternative identification and estimation methods and discuss what assumptions do the make and how they behave relatively to Proxy SVAR.

Local Projections IV

As good as Proxy SVAR might be for identification, at the end of the day it still relies on the VAR parametrics. Imposing this additional structure over/on the high frequency shocks gives us statistical power that often comes short with high frequency identification, since we are trying to calculate the effect of a narrow time window on large aggregate macroeconomic variables many periods ahead.[33] However, the benefits in terms of statistical power comes at the cost of the additional modelling choices that the VAR assumes. Moreover, VAR model misspecification compounds, given that the IRFs are produced by iterating one period ahead the initial coefficients. The opposite stand in this trade-off is to go fully non-parametric by instrumenting Jordà (2005)'s Local Projections with the high frequency shocks

$$y^j_{i,t+h} = \alpha^j_{i,0} + \beta^j_{i,h}\hat{r}^j_{i,t} + \boldsymbol{\gamma}^j_{i,h}\mathbf{x}^j_{i,t} + \xi^j_{i,t+h} \qquad \forall j \in J, i \in I, \forall h \in [0, H]$$

where $y^j_{i,t+h}$ is outcome j for country i at period $t+h$, $\alpha^j_{i,0}$ is a constant associated with outcome j and country i, $\hat{r}_{i,t}$ is the prediction coming out from the first stage on the high frequency shock for country i at period t and $\mathbf{x}^j_t$ is a vector of controls associated with outcome j for country i at period t and $\xi^j_{i,t+h}$ are error terms.

Instrumenting Local Projections with the high frequency shocks instead of directly running Local Projections on the shocks tames the aforementioned statistical power concerns and deals with potential measurement error issues. Note that the similarity of the results give us additional confidence on the VAR modelling choices made above, given the aforementioned discussion between parametrics and non-parametrics.

Proxy SVAR Local Projections

An intermediate step in the above bias-variance tradeoff between Proxy SVAR and Local Projections IV is to run Jordà (2005)'s Local Projections on monetary shocks identified from the Proxy SVAR, $\hat{\epsilon}_{1,t}$. This approach exploits the VAR structure only for identification of the shock but does not rely on the parametrics of the model for estimation. More particularly/specifically, what we do is to run the following set of regressions

$$y^j_{i,t+h} = \alpha^j_{i,0} + \beta^j_{i,h}\hat{\epsilon}^j_{i,t} + \boldsymbol{\gamma}^j_{i,h}\mathbf{x}^j_{i,t} + \xi^j_{i,t+h} \qquad \forall j \in J, i \in I, \forall h \in [0, H]$$

where $y^j_{i,t+h}$ is outcome j for country i at period $t+h$, $\alpha^j_{i,0}$ is a constant associated with outcome j and country i, $\hat{\epsilon}_{i,t} = \hat{\epsilon}^i_{1,t}$ is the high frequency shock identified from the Proxy SVAR for country i at period t and $\mathbf{x}^j_t$ is a vector of controls associated with outcome j for country i at period t and $\xi^j_{i,t+h}$ are error terms.

[33] Another gain that Proxy SVAR may have relatively to Local Projections is that one can get additional statistical power by relying on the VAR structure to go further into the past that what the instrument allows for, if the outcome variable sample is larger than the proxy sample. Given the particular nature of our proxy, which exploits deviations from the CIP after the Great Recession, we considered is was conceptually appropriated to only rely on the span of the external instrument sample.

