Open economy, redistribution, and the aggregate impact of external shocks

Haonan Zhou*

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Abstract

I investigate the role of household heterogeneity and redistribution in the transmission of foreign shocks to aggregate consumption for a small open economy. From theory, I identify key statistics that summarize systematic relationships between marginal propensity to consume (MPC) heterogeneity and shock exposure. Heterogeneous exposure across high-MPC and low-MPC households drives aggregate consumption responses through various redistribution channels. Using micro-data and a calibrated heterogeneous agent New Keynesian model, I gauge the importance of these channels. Most importantly, for an economy leveraged in foreign-currency debt as a whole, an unbalanced distribution of foreign-currency nominal wealth significantly amplifies the adverse consumption impact of depreciation when more responsive agents are disproportionately less insured against negative wealth revaluation.

JEL classification numbers: E21, E32, F42, F44.

1 Introduction

Business cycles in emerging market economies are characterized by two distinct yet interconnected features, namely high aggregate consumption volatilities (Aguiar and Gopinath, 2007) and large sensitivities to global policy spillovers (Miranda-Agrippino and Rey, 2020). For policymakers, clarifying the relationship between aggregate consumption and active conduits propagating externals shocks in an open economy context, such as exchange rate fluctuations, has

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become a first-order question. Meanwhile, the recent surge of interest in addressing rising income and wealth inequality stresses the need to understand the distributional consequences of international spillovers, so as to better inform policy responses to such distributional impact.

In this paper, I argue that to make progress in addressing both topics, it is important to consider the close interaction among international shocks, inequalities and the aggregates. More concretely, I explore the role of domestic incomplete markets and household heterogeneity in the propagation of external shocks for a small open economy. Agents' heterogeneous exposure to these shocks, particularly to the induced exchange rate fluctuations, has aggregate implications on output, consumption and welfare through a number of *redistribution* channels. These redistributive forces arise out of systematic relationships between the currency composition of households' balance sheet, consumption expenditure, sources of income, and the degree of wealth inequality in the economy reflected in households' heterogeneous marginal propensities to consume (MPC). External shocks have a larger adverse impact on the aggregates when households disproportionately affected by these shocks have relatively high MPC.

I make this point formal by identifying the redistribution channels from theory. I extend Clayton, Jaravel and Schaab (2018) to the open economy by adding foreign-currency denominated nominal bond to a simple partial-equilibrium environment featuring traded and nontraded goods. Households in my economy are potentially vulnerable to external shocks including a perturbation to the exchange rate, the price of nontradable goods, domestic interest rate, and sectoral output. Taken as given by the households, these perturbations affects individual households' consumption decision through wealth revaluation, consumer price inflation, and change in real income. The extent to which household consumption responds to these shocks depends on the specific structure of the household balance sheet, employment and consumption, as well as the MPC of each household.

As in Auclert (2019), the interaction between unequal exposure to shocks and MPC heterogeneity has aggregate implications. I analytically decompose aggregate consumption response to a transitory external shock into components that highlight the contributions of redistribution. The strength of each redistribution channel can be conveniently summarized by a key statistic – the covariance between MPC and the associated exposure. In particular, a real depreciation of domestic currency leads to wealth redistribution across households through the revaluation of nominal asset and debt positions denominated in foreign currency (the "*foreign-currency Fisher channel*"). In an economy leveraged in dollar debt in the aggregate, as high-MPC households' consumption decision is more sensitive to wealth windfall, local currency depreciation would lead to further contraction in aggregate consumption if MPC and household's foreign-currency exposure through wealth are negatively correlated. In the goods market, exchange rate depreciation is passed onto the price of tradable goods. If high-MPC households spend more on tradable goods relative to low-MPC households (Cravino and Levchenko, 2017), depreciation ef-

fectively redistributes from high-MPC to low-MPC households through a relative rise in the cost of consumption for high-MPC households. This redistribution results in additional contraction of consumption. I call this channel the "*consumption expenditure channel*."

The analytical decomposition identifies two other redistribution channels. As the counterpart to the foreign-currency Fisher channel, the "*domestic-currency Fisher channel*" redistributes across agents when external shocks dilute the real value of domestic-currency nominal position through inflation (Doepke and Schneider, 2006). In the labor market, the "*earnings heterogeneity channel*" discussed by Auclert (2019) and Patterson (2021) becomes relevant if agents' MPC is systematically related to the currency denomination and the sources of their income.

To document the degree of imbalance in households' exposure to external shocks and to provide empirical measurements of the sufficient statistics representing each redistribution channel, I turn to micro-data from Uruguay – a representative small open economy. Guided by the analytical decomposition, I exploit rich information in a number of household surveys to estimate the covariance between being liquidity-constrained (hand-to-mouth) and household exposure to external shocks. In the data, there is considerable inequality in insurance against local currency depreciation, as dollar savings are disproportionately concentrated in wealthy, unconstrained households, while the distribution of dollar liabilities is more even. Accordingly, the covariance associated with the foreign-currency Fisher channel has the largest magnitude at -0.645. On the other hand, the covariances associated with the domestic-currency Fisher channel, the consumption expenditure channel, and the earnings heterogeneity channel are negative but close to zero. These estimates suggest that while the foreign-currency Fisher channel is the most likely to amplify the effect of external shocks in the context of Uruguay, other redistribution channels may play a lesser role for Uruguay.

To evaluate the quantitative importance of the redistribution channels in general equilibrium, I construct a small open economy model with incomplete markets, liquid and illiquid assets, nontraded goods, idiosyncratic income risk and nominal rigidity. This model effectively extends the canonical two-asset Heterogeneous-Agent New Keynesian (HANK) model (Kaplan, Moll and Violante, 2018; Auclert, Bardóczy, Rognlie and Straub, 2021) to the open economy. To fit households' balance sheet structure tightly to data, the currency dimension of household portfolio is built into the model through perfectly substitutable local and foreign-currency assets and liabilities underlying households' liquid and illiquid wealth. I also introduce nonhomothetic preference over tradable and nontradable goods to generate heterogeneity in the composition of consumption basket (Cravino and Levchenko, 2017). The model is calibrated using macro and micro moments from Uruguay data. In particular, the model targets the aggregate level of wealth in the economy, the share of liquidity-constrained households, as well as the economy's exposure to exchange rate pass-through by matching expenditure shares of tradable goods in the data. My model generates realistic MPC and tradable share across the income distribution. Its

partial-equilibrium response to wealth revaluation is comparable to micro estimates (Gyöngyösi, Rariga and Verner, 2021). Untargeted model-implied covariances between liquidity-constrained status and exchange rate exposure are also close to my empirical estimates.

In my baseline model, an unexpected tightening of the foreign interest rate by 25 basis points leads to a depreciation of local currency. Both the price of tradable goods and the real value of foreign-currency debt instantaneously increase, and aggregate consumption drops by 26 basis points. The flexible structure of the household portfolio enables me to conduct several counterfactual experiments to analyze the impact of wealth revaluation. I isolate the contribution of foreign-currency Fisher channel by reshuffling wealth across portfolios and agents, while keeping the aggregate dollar position of the economy constant across specifications. Compared to the baseline specification where the household balance sheet exposure to exchange rate fluctuations is calibrated to data, a shutdown of dollar-denominated illiquid debt dampens the drop in aggregate consumption by 3 basis points (12 percent in relative terms). For a counterfactual economy with full deposit dollarization, and a higher level of liability dollarization (see Bocola and Lorenzoni (2020)), the covariance between MPC and net dollar position becomes more negative, leading aggregate consumption to decline further by 3 basis points, or 11 percent relative to the baseline. I further consider a counterfactual scenario resembling the large devaluation episode of Hungary (analyzed by Verner and Gyöngyösi (2020) and Gyöngyösi, Rariga and Verner (2021) in detail), in which nearly 70 percent of household debt is denominated in foreign currency in the lead up to the large depreciation of the Forint. Despite the economy being hit with a small monetary shock, the large exchange rate exposure of household balance sheets amplifies the contraction of aggregate consumption by 1.85 times relative to the baseline. These experiments suggest that redistribution via wealth revaluation could be an important channel aggravating the contractionary effect of international spillovers, and this channel is most relevant for countries with a heavy imbalance in the distribution of net dollar wealth.

I gauge the contribution of the consumption expenditure channel by comparing my nonhomothetic benchmark model to a recalibrated model with homothetic preference. The homothetic specification features a higher aggregate MPC coupled with a larger overall exposure to the exchange rate pass-through. Despite this, high-MPC households' consumption basket is relatively less exposed to depreciation, suggesting a stronger dampening role played by the consumption expenditure channel when moving to homothetic preferences. My quantitative exercise yields consistent results, as aggregate consumption declines following the shock is dampened by 0.6 basis points compared to the nonhomothetic benchmark. I conclude that models with nonhomotheticity could increase the sensitivity of aggregate consumption to external shocks via redistribution through the consumption expenditure channel, albeit by a modest amount in line with the quantitative finding of Auclert, Rognlie, Souchier and Straub (2021).

My analysis identifies several potential vulnerabilities at the micro level that entail significant

aggregate implications. In emerging market economies, such as Uruguay and Hungary where there is a highly unbalanced distribution of liquidity insurance, unhedged, highly consumption-sensitive households could be the ultimate bearers of the incidence of external shocks through redistribution via the foreign-currency Fisher channel. Analyzing the insurance role of dollarization for the aggregate economy, as a result, requires a careful anatomy of cross-sectional data that reveals the distribution of dollar hedges in the economy. Moreover, even when each individual redistribution channel has a quantitatively modest impact on aggregate consumption, in practice, the economy will feature multiple redistribution channels at work. The cumulative impact may be strong, especially when these channels interact with other amplification mechanisms absent in my simple setup. In terms of domestic policy response to foreign monetary tightening, my quantitative exercise shares a similar ground with Gourinchas (2017) and Auclert, Rognlie, Souchier and Straub (2021), that domestic monetary easing that depreciates exchange rate, as is traditionally prescribed, may not be the optimal response. Instead, I find that policy rules with a larger weight on managing exchange rate fluctuations could further stabilize aggregate consumption without inducing significant inflation pressure.

This paper is related to two strands of literature. First, this paper extends the analytical insight from closed-economy Heterogeneous-Agent New Keynesian (HANK) literature to the open economy. The analytical decomposition I use originates from a series of papers including Auclert (2019); Slacalek, Tristani and Violante (2020) and in particular, the two-sector setup of Clayton, Jaravel and Schaab (2018) (henceforth referred to as CJS), who use this toolkit to derive monetary policy implications when sectors feature heterogeneous price stickiness.[1] Variations in price stickiness across sectors are arguably more relevant for an open economy, where the high exchange rate pass-through to the price of tradable goods effectively increases the price volatility of the tradable sector. In my application of CJS, I also add foreign-currency bond to incorporate the unequal incidence of debt revaluation across agents owing to the exchange rate adjustment, and I provide empirical measurements of the redistribution channels from microdata.[2] In this way, my work is also related to recent literature documenting and analyzing the heterogeneous incidence for aggregate shocks (Alves, Kaplan, Moll and Violante, 2020; Broer, Kramer and Mitman, 2021). While I focus on MPC heterogeneity, systematic differences in *average* MPC across countries may also be a strong force in generating between-country heterogeneity in output and consumption response to external shocks. Almgren, Gallegos, Kramer and Lima (2019) find a positive correlation between the share of hand-to-mouth households and the elasticity of output

[1] Kekre and Lenel (2020) perform a similar decomposition on agents with heterogeneity over risk-taking capacity in a closed economy to study the effect of monetary policy shocks on the risk premia through redistribution across risk-loving and risk-averse agents.

[2] Compared to Drenik, Perez and Pereira (2018), who find a small effect of revaluation across the *income* distribution, I identify hand-to-mouth households to study the interplay between the distribution of MPC and the distribution of foreign currency exposure, as the theoretically relevant object for aggregate consumption response is the MPC.

to ECB monetary policy shocks in a sample of Eurozone economies.