Bayesian Local Projections

Another compromise between bias and variance is Bayesian Local Projections, whose IRF responses posterior means Ferreira et al. (2023) showed to span the space between VAR IRF responses ($B^{(h)}_{\text{BLP}}$) and Local Projections (B^{h}_{VAR})

$$B^{(h)}_{\text{BLP}} \propto \left(X'X + \left(\Omega^{(h)}_0(\gamma) \right)^{-1} \right)^{-1} \left(X'Y^{(h)} + \left(\Omega^{(h)}_0(\gamma) \right)^{-1} B^{h}_{\text{VAR}} \right)$$

The intuition behind such a result is that when $h = 1$, Local Projections collapses to an order one VAR. Therefore, the VAR structure can be seen as an informative prior for Bayesian estimated Local Projections. But, when $h > 1$, now the posterior coming out of the VAR-informed Local Projection serves as a prior. Therefore, as the horizon grows large, Bayesian Local Projections free itself from the VAR structure and deviates from it when necessary.[34]

Bayesian Proxy SVAR

For the sake of completeness, we present results from Bayesian estimated Proxy SVAR (as opposed to OLS estimated Proxy SVAR). Parametrization is kept as in Ferreira et al. (2023).

[34] Bayesian methods require additional parametrization that we keep as in Ferreira et al. (2023).

Appendix C

The equilibirium of the model (in sequence notation) is given by goods market clearing

$$\mathbf{Y} = \mathcal{C}\left(\mathbf{r}, \mathbf{Y}\right)$$

where $\mathcal{C}$ is a vector in which each entry is the result of the aggregate consumption function mapping current and future realizations of r an Y to present consumption. For one element of the sequence $\mathbf{Y}$, goods market clearing can be written as

$$Y_t = \mathcal{C}_t\left(\{r_s, Y_s\}\right)$$

To which we can feed an small shock $\{dr_t\}$

$$dY_t = \sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t}{\partial r_s} dr_s + \sum_{s=0}^{\infty} \frac{\partial \mathcal{C}_t}{\partial Y_s} dY_s$$

That can be taken back to sequence notation as

$$d\mathbf{Y} = \mathbf{M}^r d\mathbf{r}^{\text{ante}} + \mathbf{M} d\mathbf{Y}$$

Where $\mathbf{M^r}$ and $\mathbf{M}$ are Jacobians, for instance, the aforementioned one $\mathcal{J}^{\mathbf{C},\mathbf{Y}}$

$$M_{t,s} \equiv \frac{\partial \mathcal{C}_t}{\partial Y_s} = \mathcal{J}^{\mathbf{C},\mathbf{Y}}_{t,s}$$

In order to solve the fixed point problem, rewrite as

$$(\mathbf{I} - \mathbf{M}) d\mathbf{Y} = \mathbf{M^r} d\mathbf{r}$$

where $(\mathbf{I} - \mathbf{M})$ is not invertible but Auclert et al. (2018) showed that a unique solution is

$$d\mathbf{Y} = \mathcal{M} \mathbf{M}^r d\mathbf{r}$$

where $\mathcal{M} \equiv (\mathbf{K}(\mathbf{I} - \mathbf{M}))^{-1}\mathbf{K}$ if and only if $\mathbf{K}(\mathbf{I} - \mathbf{M})$ is invertible.[35]

[35] One possible choice is $\mathbf{K} = -\sum_{t=1}^{\infty}(1+r)^{-t}\mathbf{F}^t$, where $\mathbf{F}$ is the forward operator matrix.

Appendix D

As in the main fact, maybe a quadratic specification better describes the relationship between average excess consumption and hand-to-mouth shares. Table 6 demonstrates that it is not the case. Column 1 confirms that Figure 6's left panel's linear correlation is indeed statistically significant. Column 2 accommodates a quadratic term, which is marginally statistically significantly with the correct negative sign. Nevertheless, once one includes in Column 3 the same *WSBI* controls as in section 2's Table 2, both terms become statistically not significant. One could argue that this is due to having too few observations. But, if we drop the quadratic term, the linear one stays with the correct sign and is statistically significant despite controlling for other cross-country variables.

Table 6: Marginal Propensities to Consume and Hand-to-Mouth Shares

	(1)	(2)	(3)	(4)
	Exc. Cons.	Exc. Cons.	Exc. Cons.	Exc. Cons.
HtM Share	0.447**	2.697**	1.478	2.013***
	(0.186)	(1.149)	(1.030)	(0.574)
HtM Share Squared		-2.573*	0.788	
		(1.303)	(1.188)	
Observations	15	15	15	15
R^2	0.195	0.366	0.813	0.806
Controls	No	No	Yes	Yes

Notes. Results of OLS estimated cross-country quadratic relationship between marginal propensity to consume and development. The former is given by average excess consumption estimates compiled in Havranek and Sokolova (2020). The latter is measured as hand-to-mouth shares, where a household is classified as such if its net liquid wealth is larger or equal than zero but smaller or equal than one-half their monthly labor income. Controls from *WBSI* include per capita GDP, share of exports and share of savings. All regressions include a constant. Robust standard errors in parentheses.

Appendix E

Two-asset HANK model with caputal acummulation subject o an adjustment cost.

Households. households allocate their savings between liquid assets b_{it} and illiquid assets a_{it} subject to a convex portfolio adjustment cost $\Phi_t(a_{it}, a_{it-1})$. Hours worked are the same for all households $n_{it} = N_t$. Bellman equation then is

$$\begin{aligned} V_t(e_{it}, b_{it-1}, a_{it-1}) &= \max_{c_{it}, b_{it}, a_{it}} \left\{ \frac{c_{it}^{1-\sigma}}{1-\sigma} - \varphi \frac{N_t^{1+v}}{1+v} + \beta \mathbb{E}_t V_{t+1}(e_{it+1}, b_{it}, a_{it}) \right\} \\ \text{s.t. } c_{it} + a_{it} + b_{it} &= (1-\tau_t) w_t N_t e_{it} + (1 + r_t^a) a_{it-1} + \left(1 + r_t^b\right) b_{it-1} - \Phi_t(a_{it}, a_{it-1}) \\ a_{it} &\geq 0, \quad b_{it} \geq \underline{b}. \end{aligned}$$

The adjustment cost function is given by

$$\Phi_t(a_{it}, a_{it-1}) = \frac{\chi_1}{\chi_2} \left| \frac{a_{it} - (1 + r_t^a) a_{it-1}}{(1 + r_t^a) a_{it-1} + \chi_0} \right|^{\chi_2} [(1 + r_t^a) a_{it-1} + \chi_0]$$

Financial Intermediary. A representative financial intermediary takes households' liquid and illiquid deposits and invests them in firm equity p_t and government bonds B_t^g. Illiquid assets can be converted into liquid assets at cost $\omega \int b_{it} di$. The no-arbitrage conditions imposes that the ex-ante return $\mathbb{E}_t[1 + r_{t+1}]$ equals the expected returns on nominal government bonds and on equity. Since the financial intermediary is competitive, it passes these returns to households, who need to pay an intermediation cost

$$\mathbb{E}_t[1 + r_{t+1}] = \frac{1 + i_t}{\mathbb{E}_t[1 + \pi_{t+1}]} = \frac{\mathbb{E}_t[d_{t+1} + p_{t+1}]}{p_t} = \mathbb{E}_t\left[1 + r_{t+1}^a\right] = \mathbb{E}_t\left[1 + r_{t+1}^b\right] + \omega$$

The ex-post returns r_t, r_t^a, r_t^b are subject to surprise inflation and capital gains. Assuming that capital gains accrue to the illiquid account, we have $1 + r_t = (1 + i_{t-1}) / (1 + \pi_t) = 1 + r_t^b + \omega$ and

$$1 + r_t^a = \Theta_p \left(\frac{d_t + p_t}{p_{t-1}} \right) + (1 - \Theta_p)(1 + r_t)$$

where Θ_p denotes the share of equity in the illiquid portfolio.