My paper contributes to a small but fast-growing empirical and theoretical literature that seeks to incorporate heterogeneity and incomplete markets in the analysis of international macroeconomic issues. My quantitative model provides an environment to study the global spillovers of center-country monetary policy with heterogeneous agents through redistribution, while matching salient microeconomic features of emerging market economies. Two particularly novel contributions of my model include highlighting the general equilibrium impact of unequal foreign-currency wealth revaluation through depreciation and tightly calibrating the model to micro data.[3] Auclert, Rognlie, Souchier and Straub (2021) highlight the importance of real income effect for models featuring an open economy, incomplete markets, and heterogeneous agents, with the exchange rate as the key driver of households' real income fluctuation. My paper echoes their emphasis but focuses on how income and wealth effects interact with households' heterogeneous sensitivities of consumption, and the aggregate implication of such interactions.[4] On the topic of redistribution in the open economy, the closest to my work is Kekre and Lenel (2021), whose model rationalizes the asymmetric effect of U.S. monetary policy on currency risk premia and the exchange rate by redistributing resources among agents with heterogeneous risk aversion, and Guo, Ottonello and Perez (2021), who study the distributional effect of monetary policy and the tension between aggregate stabilization and consumption inequality. My model, in comparison, focuses on the role of redistribution across agents with heterogeneous MPC by foreign monetary policy shocks. My model features a two-asset structure with different levels of liquidity, similar to Hong (2020*a*). Hong (2020*a*) highlights the general amplifying effect due to emerging markets' high overall MPC, while I dissect the transmission mechanisms of foreign shocks by calibrating my model closely to households' exposure to exchange rate depreciation. De Ferra, Mitman and Romei (2020) use an open economy Huggett model to study the aggregate impact of household wealth revaluation and apply the model to the Hungarian devaluation episode. I complement their study by introducing micro data on the currency breakdown of household balance sheets and analyzing the effect of revaluation through various counterfactuals.[5]

The rest of this paper is organized as follows. Section 2 outlines the analytical decomposi-

[3]For the latter contribution in particular, my model takes foreign-currency wealth distribution in Uruguayan data as an input, and generates tradable expenditure shares in line with the household surveys. Previous works such as Fanelli and Straub (2020) and Auclert, Rognlie, Souchier and Straub (2021) also target expenditure shares using Brazilian and Mexican data, respectively.

[4]Otten (2021) and Oskolkov (2021) also discuss the pro-rich impact of currency depreciation through the real income channel.

[5]Other work on open economy and heterogeneous agents include Mendoza, Quadrini and Ríos-Rull (2009); Drenik, Perez and Pereira (2018); Cugat (2019); Kekre and Lenel (2021); Blanco, Drenik and Zaratiegui (2020); Ferrante and Gornemann (2021). Nuno and Thomas (2020) also construct a small open economy featuring heterogeneous agents to analyze optimal domestic monetary policy. On the firm side, di Giovanni, Levchenko and Mejean (2020) find the impact of foreign shocks on French GDP can be well explained by heterogeneity in firm exposure to foreign shocks.

tion and identifies redistribution channels of interest in the open economy. Section 3 takes the key statistics from the decomposition to Uruguayan micro-data to measure the strength of redistribution channels in partial equilibrium. Section 4 introduces the general equilibrium model and reports results from the quantitative exercise on the contribution of redistribution channels. Section 5 discusses the implications of my overall findings and concludes.

2 Redistribution in the open economy: An analytical decomposition

In this section, I introduce the redistribution channels for a small open economy. I use a simple two-period, two-sector, partial equilibrium model to demonstrate that the aggregate consumption response to an external shock is intimately related to the interaction between individual households' marginal propensity to consume and the exposure of household balance sheets, consumption and employment to shock-induced exchange rate and sectoral output fluctuations. An analytical decomposition of aggregate consumption into components that reflect such interaction yields sufficient statistics associated with the redistribution channels. These sufficient statistics are estimated in Section 3 using micro-data, and a full-blown quantitative analysis in general equilibrium follows in Section 4.

A continuum of households live for two periods, 0 and 1. There is no uncertainty. In period t, household of type $i \in I$ consumes tradable goods c_t^T and nontradable goods c_t^N, while receiving income $\gamma_i^N(y_t^N)$ from the nontradable sector, and $\gamma_i^T(y_t^T)$ from the tradable sector. $y_t^{j\in\{T,N\}}$ denotes aggregate sector-specific income that households take as given. The functions $\gamma_i^j(\cdot)$ are individual-specific, capturing idiosyncratic productivity differences in a flexible reduced form. Nontradable goods are denominated in domestic currency ("peso") with price p_t^N, while tradable goods are assumed to be denominated in foreign currency ("dollar"). Accordingly, I assume that household income from the tradable sector is denominated in dollar. The dollar price of tradable goods is fixed at 1 and the exchange rate pass-through is perfect, so that the peso price of tradable goods is given by e_t, the nominal exchange rate at period t, expressed as units of peso per dollar.

Households are born with legacy nominal bonds denominated in both pesos (a_{i0}) and dollars (b_{i0}), with each unit of debt paying $1 + i_0$ and $(1 + i_0^*)e_0$ at $t = 0$ respectively in peso terms. Both interest rates (i_0 and i_0^*) are exogenously fixed prior to period 0. At period 0, each household can save in both dollar (b_{i1}) and peso bond (a_{i1}) without any trading friction. With perfect foresight, these bonds are perfect substitutes. As a result, type-i household faces the following budget constraints:

$$p_0^N c_{i0}^N + e_0 c_{i0}^T + \omega_{i1} = p_0^N \gamma_i^N(y_0^N) + e_0 \gamma_i^T(y_0^T) + (1 + i_0)a_{i0} + (1 + i_0^*)e_0 b_{i0}$$
$$p_1^N c_{i1}^N + e_1 c_{i1}^T = p_1^N \gamma_i^N(y_1^N) + e_1 \gamma_i^T(y_1^T) + (1 + i_1)\omega_{i1}$$

where $\omega_{i1} \equiv a_{i1} + e_0 b_{i1}$ is the peso value of household savings at $t = 0$ and i_1 is the return of the portfolio ω_{i1} at $t = 1$. Let the real exchange rate q_t be defined as e_t / p_t^N, so that a rise in q_t corresponds to a real depreciation of domestic currency. I make two assumptions to simplify the analysis. As period-0 nominal interest rates are known entering period zero, I normalize both interest rates i_0, i_0^* to be zero without loss of generality. I also follow Werning (2015) and CJS to assume that household sector-specific income is proportional to the aggregate income of the corresponding sector: $\gamma_i^j(y_t^j) = \gamma_i^j y_t^j, j \in \{T, N\}$. Under these assumptions, the per-period budget constraints can be consolidated into

$$c_0^N + q_0 c_0^T + \frac{c_1^N + q_1 c_1^T}{R} = \underbrace{\gamma_i^N y_0^N + q_0 \gamma_i^T y_0^T + \frac{\gamma_i^N y_1^N + q_1 \gamma_i^T y_1^T}{R} + \frac{a_{i0}}{p_0^N} + q_0 b_{i0}}_{y_i} \tag{1}$$

where the gross domestic real interest rate from time 0 to 1 is defined as $R \equiv (1 + i_i)/(p_1^N / p_0^N)$. I use y_i to denote the right-hand-side of Equation (1), which corresponds to the present-value of individual-specific lifetime income.

Finally, overall consumption c_{it} is a Cobb-Douglas bundle of tradable and nontradable goods, with the expenditure share of tradable goods being $1 - \alpha_i$, possibly varying across household types:[6]

$$c_{it} = (c_{it}^T)^{1-\alpha_i} (c_{it}^N)^{\alpha_i}, \; t \in \{0, 1\}.$$

2.1 Tracing the consumption response to external shocks at the individual level

To understand the factors explaining the consumption behaviors of individual households in response to foreign shocks, I now consider a perturbation in the form of

$$\{\mathrm{d}q_0, \mathrm{d}q_1, \mathrm{d}p, \mathrm{d}R, \mathrm{d}y_0^N, \mathrm{d}y_0^T\},$$

where I use the shorthand notation $\mathrm{d}p \equiv \mathrm{d}p_0^N$. In words, an exogenous external shock leads to fluctuations in the exchange rate, the price of nontradables, and aggregate output. Inflation-targeting domestic monetary authority responds using monetary policy tools to affect the return on portfolio i_1, and thus the real interest rate R. While such a perturbation is often endogenous in open economy models, individual households in the small open economy take the perturbation as given. The flexibility of this perturbation approach allows me to be agnostic about the exact source of the exogenous shock that drives movements in prices and quantities. Examples include monetary policy shocks, sudden stops, or demand shocks for foreign currency as in Kekre and Lenel (2021). For the quantitative model presented in Section 4, I consider a particular instance in which shocks to foreign interest rate depreciate home currency instantly.

[6] In the general equilibrium model to be introduced in Section 4, differences in α_i across households are endogenously generated via nonhomothetic preferences.

Households have CRRA preferences with relative risk aversion σ. To make the analysis tractable, I follow Auclert (2019) and CJS to assume zero long-run real effect of monetary policy, so as to abstract away from perturbations to period-1 output y_1^N and y_1^T. For simplicity, I further consolidate terms by assuming $q_0 = q_1 = q$ and thus considering a single perturbation $\mathrm{d}q$ around a constant level of real exchange rate q. The following proposition illustrates the response of household consumption policy function to this set of perturbations.

Proposition 1. *Under the posited perturbation, an individual's consumption response is represented by*

$$\begin{aligned}\mathrm{d}c_{i0} = &\overbrace{-\sigma^{-1}(1-\kappa_i^{-1}q^{1-\alpha_i}MPC_{i0})c_{i0}\frac{\mathrm{d}R}{R}}^{\textit{Intertemporal substitution}} + MPC_{i0}\cdot\Big[\overbrace{p^{-1}\omega_{i1}\frac{\mathrm{d}R}{R}}^{\textit{Unhedged interest rate exposure}} \\ &+\overbrace{\gamma_i^N\mathrm{d}y_0^N + q\gamma_i^T\mathrm{d}y_0^T}^{\textit{Earnings exposure}} \\ &+\underbrace{\Big(qb_{i0}\frac{\mathrm{d}q}{q} - p^{-1}a_{i0}\frac{\mathrm{d}p}{p}\Big)}_{\textit{Valuation effect on nominal assets}} - \Big(\underbrace{\kappa_i^{-1}(1-\alpha_i)q^{1-\alpha_i}(c_{i0}+R^{-1}c_{i1})}_{\textit{Exchange rate pass-through to consumption basket}} + \underbrace{\gamma_i^T q(y_0^T+R^{-1}y_1^T)}_{\textit{Valuation effect on earnings}}\Big)\frac{\mathrm{d}q}{q}\Big]\end{aligned} \tag{2}$$

where $MPC_{i0} \equiv \partial c_{i0}/\partial y_i$ *and* $\kappa_i \equiv (1-\alpha_i)^{1-\alpha_i}\alpha_i^{\alpha_i}$.

Proof. See Appendix A.1. □

Proposition 1 identifies a number of forces that shapes each household's consumption response to an external perturbation. The first term on the right hand side of Equation (2) captures households' intertemporal substitution motive following shocks to domestic real interest rate. The lower is the MPC of the household, the higher is the incentive for the household to delay consumption in response to interest rate tightening, leading to a higher consumption decline at period 0. The second term reflects the "unhedged interest rate exposure" (URE) of the household, analogous to Auclert (2019). In this simple setup, the household's interest rate exposure is summarized by a single term $p^{-1}\omega_{i1}$, the real value of the household's portfolio formed at period 0 in response to the perturbation. From the point of view of period 0, this URE term accounts for the wealth effect arising from changes in the rate of return of households' future maturing assets.

In my two-sector, open-economy environment, several novel forces emerge. The magnitude of the income effect, governed by the terms associated with $\mathrm{d}y_0^N$ and $\mathrm{d}y_0^T$, depends on households' income exposure to each sector, as well as the associated shocks to sector-specific output. If a real depreciation leads to an expansion of the tradable sector, households receiving most of their income from the nontradable sector may nevertheless reduce their consumption if the nontradable sector contracts in the meantime.[7]

As the ex-post returns on the legacy assets are directly affected by the perturbation, holders of legacy nominal bond experience a wealth shock that revalues their net nominal position. In a closed economy, inflation tends to dilute the burden of borrowers in nominal bonds. This

[7]This heterogeneous exposure to sectoral fluctuations is reflected in the empirical finding of Cugat (2019), that households employed in the nontradable sector are disproportionately affected by the Mexican Tequilla crisis.

effect is captured by the term $-p^{-1}a_{i0}\frac{\mathrm{d}p}{p}$ in Equation (3). Furthermore, with the introduction of foreign-currency nominal bond in the open economy, a high level of dollar debt ($b_{i0} \ll 0$) imposes downward pressure on household consumption in situations of peso depreciation ($dq/q > 0$), as the value of debt in peso terms rises.

In CJS, changes in the relative price between two sectors lead to new forces explaining the consumption response. In my open-economy context, the relative price is the real exchange rate. Following a real depreciation, households' dollar-denominated income from the tradable sector becomes more valuable in peso terms. On the other hand, as household's consumption expenditure is tied to the peso price of the tradable goods, a real depreciation raises the cost of the overall consumption basket and, all else equal, reduces household consumption. The strength of the relative price channels crucially depends on households' exposure to the tradable sector through income and spending on tradable goods, respectively captured by household-specific parameters γ_i^T and α_i. For instance, households with a higher level of γ_i^T receives a larger amount of dollar-denominated income, so that their consumption would be more sensitive to revaluation of income due to exchange rate fluctuations.

2.2 Aggregate consumption and the redistribution channels

Households' heterogeneous vulnerabilities to the external shock analyzed above has implications for stabilization policy, because the vulnerabilities shape the response of consumption at the aggregate level. With individual MPC as the key multiplier (Equation 2), it follows that the response of consumption at the aggregate level to the perturbation is shaped by the systematic relationship between MPC and household exposure, that determines the extent to which resources are redistributed across households with different levels of consumption sensitivity. With unit mass for each type of households, assume $\mathbb{E}_I[\gamma_i^j] = 1$ for $j \in \{N, T\}$, so that the share of sector-specific income accrued to each household sums to one. Denote average MPC as $\overline{MPC}$. Proposition 2 characterizes the response of aggregate consumption to the perturbation:

Proposition 2. *Under the posited perturbation, the associated change in aggregate consumption is*

$$
\begin{aligned}
\mathrm{d}C_0 = & \overbrace{-\sigma^{-1}\mathbb{E}[c_{i0}(1-\kappa_i^{-1}q^{1-\alpha_i}MPC_{i0})]\frac{\mathrm{d}R}{R}}^{\textit{Substitution}} + p^{-1}[\overline{MPC}\cdot\mathbb{E}[\omega_{i1}] + \overbrace{Cov(MPC_{i0},\omega_{i1})}^{\textit{Unhedged interest rate exposure}}]\frac{\mathrm{d}R}{R} \\
& + \underbrace{\overline{MPC}\cdot[\mathrm{d}y_0^N + q\mathrm{d}y_0^T + (y_0^T + R^{-1}y_1^T)\mathrm{d}q]}_{\textit{Aggregate income}} + \underbrace{Cov(MPC_{i0},\gamma_i^N)\mathrm{d}y_0^N + Cov(MPC_{i0},\gamma_i^T)\cdot[q\mathrm{d}y_0^T + (y_0^T + R^{-1}y_1^T)\mathrm{d}q]}_{\textit{Earnings heterogeneity}} \\
& + \Big[q(\overline{MPC}\cdot\mathbb{E}[b_{i0}] + \underbrace{Cov(MPC_{i0},b_{i0})}_{\textit{Fisher (foreign currency)}})\frac{\mathrm{d}q}{q} - p^{-1}(\overline{MPC}\cdot\mathbb{E}[a_{i0}] + \underbrace{Cov(MPC_{i0},a_{i0})}_{\textit{Fisher (domestic currency)}})\frac{\mathrm{d}p}{p}\Big] \\
& - [\overline{MPC}\cdot\overline{\Xi} + \underbrace{Cov(MPC_{i0},\Xi_{i,0})}_{\textit{Consumption expenditure}}]\frac{\mathrm{d}q}{q}
\end{aligned}
\tag{3}
$$

where $\Xi_{i,0} \equiv \kappa_i^{-1} q^{1-\alpha_i}(1-\alpha_i)(c_{i0} + R^{-1}c_{i1})$.

Imposing resource constraint $C_0^N = y_0^N$*, the change in nontradable output is given by*

$$\mathrm{d}y_0^N = \overbrace{\mathbb{E}\left[\frac{c_{i0}^N}{c_{i0}}\right]\mathrm{d}C_0}^{\textit{Aggregate demand}} + \overbrace{\mathbb{E}[(1-\alpha_i)c_{i0}^N]\frac{\mathrm{d}q}{q}}^{\textit{Substitution}} + \overbrace{Cov\left(\frac{c_{i0}^N}{c_{i0}}, \mathrm{d}c_{i0}\right)}^{\textit{Consumption distribution}} \tag{4}$$

where $\mathrm{d}c_{i0}$ *is given by Equation (2).*

Proof. See Appendix A.2. □

The first part of Proposition 2 clarifies the relationships among aggregate consumption response, MPC, and various redistributive forces in the open economy. Economies with a large fraction of liquidity constrained households would experience a larger consumption response, as the overall level of consumption sensitivity to income windfall, captured by average MPC, is high (Almgren, Gallegos, Kramer and Lima, 2019). Furthermore, redistribution among households with different MPCs would amplify or dampen the aggregate consumption response, depending on the covariances of MPC with the balance sheet, consumption and income mix of each household. In particular, following a real depreciation ($dq/q > 0$), wealth is redistributed from households with high levels of dollar borrowings to those with high levels of dollar savings through asset revaluation. I call this redistribution channel the "*Fisher channel*" for foreign-currency bond. Whether this channel amplifies or dampens the aggregate impact of wealth revaluation depends on the overall foreign-currency position of the economy. If the economy as a whole is a net borrower of dollar bond ($\mathbb{E}_I[b_{i0}] < 0$), and it is the high-MPC households that have a net nominal debt position denominated predominantly in dollars ($Cov(MPC_{i0}, b_{i0}) < 0$), redistribution from high-MPC to low-MPC households through this Fisher channel *amplifies* the negative consumption response to foreign-currency bond revaluation, compared to models with no relationship between household MPC and foreign-currency nominal positions. On the other hand, when the economy as a whole saves in foreign-currency, the expansionary impact of depreciation would be partially offset by the lack of foreign-currency hedges for high-MPC households. An alternative Fisher channel works through domestic-currency assets. This channel amplifies the negative impact of deflation (in the nontradable sector) in an economy with aggregate domestic-currency debt and with high-MPC households being disproportionately leveraged in domestic-currency bond.

The income effect induced by real exchange rate depreciation also redistributes from high-MPC to low-MPC households in the case when low-MPC households disproportionately benefit from a higher dollar-denominated income in peso terms. Aggregate consumption is also subject to the redistribution of income across agents working in different sectors. If high-MPC households predominantly receive income from the tradable sector, an expansion of the tradable sector

will result in a more responsive consumption. These two redistributive forces constitute the "*earnings heterogeneity*" channel.

Finally, the last covariance term in Equation (3) is related to the structure of household consumption expenditure, known to vary across the income distribution (Cravino and Levchenko, 2017). The negative aggregate consumption response to a more expensive consumption bundle – driven by real depreciation – is amplified by this "*consumption expenditure channel*" if high-MPC households have a higher expenditure on tradable goods relative to low-MPC households.

While shocks to aggregate sectoral income y_0^N and y_0^T, among perturbations to other variables, are taken as given by the households, the resource constraint for the nontradable sector, $C_0^N = y_0^N$, enables me to characterize the equilibrium outcome of households' consumption adjustment in this sector. The second part of Proposition 2 uses this resource constraint to decompose the resulting change in aggregate nontradable output into a component that incorporates changes in aggregate demand for consumption, a substitution effect coming from the relative price change induced by the real depreciation, and a covariance term. While the response of nontradable output is positively correlated with changes in aggregate consumption (scaled by the average share of nontradable consumption in a consumption basket,) real depreciation also makes the price of nontradable goods lower relative to tradable goods, thus tilting consumer demand toward nontradable goods. The final covariance term associates the response of aggregate nontradable output to the distribution of nontradable consumption in the economy. If households with a high nontradable share in their consumption basket adjust their aggregate consumption by more in response to an adverse perturbation, aggregate contraction in nontradable output would be amplified.

Proposition 2 shows that the covariances between MPC and exposure are the key statistics affecting the magnitude of aggregate consumption reaction to external shocks. In subsequent sections, I will attempt to estimate these covariances from household-level survey data. But based on a number of recent studies, it is worth highlighting first that these redistributive forces are likely present in the data, able to be endogenously rationalized in models, and could potentially explain emerging market economies' volatile business cycle and the substantial global spillover of center-country monetary policy. Heterogeneous financial exposure to currency fluctuations with high-MPC individuals taking on foreign-currency leverage can be easily generated in a mechanism akin to Bocola and Lorenzoni (2020), in which savers prefer dollar assets to insure against frequent devaluations, leading to UIP violations and driving down dollar borrowing rates, thus introducing potentially destabilizing currency mismatches in borrowers' balance sheets. Empirically, Verner and Gyöngyösi (2020) and Gyöngyösi, Rariga and Verner (2021) find large negative demand effect after foreign-currency debt revaluation in Hungary. Consumption inequality, represented by varying shares of expenditure share in tradable goods across the wealth distribution, may lead to a sharp rise in prices and living costs, particularly affecting high-MPC households, as

demonstrated by Cravino and Levchenko (2017). The earnings heterogeneity channel, due to the matching of high-MPC workers to industries sensitive to external shocks, echoes the "matching multiplier" mechanism studied by Patterson (2021) in the closed economy. While households are unlikely to directly receive wages in foreign currency, the relative price-of-earnings channel would also be relevant if a substantial fraction of high-MPC households receive unilateral wealth transfers in the form of foreign-currency remittances from emigrant household members to support consumption, especially during domestic economic downturns.

3 Channels of redistribution in the data: The case of Uruguay

Guided by the analytical decomposition in Section 2, this section combines household-level microdata from Uruguay to provide measurements for the redistribution channels. I first offer an overview of survey datasets used in the empirical exercise and report relevant summary statistics that sketch the heterogeneous exposure of households to potential exchange rate and sectoral output variations. Informed by Proposition 2, I then compute the covariances between hand-to-mouth status and the household balance sheet, employment and consumption structure to shed light on the role of each redistribution channel in amplifying the impact of external shocks for the case of Uruguay. The exercise suggests that the most significant redistribution channel in Uruguay is the foreign-currency Fisher channel, while other channels are associated with near-zero covariances. I close this section by discussing the potential macroeconomic significance of my estimates.

3.1 Data

I use three household survey datasets from Uruguay covering rich details on balance sheet composition, consumption expenditure, and socio-demographic characteristics. Table 1 provides a brief summary of each dataset. Sampling schemes and linkages across datasets are also discussed in Table 1. More details on the datasets, include the sample selection rule, are included in Appendix B.1.

Uruguay is the ideal country to conduct my estimation. This country is among a group of very few countries that collect information on the currency breakdown of balance sheets at the household level through three waves of household financial surveys, and among the few emerging market economies that publish reliable data on household-product-level consumption expenditure. The availability of these datasets partly reflects the fact that Uruguay has long been a heavily dollarized economy and has been through frequent episodes of devaluation and high inflation. With a net foreign asset position (net of reserves) at the level of -50 percent of GDP, deposit and credit dollarization are prevalent. Recent data suggests that over 70 percent of all deposits and 50 percent of loans are denominated in the U.S. dollar (Toscani, 2018).

What's more, a unique feature among several Latin American economies, but in particular Uruguay, is that a considerable fraction of goods sold in the domestic market are directly quoted in U.S. dollar instead of domestic currency. Of the goods in the basket used to compute the consumer price index in Uruguay, 14 percent are dollar-priced (Toscani, 2018). Product-level data from online retailers used by Drenik and Perez (2021) paints a similar picture, with tradable goods and housing more likely to be priced in dollar. This feature likely exacerbates concern about households' exchange rate exposure through consumption, as goods whose prices are sticky in dollar tend to have almost-complete exchange rate pass-through that would directly affect the costs of living in the short-term (Gopinath, Itskhoki and Rigobon, 2010).[8]

To measure the redistribution channel, one needs to estimate marginal propensities to consume for each household. Typically, this is either achieved using panel data, direct survey questions or event studies using unexpected transfers.[9] Unfortunately for Uruguay, there is no data that enables me to provide a direct household-specific estimate of the MPC using these methods. However, I am able to infer if the households are likely to have high MPC by labeling households into hand-to-mouth groups using data on household balance sheet from the third wave of the households financial survey (EFHU-3). The EFHU-3 survey, with a similar structure to Spain's Survey of Household Finances (EFF), obtains information on homeownership, as well as types and amounts of liabilities and assets from more than nine thousand households.[10] In particular, the survey explicitly asks for a currency breakdown of households' debt and liquid savings, the latter component including cash holdings that rarely appear in surveys conducted in advanced economies (Kaplan, Violante and Weidner, 2014). As an add-on module to the annual Continuous Household Survey (ECH) conducted in 2017, the EFHU-3 dataset can be linked to a subsample of the master survey, in order to connect balance sheet structure to other characteristics of household members. Like household financial surveys in other countries, EFHU oversamples wealthy households. By using the associated sample weights, one can construct summary measures that are representative of the population. These features of the EFHU-ECH dataset enables me to construct hand-to-mouth indicators and estimate the redistribution channel related to financial and labor market exposure to exchange rate fluctuations.

To capture the interaction between MPC and consumption inequality, I supplement the EFHU-ECH linked dataset with Uruguay's household consumption expenditure survey (ENGIH), conducted most recently from late 2016 to late 2017 as an official input to the construction of

[8]For simplicity, in both the analytical and quantitative models, I do not distinguish between border prices and retail prices. The latter typically features incomplete pass-through due to nontradable distribution margins (Burstein and Gopinath, 2014).

[9]For instance, see Johnson, Parker and Souleles (2006); Blundell, Pistaferri and Preston (2008), and Jappelli and Pistaferri (2014).

[10]Data from earlier waves of the EFHU survey are used in Lluberas and Odriozola (2015) and Drenik, Perez and Pereira (2018) to estimate the wealth revaluation effect of devaluation.

Uruguay's consumer price index. Surveyed households are asked to record all items in their monthly consumption expenditure, including the sources of acquisition and the value of the items. As all transactions are reported in peso terms, I manually identify tradable (and likely dollarized) goods based on Cravino and Levchenko (2017) and Drenik and Perez (2021). While the socio-demographic components in the consumption expenditure survey are comparable to the ECH survey, it does not have a balance sheet component. Using both the characteristics from identified hand-to-mouth households in the EFHU-ECH dataset and subjective questions asked in ENGIH, I impute the hand-to-mouth status of households in the ENGIH survey. Appendix B.1 outlines my imputation procedure.