Firms. Intermediate goods firms have a Cobb Douglas production function $y_{jt} = F(k_{jt-1}, n_{jt}) \equiv k_{jt-1}^{\alpha} n_{jt}^{1-\alpha}$. Firms choose capital subject to a quadratic adjustment costs $\zeta\left(\frac{k_{jt}}{k_{jt-1}}\right) k_{jt-1}$ with $\zeta(x) \equiv x - (1-\delta) + \frac{1}{2\delta\epsilon_I}(x-1)^2$, where $\delta > 0$ is depreciation and $\epsilon_I > 0$. The Phillips curve is given by $mc_t = w_t / F_N(K_{t-1}, N_t)$. Aggregate investment by $I_t = K_t - (1-\delta)K_{t-1} + \zeta\left(\frac{K_t}{K_{t-1}}\right) K_{t-1}$. Dividends equal output net of investment, labor costs, and price adjustment costs $d_t = Y_t - w_t N_t - I_t - \psi_t$. Tobin's Q and capital follow

$$\begin{aligned} Q_t &= 1 + \frac{1}{\delta \epsilon_I} \frac{K_t - K_{t-1}}{K_{t-1}} \\ (1 + r_{t+1}) Q_t &= \alpha \frac{Y_{t+1}}{K_t} mc_{t+1} - \left[\frac{K_{t+1}}{K_t} - (1-\delta) + \frac{1}{2\delta\varepsilon_I} \left(\frac{K_{t+1} - K_t}{K_t} \right)^2 \right] + \frac{K_{t+1}}{K_t} Q_{t+1} \end{aligned}$$

Unions. A competitive union aggregates labor with constant elasticity of substitution $\mu_w/(\mu_w-1)>1$. The wage for each labor type is set by a each labor union. Unions optimize by setting wages to maximize the average utility of households, taking as given their consumption-savings decisions. Setting a nominal wage W_{kt} incurs quadratic adjustment cost $\psi_t^w(W_{kt},W_{kt-1})=\frac{\mu_w}{\mu_{ww}-1}\frac{1}{2\kappa_w}\left[\log(W_{kt}/W_{kt-1})\right]^2$ in utils. Aggregate wage inflation $1+\pi_t^w=(1+\pi_t)\,w_t/w_{t-1}$ evolves according to the Phillips curve

$$\log(1+\pi_t^w)=\kappa_w\left(\varphi N_t^{1+v}-\frac{(1-\tau_t)\,w_tN_t}{\mu_w}\int e_{it}c_{it}^{-\sigma}di\right)+\beta\log\left(1+\pi_{t+1}^w\right)$$

Policy. τ_t is a proportional tax on labor and budget balance requires $\tau_t w_t N_t=r_tB^g+G_t$.

Market Clearing. Good markets clear $Y_t=\int c_{it}di+G_t+I_t+\psi_t+\omega\int b_{it-1}di+\int\Phi_t(a_{it},a_{it-1})\,di$ and assets market too $p_t+B^g=\int a_{it}+b_{it}di$.

Table 7: Calibration of Two-Asset HANK Model

Parameter		Value	Target
A. Households			
β	Discount factor	0.976	$r=0.0125$
σ	Inverse IES	2	
χ_0	Portfolio adj. cost pivot	0.25	
χ_1	Portfolio adj. cost scale	6.416	$B=1.04Y$
χ_2	Portfolio adj. cost curvature	2	
$\underline{b}$	Borrowing constraint	0	
ρ_e	Autocorrelation of earnings	0.966	
σ_e	Cross-sectional std of log earnings	0.92	
B. Labor unions			
φ	Disutility of labor	2.073	$N=1$
ν	Inverse Frisch elasticity	1	
μ_w	Steady state wage markup	1.1	
κ_w	Slope of wage Phillips curve	0.1	
C. Firms			
Z	TFP	0.468	$Y=1$
α	Capital share	0.33	$K=10Y$
μ_p	Steady-state markup	1.015	$p+B^g=14Y$
δ	Depreciation	0.02	
κ_p	Slope of price Phillips curve	0.1	
D. Financial intermediary			
ω	Liquidity premium	0.005	
E. Policy			
τ	Labor tax	0.356	budget balance
G	Government spending	0.2	
Bg	Bond supply	2.8	
ϕ	Taylor rule coefficient	1.5	
ϕ_y	Taylor rule coefficient on output	0	
F. Discretization			
n_e	Points in Markov chain for e	3	
n_b	Points on liquid asset grid	50	
n_a	Points on illiquid asset grid	70	