Dataset name (Spanish abbr.)	**Sample years (observations)**	**Contents/Notes**
Continuous Household Survey (ECH)	2017 (45360)	Basic socio-demographic and labor market information; Multi-layered stratified sampling according to nineteen country departments, metropolitan area (Montevideo), and sizes of the localities; Information contained is comparable to US CPS data.
Household Financial Survey (EFHU-3)	2017 (9412)	Add-on module to ECH (2017); Contains asset and liability information with currency breakdowns; Oversamples wealthy households; Structurally similar to Spanish EFF.
Consumption Expenditure Survey (ENGIH)	2016-2017 (6889)	8-digit product level expenditure survey; Purchases with reference periods more than one month are standardized into monthly expenses; Similar stratification as ECH; Direct linkage to ECH-EFHU is not available, but allows for imputation.

Table 1: Basic description of the datasets

3.2 Hand-to-mouth households and foreign currency leverage

Using ECH-EFHU data, I first inspect the foreign-currency exposure of households. I identify households who are likely liquidity constrained ("hand-to-mouth") following the criteria proposed by Kaplan, Violante and Weidner (2014). A household is considered to be a poor hand-to-mouth household if the household has zero or negative net illiquid wealth[11] and satisfies one of the following two criteria: either the value of (peso and dollar) liquid asset holdings are less than one half of the households total monthly income ("zero kink" households), or the value of net liquid liabilities are larger than one half of the total monthly income minus the credit limit

[11]Note from Table 2 that only housing and auto have corresponding asset and debt information in EFHU, while other debt categories do not. For the identification of hand-to-mouth households, I use housing equity as the net illiquid wealth measure whenever it is non-negative, and use housing plus auto equity otherwise.

("credit limit" households).[12] A wealthy hand-to-mouth household is similarly defined, except that the households have positive net illiquid wealth.

Table 2 reports the balance sheet items available in the ECH-EFHU dataset, and my classification of these items into liquid and illiquid assets and debt.[13] For non-mortgage, non-credit card debt, the dataset does not provide item-specific stock amounts. I back out stock amounts from item-specific monthly payment shares and total amount of illiquid debt. Currency breakdown is available for liquid assets and illiquid debt. In particular, mortgage debt can be denominated in Uruguayan peso and dollar, indexed to inflation, or readjustable. I assume credit card debt is taken out in Uruguayan peso.

Table 3(a) reports basic summary statistics on the households in the ECH-EFHU dataset, classfied into three groups. One observation that stands out in contrast to advanced economies is that a predominant fraction (more than three-fourths) of households is considered liquidity-constrained according to the definition of Kaplan, Violante and Weidner (2014).[14] Of all households, half are "wealthy" hand-to-mouth, largely due to a high homeownership rate. The reason behind the large share of hand-to-mouth households in the data is that nearly 70 percent of all households do not have positive net liquid wealth, and less than 15 percent of them hold assets that exceed one month's income.[15] Households that are not hand-to-mouth earn significantly more than hand-to-mouth households, and are more likely to have access to credit cards to smooth consumption. There is also a sizable income gap between poor and wealth hand-to-mouth households.

Classification	**Asset**	**Debt**
Liquid	Cash holding Bank savings account	Credit card balance
Illiquid	Housing Auto	Mortgages Auto debt Bank debt Other credit institution debt Family members and friends

Table 2: Household balance sheet information from ECH-EFHU

[12] I follow Kaplan, Violante and Weidner (2014) to assume a benchmark credit limit of one month's income.

[13] As the values of illiquid assets are self-assessed, I do not include owned businesses as an asset class.

[14] Guntin (2020) uses a similar definition of HtM and the same EFHU data and get a 77 percent hand-to-mouth share, very close to my calculation.

[15] A substantial fraction of households report zero financial assets, despite the fact that the survey covers cash holdings. As there is no foreign exchange restriction in Uruguay, delibrate misreporting is unlikely. A possible interpretation of this finding is that households who report zero cash holding are unlikely to hold large amount of cash to effectively insure themselves against adverse shocks.

	Non-HtM	Poor HtM	Wealthy HtM
Population share (%)	23.34	21.24	55.42
Average age	50.23	50.35	50.00
Median monthly income (USD)	2904	1428	1958
Average monthly income (USD)	3619	1639	2357
Has credit cards (% within group)	84.55	43.36	57.64

(a) ECH-EFHU data

	Non-HtM	Poor HtM	Wealthy HtM
Population share (%)	23.31	18.09	58.60
Average age	49.78	49.52	50.56
Median monthly income (USD)	2865	1164	1576
Average monthly income (USD)	3417	1268	1760
Tradable share in consumption expenditure (%)	41.32	40.65	45.50

(b) ENGIH data (with imputed hand-to-mouth status)

Table 3: Characteristics of hand-to-mouth households

Turning to the currency composition of household balance sheets, Table 4 shows that the share of households with dollar-denominated debt is only around five percent, despite the high aggregate level of financial dollarization in Uruguay. For households that are not liquidity-constrained, their savings are predominantly denominated in U.S. dollars. Driven by households that are not hand-to-mouth, aggregate dollar share in net savings is 77 percent. On the other hand, less than 10 percent of all hand-to-mouth households hold some dollar assets. The degree of inequality in liquid assets holdings is large: the median net liquid wealth for hand-to-mouth households is zero. Meanwhile, while non-HtM households tend to hold much more debt than poor HtM households, wealthy HtM households also hold a considerable amount of debt. Conditional on holding a positive amount of illiquid debt, the median level of dollar debt burden faced by wealthy HtM households is close to the dollar indebtedness of non-HtM households.

To concisely capture the currency choice of households in the data, I run local-linear regressions to estimate the propensity of households holding dollar assets or liabilities by income deciles.[16] Figure 1 reports the estimates based on the entire sample (left panel) and on the sample of households with a positive amount of nonzero wealth. High-income households have a high probability to save in dollars, while low-income households are likely to be subject to liquidity constraints and thus unlikely to have dollar assets. For liabilities, the propensity to take on dollar debt is only slightly higher as individuals move up along the income distribution. Table 4 and Figure 1 jointly characterize the inequality of household insurance from wealth revaluation

[16]The regressions estimate the share of households holding dollar asset or debt conditional on being in a specific income group: $\mathbb{1}(\$ \text{ asset or debt}_i > 0) = g(\text{Income decile}_i) + \varepsilon_i$, where $g(\cdot)$ is the conditional mean function.

due to dollar appreciation: dollar savings are disproportionately concentrated in unconstrained households, while dollar liabilities are more evenly distributed.[17]

	Non-HtM	Poor HtM	Wealthy HtM
Has dollar assets (% within group)	81.55	9.43	12.68
Has dollar debt (% within group)	7.09	3.44	6.26
Median illiquid debt (if nonzero, in USD)			
All	5000	1500	2666
Peso	3772	1448	2145
Dollar	3255	625	2500
Median net liquid wealth (in USD)			
All	3000	0	0
Peso	375	0	0
Dollar	2625	0	0
Average net liquid wealth (in USD)			
All	8845	0.38	50.49
Peso	1937	-17.87	-11.80
Dollar	6908	18.25	62.29

Table 4: Characteristics of hand-to-mouth agents: Currency dimension

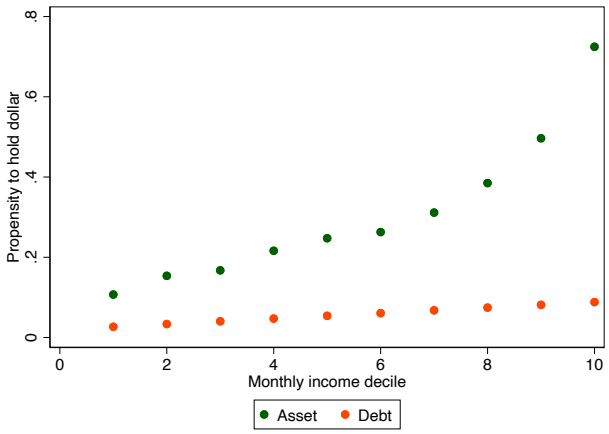


Figure 1: Propensity to hold dollar asset and debt by income decile

[17] While the definition of liquidity-constrained households is linked with the amount of savings, wealthy households choose to denominate their savings in foreign currency instead of domestic currency. It is this currency choice that makes the distribution of dollar insurance more unequal across households.

3.3 Consumption inequality along the wealth distribution

This section reports the structure of consumption expenditure across different groups of households using ENGIH data. As hand-to-mouth labels are imputed based on common characteristics and subjective questions in the ENGIH questionnaire, I first report in Table 3(b) basic characteristics of non-HtM, wealthy HtM, and poor HtM households and compare the summary statistics with their EFHU counterparts. The income, age profile, and population share of each group are comparable to those of the corresponding group identified using ECH-EFHU data, suggesting a reasonable quality of imputation. Table 5 compares the expenditure shares of households at one-digit level. Necessities, such as food and beverage items, comprise a significantly smaller share of non-HtM households' consumption bundle compard to HtM households. Instead, they spend relatively more on nontradable items such as education and recreation. On the other hand, poor hand-to-mouth households have the lowest share of expenditure share on tradables. As Table 5 suggests, the low tradable share is primarily driven by their much higher fractions spent on nontradable items such as housing and utilities. In Appendix B.1, Table B2 reports the one-digit expenditure share of households by income decile. Low-income households spend more than 60 percent of expenditure on food, beverages and housing, while the number for the richest decile is less than 40 percent.

Category / Group	Non-HtM	Poor HtM	Wealthy HtM	Aggregate
Food and non-alcoholic beverages	14.61	21.89	20.28	18.57
Alcoholic beverages and tobacco	0.98	1.44	1.11	1.10
Apparel	3.02	3.22	3.36	3.23
Housing and utilities	27.03	33.95	27.64	28.27
Furniture and home appliances	5.01	2.78	3.37	3.86
Medical care	10.00	12.92	12.33	11.57
Transportation	14.62	4.41	10.92	11.40
Communications	3.10	4.08	3.76	3.57
Culture and recreation	7.37	5.96	5.71	6.29
Education	4.44	1.37	2.28	2.87
Hotels and restaurants	4.74	3.42	3.42	3.87
Other goods and services	5.08	4.55	5.82	5.41

Table 5: Expenditure share (%) by types of households

3.4 Sectoral employment structure

The linked EFHU-ECH dataset also enables me to investigate whether households' income sources vary systematically across the income and wealth distribution. The earnings heterogeneity channel identified in Section 2 is likely to play a role in amplifying the impact of external shocks if

households whose consumption is highly sensitive to income fluctuations are disproportionately employed in sectors more vulnerable to the same shocks. While there is no consensus on whether the tradable or the nontradable sector is more exposed to exchange rate movements, recent studies suggest that nontradable employment and output fall more during domestic recessions (Mian and Sufi, 2014) and currency crises (Cugat, 2019). Table 6 reports the income share and employment share due to tradable sectors along the share of the income distribution. I find inverted-U shapes in both the employment and income share of the tradable sector. This pattern is likely driven by the fact that the nontradable sector encompasses industries with workers at both ends of the skill spectrum. A large share of income-poor households are employed in construction, domestic services and maintenance, while high-income households receive income from public administration and finance.

Decile	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Employment share	0.197	0.222	0.225	0.247	0.263	0.239	0.252	0.255	0.231	0.223
Income share	0.180	0.202	0.189	0.208	0.210	0.170	0.172	0.161	0.140	0.144

Table 6: Employment and income due to tradable sectors by income decile

3.5 Quantifying the redistribution channels from data

After empirically documenting the heterogeneous exposure to external shocks between households with different levels of MPC, I now formally connect my analytical decomposition presented in Section 2 to the data by estimating the covariance terms in Equation 3 that summarize the magnitudes of the corresponding redistribution channels. As the data does not allow me to estimate MPC directly, I compute instead the covariance between households' relevant balance sheet, income and consumption characteristics, and an indicator variable of households' hand-to-mouth status. The covariances obtained would be reasonable approximations to the true covariances computed using MPC, to the extent that wealthy households have low MPC and liquidity-constrained households' consumption is highly sensitive to income windfall.

I focus on the new channels derived from my open-economy extension. Following Auclert (2019), I divide both sides of Equation (3) by average consumption, so that the normalized covariances are tied to the consumption impulse response and can be interpreted as elasticities in a two-agent framework with one type of agent being constrained (HtM). As my data does not have a longitudinal dimension, in estimating the redistribution channel related to the price of tradable expenditure, I map consumption data to period 0 and ignore c_{i1} in Equation (3).

Table 7 reports the magnitudes of the covariance terms estimated from survey data. Bootstrap standard errors are obtained from 200 replications, taking into account stratified sampling in

the data.[18] All four covariances have negative signs. For the Fisher channel associated with dollar-denominated nominal bonds, a negative covariance implies that high-MPC households are relatively more vulnerable to debt revaluation due to depreciation. On the other hand, the negative covariance associated with the Fisher channel of peso nominal bonds suggests that a surprise deflation will also redistribute from high-MPC households to low-MPC households as the latter group has more peso-denominated assets with real values bolstered by deflation. Both covariances are consistent with empirical evidence presented in Figure 1 and Table 4. As a result, if a contractionary foreign shock leads to both real depreciation and deflation in the economy (the latter likely due to a depressed demand for nontradable goods), then both redistribution channels would amplify the negative consumption response to the external shock, relative to the situation in which the Fisher channels are absent.

Covariate	**Model correspondence**	**Channel**	**Value (s.e.)**
Net dollar position	$Cov\left(HtM_{i0}, \frac{qb_{i0}}{\mathbb{E}[c_{i0}]}\right)$	Fisher (foreign currency)	-0.645 (0.024)
of which: liquid dollar savings			-0.660 (0.023)
of which: illiquid dollar debt			-0.015 (0.005)
Net peso position	$Cov\left(HtM_{i0}, \frac{p_i^{-1}a_{i0}}{\mathbb{E}[c_{i0}]}\right)$	Fisher (domestic currency)	-0.005 (0.027)
Household income due to tradable sectors	$Cov\left(HtM_{i0}, \frac{\gamma_i^T q y_0^T}{\mathbb{E}[c_{i0}]}\right)$	Earnings heterogeneity	-0.011 (0.002)
Tradable consumption expenditure	$Cov\left(HtM_{i0}, \frac{(1-\alpha_i)p_i c_{i0}}{\mathbb{E}[c_{i0}]}\right)$	Consumption expenditure	-0.045 (0.003)

Table 7: Channels of redistribution in the data: Covariances with hand-to-mouth status

The fifth row of Table 7 reports a negative covariance between hand-to-mouth status and household income due to the tradable sector. To the extent that the nontradable sector may suffer more in response to contractionary shocks, the negative sign indicates another redistributive force amplifying the shocks as high-MPC households tend to receive more income from the nontradable sector. On the other hand, the negative covariance associated with the tradable expenditure channel likely suggests that this channel would dampen the impact of a contractionary shock. This negative covariance is driven by both a smaller share of tradable expenditure by poor-HtM households (Table 3(b)), as well as a large level of tradable expenditure by low-MPC, wealthy households due to a higher spending overall.

In terms of the magnitudes, Table 7 indicates that the most important redistribution channel is the Fisher channel of dollar-denominated bonds, driven primarily by an unequal distribution of dollar savings across households. In a two-agent model with unconstrained and constrained households, the covariance associated with the foreign-currency Fisher channel can be interpreted as an (partial equilibrium) elasticity, indicating that a one percent depreciation

[18] When computing the covariances related to dollar and peso wealth, I drop the top and bottom 1 percent to prevent outliers from driving the estimates.

will result in a 0.645 percent lower consumption, mostly driven by an unequal distribution of dollar savings[19] for an economy with net dollar debt, relative to the same economy but with zero correlation between MPC and dollar leverage. This covariance is negative, despite the fact that households do save predominantly in dollars, and a large share of aggregate deposits is dollar-denominated. Instead, a wealth distribution that features an uneven distribution of dollar assets, a large share of liquidity constrained households, and some constrained households with dollar-denominated debt contributes to the amplification of negative external shocks that give rise to depreciation. This finding complements and brings some nuances to the idea that dollarization of emerging market economies arises out of risk-sharing motives of households within borders (Dalgic, 2019; Christiano, Dalgic and Nurbekyan, 2020). If dollar assets are accumulated disproportionately by agents who are not liquidity constrained in the first place, then financial dollarization would be less effective in stabilizing *aggregate* consumption, since high-MPC agents still do not have the means to insure against revaluation.

The other three covariances, on the other hand, are negative but close to zero, suggesting that these redistribution channels are unlikely to significantly affect Uruguay's aggregate consumption response to foreign shocks in a partial equilibrium sense. For economies with a larger degree of wealth inequality, more reliance on goods with a high exchange rate pass-through and stronger matches between high-MPC households and sectors sensitive to external fluctuations, the covariances associated with these channels could nonetheless be higher.[20]

4 Quantifying the aggregate impact of redistributive external shocks

Moving from partial equilibrium to general equilibrium, I build on the contribution of Kaplan, Moll and Violante (2018) and Auclert, Bardóczy, Rognlie and Straub (2021) to introduce a two-asset, heterogenous agent, small open economy model with price rigidity, disciplined by both macro- and micro-level data from Uruguay. I focus on the foreign-currency Fisher channel and the consumption expenditure channel. My model incorporates non-homothetic consumer preference over tradable and nontradable goods, and accommodates liquid and illiquid wealth partially denominated in foreign currency. In this way, I pin down the quantitative contribution of both channels to aggregate fluctuations in consumption by studying both the calibrated model and model counterfactuals with varying degrees of heterogeneity in exposure to wealth revaluation and exchange rate pass-through to consumer prices.

[19] Real consumption is monthly and is expressed in units of December 2010 peso. In Section 4, the HtM and MPC covariances are transformed to monthly frequency for consistency.

[20] For comparison with Uruguay, in Appendix B.2, I explore the relationship between foreign-currency leverage and hand-to-mouth status for Polish households using micro data in year 2013 and 2015.

4.1 Model Setup

Households Time is discrete. There is no aggregate risk. A small open economy is populated by a continuum of ex-ante homogeneous households indexed by $i \in [0,1]$. Households consume a bundle of tradable and nontradable goods. They supply labor to both tradable and nontradable sectors, with the labor supply decision dictated by labor unions. In return, they receive labor income from each sector, scaled by households' idiosyncratic, sector-specific productivities z_{it}^j which follow exogenous AR(1) processes. Asset markets are incomplete, but as in Kaplan, Moll and Violante (2018), households have access to two types of assets. They can save in the form of nominal liquid wealth b^{nom}, or deposit into nominal illiquid account a^{nom} while paying an adjustment cost denominated in foreign currency ("dollar").

Each household chooses consumption and holding of nominal liquid and illiquid wealth to maximize lifetime utility

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big[\frac{c_{it}^{1-\sigma}}{1-\sigma} - \Big(\kappa \frac{(n_{it}^T)^{1+\phi}}{1+\phi} + (1-\kappa) \frac{(n_{it}^N)^{1+\phi}}{1+\phi} \Big) \Big]$$

subject to the nominal budget constraint each period, expressed in local-currency ("peso") terms, such that

$$p_t c_{it} + b_{it+1}^{nom} + a_{it+1}^{nom} = (1+i_t^b) b_{it}^{nom} + (1+i_t^a) a_{it}^{nom} + p_t \sum_{j \in \{T,N\}} w_t^j z_{it}^j n_{it}^j - \mathcal{E}_t \Phi\Big(\frac{a_{it+1}^{nom}}{p_t}, \frac{a_{it}^{nom}}{p_{t-1}} \Big) \tag{5}$$

as well as the borrowing constraint

$$b_{it+1}^{nom} \geq 0; \quad a_{it+1}^{nom} \geq 0. \tag{6}$$

In the budget constraint (5), i^b, i^a are the nominal return of liquid and illiquid wealth, respectively. w_t^j denotes real wage of sector $j \in \{T,N\}$ and $\mathcal{E}_t$ represents exchange rate against dollar in units of peso. The parameter κ in households' utility function controls the disutility from supplying labor to the tradable sector relative to the nontradable sector.

It is useful to cast the model in real terms (the consumption bundle) by scaling the nominal variables with consumer price p_t. Redefine the endogenous state variables, such that $b_{t+1} = b_{t+1}^{nom} / p_t$ and $a_{t+1} = a_{t+1}^{nom} / p_t$. The budget constraint for households in real terms becomes

$$c_{it} + b_{it+1} + a_{it+1} = (1+r_t^b) b_{it} + (1+r_t^a) a_{it} + \sum_{j \in \{T,N\}} w_t^j z_{it}^j n_{it}^j - q_t \Phi\Big(a_{it+1}, a_{it} \Big) \tag{7}$$

where by definition, $1 + r_t^l = \frac{1+i_t^l}{p_t / p_{t-1}}$ for $l \in \{a,b\}$. $q_t \equiv \mathcal{E}_t / p_t$ is the real exchange rate. Following Auclert, Bardóczy, Rognlie and Straub (2021), the illiquid wealth adjustment cost function Φ has the functional form

$$\Phi(a', a) = \frac{\chi_1}{\chi_2} \left| \frac{a' - (1+r_t^a) \cdot a}{(1+r_t^a) \cdot a + \chi_0} \right|^{\chi_2} \left[(1+r_t^a) \cdot a + \chi_0 \right] \tag{8}$$

where χ_0, χ_1, χ_2 are parameters.

I introduce nonhomotheticity in household preference by assuming that household's consumption bundle takes the Stone-Geary form:

$$c_{it} \equiv \left[(1-\alpha)^{\frac{1}{\eta}}(c_{it}^N)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}(c_{it}^T - \underline{c})^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

where η is the elasticity of substitution between tradable good c^T and nontradable good c^N. I normalize the dollar (world) price of tradable good to one, and assume complete exchange rate pass-through, so that the peso price of tradable goods is equal to the nominal exchange rate $\mathcal{E}_t$. As a result, consumer price index p_t is given by

$$p_t = \mathcal{E}_t \underline{c} + \left[(1-\alpha)(p_t^N)^{1-\eta} + \alpha \mathcal{E}_t^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

where p_t^N is the price of nontradable good. We obtain a relationship between real exchange rate q_t, and the price of nontradable good relative to the consumption bundle:[21]

$$q_t \underline{c} + \left[(1-\alpha)(p_t^N/p_t)^{1-\eta} + \alpha q_t^{1-\eta}\right]^{\frac{1}{1-\eta}} = 1. \tag{9}$$

Household balance sheet I introduce currency dimension into household balance sheet by further specifying the structure of liquid and illiquid wealth using perfectly substitutable dollar and peso assets. With perfect substitutability, absent unanticipated shocks, the portfolio (currency) choice of households within asset class is indeterminate. Computationally tractable, this feature enables me study the impact of revaluation by fitting arbitrary currency composition to steady-state household balance sheets.[22]

First, I assume that liquid wealth consists of dollar-denominated and peso-denominated nominal savings in the form of bonds ($b^{\$}$ and b^{peso}, respectively). As a result, the real value of liquid wealth is given by

$$b_{it+1} \equiv q_t b_{it+1}^{\$} + p_t^{-1} b_{it+1}^{peso} \tag{10}$$

The peso-denominated bond has a real return of $1 + r_t$, set indirectly by the monetary authority but subject to unanticipated inflation. Real return on the dollar-denominated bond is exogenously given by $1 + r_t^*$. As the bonds are perfectly substitutable, the real no-arbitrage condition is given by

$$(1 + r_{t+1}^*)\frac{q_{t+1}}{q_t} = (1 + r_{t+1}). \tag{11}$$

[21] Quantitatively, in the stationary equilibrium, each household's tradable consumption c_i^T is always above the subsistence parameter $\underline{c}$.

[22] See Ferrante and Gornemann (2021) for an extension of Devereux and Sutherland's (2011) method to evaluate household portfolio in the context of HANK models.

Household's net illiquid wealth is invested into a mutual fund, which in return frictionlessly channels the fund into ownership claims for firms in both the tradable and nontradable sectors. To tightly map the structure of illiquid wealth to the data in a tractable way, I assume that net illiquid wealth has three substitutable components: real asset, nominal dollar debt, and nominal peso debt, so that net illiquid wealth is specified by[23]

$$a_{it+1}^{nom} \equiv \underbrace{p_t v_{t+1}}_{\text{nominal value of real asset}} - \underbrace{\mathcal{E}_t a_{it+1}^{\$}}_{\text{dollar debt}} - \underbrace{a_{it+1}^{peso}}_{\text{peso debt}} \tag{12}$$

$$a_{it+1} \equiv v_{t+1} - q_t a_{it+1}^{\$} - p_t^{-1} a_{it+1}^{peso}. \tag{13}$$

The profits of the firms are distributed to illiquid asset holders in the form of return on equity. The real return on net illiquid wealth is given by

$$1 + r_t^a = \frac{\Pi_t^T + \Pi_t^N + Q_{t+1}}{Q_t}$$

where Π^T and Π^N are profits from tradadable and nontradable production, respectively. Q_t denotes the equity price.

Labor unions I introduce wage rigidity through labor unions by extending the standard formulation into a setting with multiple sectors.[24] A labor union hires household labor in both sectors and set hours equally across households so that $n_{it}^j = N_t^j$ for all $i \in [0,1]$ and $j \in \{T, N\}$. The union also determines nominal wages by maximizing average household utility, as in Auclert, Rognlie and Straub (2018) and Auclert, Bardóczy, Rognlie and Straub (2021), subject to the wage demand curve for individual labor, with the demand elasticity given by ε_w for both sectors. Define nominal wage inflation for sector j as $\pi_t^{w,j} \equiv \frac{W_t^j}{W_{t-1}^j}$. The wage Phillips curves are given by

$$\pi_t^{w,T} = k_w \left[\kappa \frac{(N_t^T)^\phi}{\frac{\varepsilon_w - 1}{\varepsilon_w} w_t^T \mathcal{U}_t^T} - 1 \right] + \beta \pi_{t+1}^{w,T} \tag{14}$$

$$\pi_t^{w,N} = k_w \left[(1-\kappa) \frac{(N_t^N)^\phi}{\frac{\varepsilon_w - 1}{\varepsilon_w} w_t^N \mathcal{U}_t^N} - 1 \right] + \beta \pi_{t+1}^{w,N} \tag{15}$$

[23] I ignore the non-negativity constraints characterizing gross "asset" and "debt" throughout for simplicity. Similar to Kaplan, Moll and Violante (2018), the relevant endogenous state variables in my model are in net terms. One way to interpret the structure of illiquid wealth is as follows: households take out dollar- and peso-denominated mortgage to purchase housing (real asset). The housing equity is collateralized by the mutual fund to fund investment into production.

[24] By incorporating wage rigidity through a computationally-simple labor union problem, in which labor supply decision is taken as given by the households, the model alleviates the issue of countercyclical profit appearing in canonical HANK models without wage rigidity (Broer, Hansen, Krusell and Öberg, 2020).

where $\mathcal{U}_t^j \equiv \int z_{it}^j u'(c_{it}) \mathrm{d}\lambda_t$ is the sector-specific, productivity-weighted average marginal utility of consumption. With a positive slope parameter k_w, current wage inflation is higher if the average marginal disutility of labor, appropriately scaled, outweighs the average marginal utility of consumption.

Firms The firms' problems are standard. I assume that price is flexible in the tradable sector. Homogenous firms in the tradable sector produce tradable good using labor as the only input. Each firm takes the price of tradable goods $\mathcal{E}_t$ as given, and has access to a technology with decreasing returns to scale, summarized by the curvature parameter δ. Each firm solves the following problem to maximize profit:

$$\max_{N_t^T} \mathcal{E}_t (N_t^T)^\delta - W_t^T N_t^T.$$

In the nontradable sector, a continuum of firms hire a representative workforce from the labor union. Each firm produces a single variety, indexed by $j \in [0,1]$. Firms choose labor demand and price of their varieties to maximize lifetime profits, but must pay a Rotemberg-type adjustment cost when their prices change. Taking last period's price as the state variable, each firm faces the following recursive problem:[25]

$$J_t(p_{jt-1}^N) = \max_{Y_{jt}^N, p_{jt}^N, n_{jt}^N} \left\{ \frac{p_{jt}^N}{p_t} Y_{jt}^N - w_t^N n_{jt}^N - \frac{\theta_p}{2} \Big[\log(1+\pi_{jt}^N) \Big]^2 \frac{p_t^N}{p_t} Y_t^N + \frac{J_{t+1}(p_{jt}^N)}{1+r_{t+1}^a} \right\}$$

subject to

$$Y_{jt}^N = (n_{jt}^N)^\delta \tag{16}$$

$$Y_{jt}^N = \Big(\frac{p_{jt}^N}{p_t^N} \Big)^{-\varepsilon_p} Y_t^N. \tag{17}$$

Nontradable firms employ the same technology as tradable firms (Equation (16)), and face a downward-sloping demand curve for their varieties. The slope of the demand curve is determined by the demand elasticity ε_p (Equation (17)). In equilibrium, each firm demands the same amount of labor N_t^N. Defining nontradable inflation as $1+\pi_t^N \equiv p_t^N / p_{t-1}^N$, we arrive at the following New-Keynesian Phillips curve for the nontradable sector:

$$\log(1+\pi_t^N) = \frac{\varepsilon_p}{\theta_p} \Big(\frac{w_t^N}{(p_t^N/p_t) \cdot \delta (N_t^N)^{\delta-1}} - \frac{\varepsilon_p}{\varepsilon_p - 1} \Big) + \frac{1}{1+r_{t+1}^a} \frac{Y_{t+1}^N}{Y_t^N} \log(1+\pi_{t+1}^N). \tag{18}$$

[25] The firms discount future value by r^a, as they are owned by illiquid asset holders expecting payouts in the form of return to illiquid wealth.

Monetary authority At time t, the central bank of the small open economy pre-determines domestic nominal interest rate i_{t+1} (on peso-denominated bond) based on a backward-looking monetary policy rule:

$$1 + i_{t+1} = (1 + \bar{r})(1 + \pi_t)^{\phi_\pi}(e_t / e_{t-1})^{\phi_e} \tag{PR}$$

where $\pi_t \equiv p_t / p_{t-1} - 1$ is the CPI inflation. As a result, the real return on the peso bond is

$$1 + r_{t+1} = (1 + \bar{r})(1 + \pi_{t+1})^{-1}(1 + \pi_t)^{\phi_\pi + \phi_e}(q_t / q_{t-1})^{\phi_e}, \tag{19}$$

so that the peso-denominated bond maturing at $t+1$ is subject to revaluation through surprise inflation at $t+1$. Similar to the formulation in Cugat (2019), the size of the parameter ϕ_π and ϕ_e control the sensitivity of the central bank in reacting to domestic inflation and real depreciation.

Definition 1. *An equilibrium consists of prices* $\{p_t^N / p_t, w_t^T, w_t^N, r_t, r_t^a, r_t^b, \pi_t^N, \pi_t, \pi_t^{T,w}, \pi_t^{N,w}, q_t\}$*, quantities* $\{A_t, B_t, C_t, C_t^T, C_t^N, Y_t^T, Y_t^N, N_t^T, N_t^N, \Pi_t^T, \Pi_t^N, Q_t, \Phi_t\}$*, individual policy rule* $\{c_t, b_{t+1}, a_{t+1}\}$*, and a path of distributions* $\{\lambda_t(z,b,a)\}$ *such that*

- *All agents optimize.*
- *Central bank follows monetary policy rule.*
- *Markets clear for labor, nontradable consumption and illiquid assets. In particular, normalize aggregate equity to one, we have*

$$Q_t = \int a_t(z,b,a)\mathrm{d}\lambda_{t-1} = A_t.$$

- *The balance-of-payment equation holds:*

$$q_t(C_t^T - Y_t^T + \Phi_t) + B_{t+1} = (1 + r_t^b)B_t + \underbrace{\int (r_t^{b,p}(b) - r_t^b)b\mathrm{d}\lambda_t(z,b,a) + \int (r_t^{a,p}(a) - r_t^a)a\mathrm{d}\lambda_t(z,b,a)}_{\textit{Revaluation}} \tag{20}$$

where $B_{t+1} \equiv \int b_{t+1}(z,b,a)\mathrm{d}\lambda_t$*.* $\Phi_t \equiv \int \Phi(a_{t+1}(z,b,a),a)\mathrm{d}\lambda_t$ *and* $r_t^{b,p}(b) = r_t^b$ *and* $r_t^{a,p}(a) = r_t^a$ *for* $t \geq 1$*.*

Appendix C.1 lists the equilibrium conditions of the model. The balance-of-payment equation (20) stipulates that, absent valuation effect, a long-run positive net foreign asset position must be counterbalanced by a long-run trade deficit, and vice versa. With idiosyncratic risk, net foreign asset position is well-defined in a stationary equilibrium, whereas in incomplete market representative agent models, steady-state NFA is indeterminate when the small open economy faces an exogenous interest rate (Schmitt-Grohé and Uribe, 2003). As the steady state of this

model is solved globally, I also avoid using ad-hoc stationary-inducing devices that appear in linearized representative-agent models.

The main quantitative experiment, to be introduced in Section 4.2, assumes an unanticipated tightening of foreign interest rate r^* at $t = 0$, prior to which the economy is at steady state. Surprise inflation and depreciation lead to valuation effect on individual wealth holdings, and thus on aggregate net foreign assets, by introducing a wedge between ex-ante and ex-post return (denoted $r^{b,p}$ and $r^{a,p}$) on liquid and illiquid wealth. No-arbitrage is restored by $t = 1$, so that the revaluation terms become zero from $t = 1$ onwards. Section 4.2 provide more detail on how my model accounts for wealth revaluation and connects to data.

4.2 Calibration and transition dynamics

I calibrate the model at quarterly frequency to match aggregate and cross-sectional moments to Uruguayan data. Closely following the literature on the Uruguayan economy, international macroeconomics and heterogeneous agent models, most parameters are set externally. I choose the remaining parameters to target the level of aggregate wealth in the economy, relative labor supply between sectors, and average expenditure share of tradable goods. In addition, I also target moments related to the wealth and income distribution, including the share of liquidity-constrained households as well as the expenditure share of tradables by income-rich households. Table 8 reports the parametrization of my model. In analyzing the impact of the consumption expenditure channel, I compare my baseline model to a model with homothetic preferences, by setting $\underline{c} = 0$. I repeat the internal calibration for the homothetic model, targeting the same moments except the tradable share of rich households. The calibrated parameters for the homothetic model is reported in Table 8(b).

As my model seeks to generate a realistic level of aggregate wealth in the Uruguayan economy in order to measure the impact of wealth revaluation, the calibration needs to overcome the data constraint caused by Uruguay's lack of a dataset comparable to the U.S. Flow of Funds data used by Kaplan, Moll and Violante (2018). Instead, I resort to a recently available sectoral balance sheet matrix constructed by IMF (2017), and the wealth-to-income ratio estimated by De Rosa (2019) using household surveys and administrative records. According to IMF (2017), the private non-financial sector (household and corporate) has a net wealth position at 10 percent of GDP, with the aggregate long FX position primarily driven by household savings in dollars. De Rosa (2019) argues that net financial assets owned by the firms are very small in Uruguay, given an underdeveloped capital market. In addition, De Rosa (2019) uses the capitalization method to pin down households' financial wealth at a level between 8 and 16 percent of GDP between 2009 and 2014. Based on this information, I target a liquid wealth to GDP ratio (the counterpart to household liquid savings to output in my model) of 10 percent. In terms of illiquid wealth, the closest data counterpart to my model (A/GDP) is the real estate wealth owned by households. I

target a GDP ratio of 2.54, based on the estimate of De Rosa (2019) for 2014.

Household block Key parameters on household preferences, including intertemporal elasticity of substitution, Frisch elasticity of labor supply, and elasticity of substitution between tradable and nontradable goods, are set to standard values in the literature on open-economy business cycles (Stockman and Tesar, 1995; Cugat, 2019). Constrained by data, it is difficult to come up with estimates of Uruguayan households' income processes. Instead, I resort to off-the-shelf estimates by Hong (2020*a*) using household panels from Peru, also a Latin American country. I set equal persistence and volatility for the income processes of both sectors. For parameters in the household utility function, I calibrate β at 0.975. The implied level of discount rate (2.5% per quarter) is higher than the estimate of Hong (2020*a*) for Peru, but lower than that of Kaplan, Moll and Violante (2018) calibrated to the U.S. economy. The relative labor supply disutility parameter identifies the ratio between hours supplied to the tradable and nontradable sectors. In the data, this ratio ranges from 0.23 to 0.40, depending on data sources and classification of sectors.[26] I target the upper end of this range (0.4) by calibrating κ at 0.772.

For portfolio adjustment cost, I calibrate the scale parameter χ_1 at 1.762. Together with the discount factor, my calibration generates a liquid wealth to GDP ratio at 8 percent and a share of liquidity-constrained households at 77 percent, the latter consistent with the EFHU data counterpart. A positive pivot parameter χ_0 ensures the cost being well-defined at zero illiquid wealth (Kaplan, Moll and Violante, 2018). I therefore set χ_0 to a small value (0.01, same as Hong (2020*a*)). I control the convexity of the adjustment cost function by fixing χ_2 at 2.05, slightly higher than the quadratic cost formulation adopted by Schaab (2020) and Auclert, Bardóczy, Rognlie and Straub (2021).[27]

Finally, the weight of tradable goods in the consumption aggregator α and the degree of consumption bias $\underline{c}$ are chosen to match the expenditure share of tradable goods (based on my manual classification used in Section 3) computed from ENGIH data. α is set to 0.296 to control for the average share (44 percent), and $\underline{c}$ is calibrated at 0.173 so that the households in the top 20 percent of the income distribution spend 41.5 percent of their consumption expenditure on tradable goods. For the homothetic specification with $\underline{c} = 0$, the tradable share of consumption

[26] Using my classification of industries based on export volume, I get a ratio of 0.23 from micro data (ECH 2017). The SEDLAC database (CEDLAS and the World Bank, available at https://www.cedlas.econo.unlp.edu.ar/wp/en/estadisticas/sedlac/) provide information on sectoral employment shares and weekly hours compiled from household surveys and comparable across Latin American countries. I compute the tradable to nontradable hours ratio at 0.40 for Uruguay at 2017. The following three sectors are classified as tradable sectors: "primary activities", "industry low tech", "industry high tech". I drop the "commerce" sector for which the underlying industry composition is unclear.

[27] I find setting χ_2 slightly higher than 2 helpful in targeting both aggregate liquidity and wealth distribution for my model. Of the two studies setting $\chi_2 = 2$, Schaab (2020) does not target the former, while Auclert, Bardóczy, Rognlie and Straub (2021) does not match the latter.

is constant across all households. As a result, I only target the average share by setting α to 0.376.

Other blocks Key parameters for the firm and labor union block include the curvature of technology and parameters related to price and wage adjustment. Given a steady-state markup of 10 percent, the curvature δ captures the share of income going to illiquid asset holders as profit, thus determining the aggregate level of illiquid wealth in the economy. I calibrate δ to 0.83, targeting an aggregate illiquid wealth to GDP ratio of 2.54. The implied return on illiquid wealth at steady state is 2.08 percent per quarter. I set the Rotemberg adjustment cost parameter θ_p to 20, based on the recent estimate of Drenik and Perez (2021) using online price adjustment frequency for dollarized and non-dollarized goods in Uruguay.[28] In comparison, Kaplan, Moll and Violante (2018) and De Ferra, Mitman and Romei (2020) set θ_p to 100, implying a much flatter price Phillips curve likely more relevant for advanced economies. For wage adjustment, it is difficult to estimate the slope of the Phillips curve directly. Instead, I pin down the wage adjustment probability (η_w in Table 8(a)) from literature, and set k_w equal to the implied slope from Calvo adjustment.[29] Messina and de Galdeano (2014) use administrative records from Uruguay and find that in low-inflation years, 25 percent of wages remain unchanged in a year. The corresponding quarterly adjustment probability is 0.3, implying a slope coefficient around 0.136 and thus a flatter wage Phillips curve compared to its price counterpart.

For parameters related to domestic and foreign interest rate, I fix steady-state exogenous foreign interest rate at one percent per quarter. Central bank's sensitivity to inflation is set to 1.5, and its sensitivity to depreciation is set to 0.5, implying a moderate degree of "fear of floating" (Calvo and Reinhart, 2002; Cugat, 2019).

Model validation The model is successful in matching the target moments (see Table 8(c)). I further assess the quantitative properties of the calibrated model in three dimensions. First, with appropriately calibrated share of dollar in liquid and illiquid wealth from micro data, the model is able to generate levels of covariances between hand-to-mouth status and dollar position close to the estimates in Section 3. More details are provided in Section 4.2.1.

I check whether a number of cross-sectional untargeted moments from the model match the empirical counterparts. Figure 2(a) plots the model-implied expenditure share on tradable goods across the income distribution and compare with those estimated from ENGIH data. Despite only using two parameters to pin down the average share and the share of top quintile, the

[28] Drenik and Perez (2021) estimate the daily frequency of price changes at 0.72% and 0.27% for LC and FC goods respectively. 35 percent of all goods is priced in dollars. I assume that within the nontradable sector, the same fraction of goods is priced in dollars. Thereby, the nontradable sectors has an implied duration between prices changes of 5.9 months, or approximately 2 quarters. This translates to a Calvo adjustment probability of 0.5 and a Rotemberg cost parameter of 20.

[29] The conversion from η_w to k_w is given by $k_w = \frac{\eta_w[1-\beta(1-\eta_w)]}{1-\eta_w}$.

baseline non-homothetic model generates a decreasing share with income, very much in line with data. The average annual MPC out of liquid wealth in my model is 0.642, very close to Hong's (2020*b*) estimate of 0.632 using Peruvian household panels. Figure 2(b) plots the MPC out of liquid wealth across the income distribution, showing a pattern qualitatively consistent with Peruvian data.

I also study the partial-equilibrium steady-state consumption response to wealth revaluation in order to gauge the plausibility of the model-implied contribution of Fisher channels. To put this validation exercise into context, I compute the model-generated response under the same amount of real depreciation as in the devaluation episode studied by De Ferra, Mitman and Romei (2020); Verner and Gyöngyösi (2020) and Gyöngyösi, Rariga and Verner (2021) for Hungary from late 2008 to early 2009. Assuming net illiquid wealth consists entire of real assets and dollar debt, revaluation reduces aggregate consumption by 3.33 percent. This number is slightly smaller than the 4.5 to 5.3 percent estimate by Gyöngyösi, Rariga and Verner (2021) using Hungary data, but qualitatively in line. I provide more details on the exercise in Appendix C.3.

Parameter	Description	Value	Source
Household			
σ	Inverse of intertemporal elasticity of substitution	2	Stockman and Tesar (1995)
ϕ	Inverse of Frisch elasticity	0.5	Standard value
η	Tradable/nontradable goods elasticity of substitution	0.5	Cugat (2019)
ρ_z	Persistence of idiosyncratic productivity process	0.968	Hong (2020*a*)
σ_z	S.D. of productivity shocks	0.487	Hong (2020*a*)
χ_0	Portfolio adj. cost: pivot	0.01	
χ_2	Portfolio adj. cost: convex	2.05	
Firm			
ε_p	Demand elasticity for varieties	11	Standard value
θ_p	Price adjustment cost parameter	20	Drenik and Perez (2021)
Labor union			
ε_w	Demand elasticity for labor services	11	Standard value
η_w	Wage adjustment probability	0.3	Messina and de Galdeano (2014)
Monetary policy and external finance			
ϕ_π	Interest rate sensitivity to inflation	1.5	
ϕ_e	Interest rate sensitivity to depreciation	0.5	
i^*	Foreign interest rate (steady state)	0.01	Standard value

(a) Parameters set externally

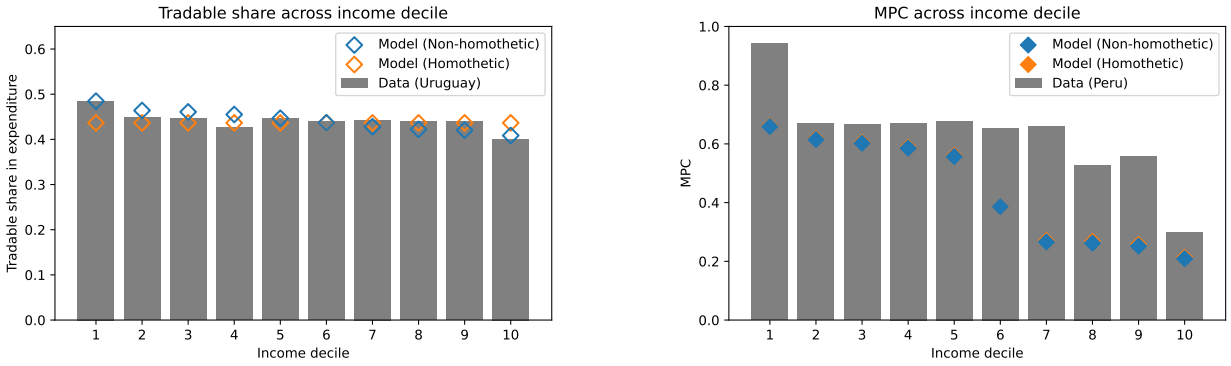
Parameter	Description	Non-homothetic	Homothetic
β	Time preference	0.975	0.975
χ_1	Scale parameter of illiquid asset adjustment cost	1.762	1.510
κ	Relative labor disutility of tradable sector	0.772	0.775
α	Weight of tradable goods in consumption basket	0.296	0.376
$\underline{c}$	Subsistence for tradable goods	0.173	0
δ	Curvature in production (labor share)	0.831	0.830

(b) Parameters internally calibrated

Moment	Description	Model	Data	Source
B/GDP	Liquid savings to GDP ratio	0.08	0.10	IMF (2017); De Rosa (2019)
A/GDP	Illiquid wealth to GDP ratio	2.54	2.54	De Rosa (2019)
$\Pr(b=0)$	HtM agent share	0.76	0.77	EFHU-3
N^T/N^N	Relative hours, tradable vs. nontradable	0.40	0.40	SEDLAC
qC^T/C	Tradable share in aggregate consumption	0.44	0.44	ENGIH
$(qC^T/C)_{top20\%}$	Tradable share of top income quintile	0.415	0.416	ENGIH

(c) Targeted moments

Table 8: Model calibration



(a) Tradable share

(b) MPC (Peru data)

Figure 2: Model validation: Untargeted moments across income distribution

4.2.1 Transition dynamics and wealth revaluation

Suppose at the beginning of period 0, the economy is in stationary equilibrium. My main quantitative experiment is a surprise announcement in period 0, of a 25 basis point tightening of period-1 foreign nominal interest rate (MIT shock), which subsequently decays at rate 0.9. Figure 3 illustrates the timeline of the experiment.

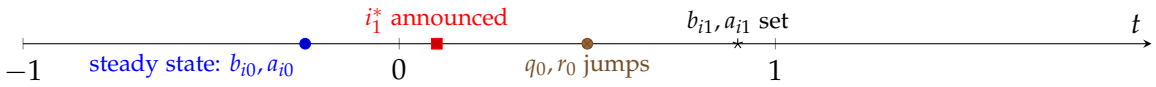


Figure 3: Timeline of quantitative experiment

With both domestic and foreign period-0 interest rates known prior to the announcement, the unanticipated MIT shock leads to instantaneous response of period-0 real exchange rate and inflation, and thus the ex-post failure of no-arbitrage condition for period-0 returns on domestic and foreign assets. As a result, households with different shares of dollar in their liquid and illiquid wealth would face different ex-post rates of return at $t = 0$. The assumption of perfect substitutability between currency denominations enables me to fit a flexible distribution of dollar shares to the steady state and account for heterogeneous revaluation effect across households.

To see more closely how wealth is revalued in the model, an individual with a liquid portfolio that contains $s^b(b_t) \equiv \frac{q_t b_t^\$}{b_t}$ fraction of dollar savings would earn an ex-post real return

$$1 + r_{t+1}^{b,p}(b_t) \equiv (1 + r_{t+1}^*)\frac{q_{t+1}}{q_t} \cdot s^b(b_t) + (1 + r_{t+1}) \cdot (1 - s^b(b_t))$$

while the real ex-ante return r^b satisfies $1 + r_{t+1}^b = 1 + r_{t+1} = (1 + r_{t+1}^*)\frac{q_{t+1}}{q_t}$ (Equation 11). When unanticipated shock arrives at period 0, $r_0^{b,p}(b_0)$ does not equal to r_0^b in general, due to the endogenous response of q_0 and r_0, the latter driven by surprise inflation at period 0.

For illiquid wealth, given the structure specified by Equation (13), define

$$s^v(a) = \frac{v}{a}; \quad s^{\$}(a) = \frac{qa^{\$}}{a}; \quad s^{peso}(a) = \frac{p^{-1}a^{peso}}{a},$$

then net illiquid wealth can be rewritten as

$$a_{t+1} = s^v(a_{t+1})a_{t+1} - s^{\$}(a_{t+1})a_{t+1} - s^{peso}(a_{t+1})a_{t+1}$$

with $s^v(a) - s^{peso}(a) - s^{\$}(a) = 1$, where r^{a*} is the real return on dollar-denominated debt component of illiquid wealth. I maintain the assumption that the real value of asset v_{t+1} does not respond to revaluation shocks. The following proposition states that, with no-arbitrage between dollar and peso debt in the illiquid portfolio[30], revaluation of illiquid wealth is related to the breakdown of no-arbitrage of liquid bonds, and the share of dollar in the illiquid portfolio $s^{\$}$:

Proposition 3. *The ex-post return on the illiquid portfolio $r^{a,p}$ satisfies*

$$1 + r^{a,p}(a_{t+1}) = (1 + r^a_{t+1}) \cdot (1 + s^{\$}(a_{t+1})) - \left[\left((1 + r^*_{t+1})\frac{q_{t+1}}{q_t} - r^b_{t+1}\right) + r^a_{t+1}\right] s^{\$}(a_{t+1}).$$

Proof. See Appendix A.3. □

According to Proposition 3, at period 0 following the unexpected shock, the failure of no-arbitrage for liquid wealth opens up wedges between the ex-ante and ex-post returns of both liquid and illiquid wealth. As a result, the return on illiquid wealth is no longer equal to $1 + r^a_0$, but potentially differs across agents given heterogeneous dollar shares $s^{\$}$. From period 1 onwards, the no-arbitrage condition for liquid wealth is restored, so that r^a_t is equal to the ex-post return on net illiquid wealth. Given the assumption on the structure of household's illiquid portfolio, per Proposition 3, we only have to know $s^{\$}(a)$ to compute the revaluation of illiquid wealth.

Calibrating the dollar share The previous section highlights the importance of two functions, s^b and $s^{\$}$, in determining the heterogeneous exposure to revaluation at the initial period. For my baseline analysis, I calibrate both dollar share functions using the ECH-EFHU dataset analyzed in Section 3. For simplicity, I choose cutoff points in the stationary distribution of liquid and illiquid wealth and map their positions to the empirical distribution. As a result, I get two step functions with group-specific dollar shares s^b and $s^{\$}$. Appendix C.4 illustrates the procedure and reports the calibrated functions. The share of dollar in liquid wealth is increasing in liquid savings, while the ratio between dollar debt and net illiquid wealth is in general declining in the amount of net illiquid wealth households have.

[30] That is: $(1 + r^{a*}_{t+1})\frac{q_{t+1}}{q_t} = 1 + r^a_{t+1}$. This no-arbitrage condition is not an assumption, but serves as an additional equilibrium condition between dollar and peso debt, and as the illiquid return is determined contemporaneously, this condition always holds.

With calibrated dollar shares, I compute the model counterparts of hand-to-mouth covariances – the partial-equilibrium sufficient statistics that determine the strength of redistribution channels. With the model, I could also compute the covariance of household balance sheets and consumption expenditures to MPC out of liquid and illiquid wealth. The statistics are reported in Table 9. As an additional validation of my model, despite the extreme simplicity of my data-fitting procedure, the model is able to generate covariances between hand-to-mouth status and dollar position very close to the empirical estimates. The nonhomothetic model also yields a negative MPC covariance with tradable goods expenditure, in line with the negative sign estimate of the HtM counterpart. Relative to models with zero covariances between MPC and household exposure to exchange rates (such as representative-agent models), my quantitative model with the baseline calibration is expected to amplify shocks through the Fisher channel and dampen shocks through the consumption expenditure channel.

	HtM covariance		**MPC covariance**
	Model	Data	Model
Liquid Saving$_i^{\$}$ − Illiquid Debt$_i^{\$}$	-0.495	-0.645	/
Liquid Saving$_i^{\$}$	-0.541	-0.660	-0.137
Illiquid Debt$_i^{\$}$	-0.046	-0.015	0.003
Tradable Expenditure$_i$	0.014	-0.045	-0.068

Table 9: Untargeted moments: Hand-to-mouth / MPC covariances

Note: For liquid dollar holdings and tradable expenditure, the relevant MPC is MPC out of liquid wealth. The covariance with illiquid dollar position is computed using MPC out of illiquid wealth.

4.3 Properties of impulse responses

The first-order transition dynamics of the model are solved using the sequence-space Jacobian technique introduced by Auclert, Bardóczy, Rognlie and Straub (2021). Appendix C.2 provides more details on the algorithm. Figure 4 plots the impulse response functions of key endogenous variables. I focus on the blue lines, associated with non-homothetic preferences and dollar shares calibrated to data, to analyze the qualitative nature of the impulse responses. My model is able to generate a contractionary depreciation to the nontradable sector due to foreign monetary tightening. Following the surprise announcement, unconstrained households reduce demand for consumption and substitute for more savings. In equilibrium, this reduction in demand lowers the income of constrained agents, leading to more reduction in overall demand. Meanwhile at the asset market, the no-arbitrage condition between domestic and foreign bond leads to an expected appreciation of domestic currency at period 1, which in turn triggers an immediate nominal and real depreciation at period 0.

For households with a balance sheet exposed to exchange rate fluctuations, revaluation kicks

in. Constrained households leveraged in dollar debt further reduce demand for consumption, while households with dollar assets benefit from local currency depreciation. As the dollar-peso exchange rate also affects the peso price of tradable goods, a real depreciation also lead households to tilt consumption towards the nontradable sector. A changing demand for tradable goods interacts with a higher tradable sector output, driven by the wealth effect of labor supply, to pin down the level of real exchange rate depreciation (8.55 basis points) using the balance-of-payment equation (20). As the output of tradable goods rises but domestic absorption contracts, trade surplus must rise, resulting in an improved net foreign asset to GDP ratio that peaks at 2 percent. Meanwhile, as demand declines for both sectors, return on illiquid wealth (equity claims) declines at period 0, resulting in a sharp contraction of illiquid wealth to GDP ratio of more than 3 percent.

Now consider the responses of nontradable consumption, output and inflation. To the extent that demand for aggregate consumption drops, nontradable sector also faces a lower demand, despite some reallocation of demand from the tradable sector. Constrained by nominal rigidity, however, price of nontradable goods cannot fully adjust to accommodate the change in demand, resulting in a demand-driven output contraction. Nontradable goods consumption falls by 17.6 basis points on impact, and overall consumption drops by 25.9 basis points. There is inflation in the overall CPI index, which is a combination of a depreciation-induced inflation in the tradable sector and a demand-driven deflation in the nontradable sector. In response to exchange rate depreciation and inflation, the domestic central bank raises the nominal interest rate by more than 40 basis points. The overall inflation also results in a reduction in the real period-0 return of peso-denominated bond, resulting in a negative wealth effect for peso creditors.

Figure 4 also plots the impulse response functions of the model with homothetic preferences in red. Qualitatively, there is little difference in the shape of the impulse responses. The initial response of consumption is quantitatively similar to the benchmark. Meanwhile, households reallocate further to the nontradable sector amidst a slightly stronger depreciation relative to the non-homothetic specification, resulting in a smaller contraction of nontradable consumption.

4.4 How big is the role of redistribution?

I now analyze a number of specifications and counterfactuals to quantify the general equilibrium contribution of the foreign-currency Fisher channel and the consumption expenditure channel. For the consumption expenditure channel, I compare the consumption response to foreign monetary tightening across models with and without non-homotheticity. Non-homothetic preferences generate heterogeneous expenditure share on tradable goods across households. As a result, households' exposure to exchange rate shocks may exhibit a higher degree of inequality. A large role of the consumption expenditure channel would signal that canonical models based on homothetic preferences miss an important amplification mechancism through the households'

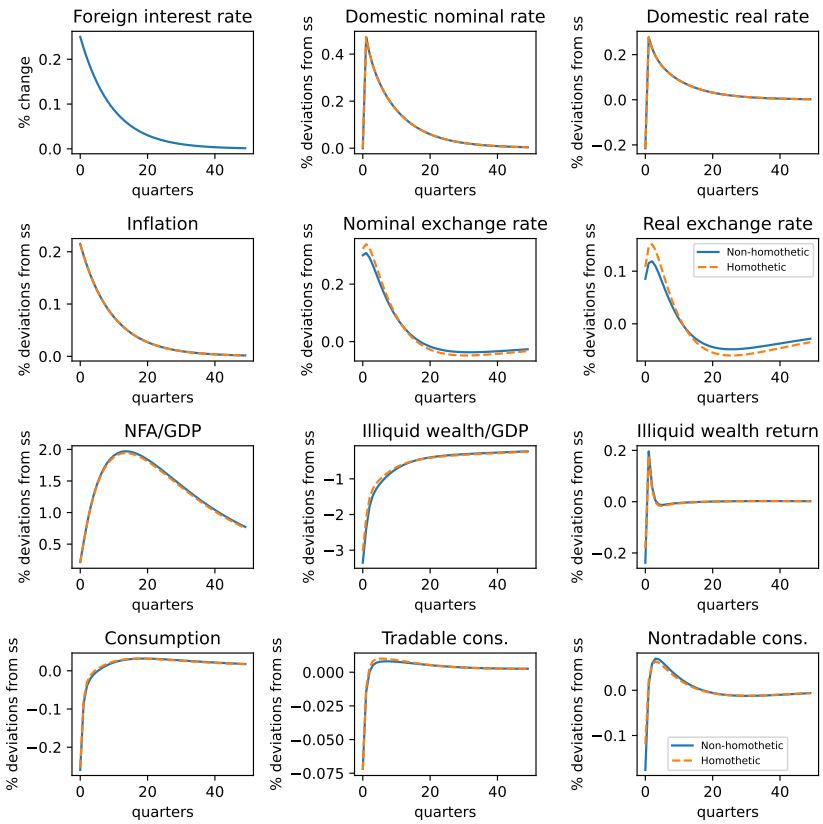


Figure 4: Impulse response functions to 25bps unexpected tightening of foreign interest rate

consumption baskets.

In a similar fashion, I gauge the strength of the foreign-currency Fisher channel by comparing the baseline period-0 consumption response to a number of counterfactuals with different currency composition in household wealth. In all exercises, the flexibility of my setup allows me to isolate the redistribution channel from the revaluation of aggregate foreign-currency positions. In particular, I make sure the size of the dollar position in the economy is fixed (see Proposition 2) by choosing *scalar* values of s^b and $s^\$$ to reshuffle aggregate wealth across liquid and illiquid portfolios and among agents. The differential response of endogenous variables across specifications can largely be attributed to differences in MPC covariances and the associated redistribution channels, as the counterfactual experiments deviate from the benchmark only in terms of the dollar wealth distributions.[31]

[31] Endogenous responses of real exchange rate only differ by one to two basis points across specifications. Robustness exercise suggests that aggregate consumption barely changes when I target the product of RER and dollar position instead.

The foreign-currency Fisher channel The first counterfactual experiment sets the dollar indebtedness of agents to zero (column 2 of Table 10) and compensates the change with a uniformly lower share of dollars in liquid wealth for all households. Compared to the baseline specification with non-homothetic preferences and dollar shares calibrated to data (column 1 of Table 10), aggregate consumption response is dampened by 3.1 basis points (12 percent in relative terms). This response is driven by a weaker Fisher channel entirely captured by the reduced magnitude of covariance between MPC and liquid dollar savings.

The scenario "high dollar liability" is reported in column 3. This counterfactual environment replicates the situation of Hungary before the devaluation of Forint in 2008. By 2007Q4, household FX loan amounted to 16.9 percent of annual GDP.[32] Mapped to my model, this amounts to a ratio between dollar debt and net illiquid wealth at 6.7 percent.[33] With a much stronger Fisher channel working through a higher covariance between MPC and illiquid debt, as well as the additional liquid dollar savings distributed to wealthy households to maintain a constant aggregate dollar position, the effect of foreign monetary tightening is amplified significantly. The economy with large dollar liabilities and more unequal distribution of dollar assets has a consumption contraction 1.85 times relative to the baseline, driven almost equally by tradable and nontradable consumption.[34] As implied by this exercise, a heavily dollarized economy is highly vulnerable to the household balance sheet channel, even though the size of the external shock causing the depreciation of local currency is moderate (25 basis points).

Emerging market economies often feature simultaneous deposit and credit dollarization (Bocola and Lorenzoni, 2020; Montamat, 2020). My final counterfactual experiment assumes that households save fully in dollars for liquid wealth, while adding dollar indebtedness to illiquid asset holders to maintain a constant aggregate dollar position. Similar to Scenario 3, relative to the baseline, as less liquidity-constrained agents hold more liquid dollar assets, aggregate consumption further declines by 2.93 basis points, or 11 percentage points in relative terms (column 4).

[32] Data on household loan composition can be found at MNB's website: https://www.mnb.hu/en/publications/reports/financial-stability-report/financial-stability-report-november-2020.

[33] As in all counterfactual exercises, I map the data to a scalar $s^{\$}$ value: $s^{\$} = 0.169/(A/GDP)$. As there lacks an estimate on net housing wealth to GDP ratio for Hungary, I use model-implied value (2.54) targeted to Uruguay data. This number is close to the 300 percent housing wealth to annual personal disposable income ratio in year 2006 estimated by Vadas (2007).

[34] Appendix C.5 shows that despite varying only the initial dollar wealth distribution across agents, this specification generates a large negative response of illiquid wealth return contemporaneously relative to other experiments.

Variable/Statistic	(1) Baseline	(2) No illiquid dollar	(3) High dollar liability	(4) Deposit & liability dollarization
Aggregate dollar wealth	0.220	0.220	0.220	0.220
Cov($MPC_{i,b}$, Liquid Saving$^{\$}_i$)	-0.137	-0.085	-0.472	-0.184
Cov($MPC_{i,a}$, Illiquid Debt$^{\$}_i$)	0.003	0	0.020	0.005
Time-0 deviation from steady state (bps):				
Consumption (C)	-25.93	-22.82	-48.02	-28.86
Tradable consumption (C^T)	-7.17	-6.22	-13.89	-8.06
Nontradable consumption (C^N)	-17.62	-14.84	-37.33	-20.24
RER (q)	8.55	8.34	10.04	8.74

Table 10: Quantitative impact of dollar Fisher channel: Nonhomothetic model

The consumption expenditure channel Table 11 presents numerical results related to the impulse responses across models with and without non-homotheticity, reported graphically in Figure 4. With homothetic preferences, households consume the same fraction of expenditure on tradable goods. Compared to the baseline model, the covariance between MPC out of liquid wealth and tradable expenditure is more negative, driven by relatively richer households' reallocation towards tradable goods under homotheticity. The same force also increases the homothetic economy's aggregate spending on tradable goods ($\bar{\Xi}$ in Proposition 2). Similar to the counterfactual experiments above, aggregate dollar wealth is controlled across specifications. Average MPC is slighly larger in the homothetic model, with a relatively weaker link between MPC and liquid dollar wealth.

For the homothetic specification, despite a slighly larger average MPC, a much higher aggregate tradable expenditure and a slightly stronger depreciation, consumption declines by a smaller amount (0.6 basis points), driven by a much more muted response of nontradable consumption (5.66 basis points, and 32 percent in relative terms). Moving to homothetic preference dampens the contractionary impact of foreign monetary tightening through the consumption expenditure channel, although the overall impact on consumption is modest compared to the foreign-currency Fisher channel. This finding is in line with Auclert, Rognlie, Souchier and Straub (2021), whose quantitative exercise yields a slightly smaller contraction of output in response to foreign monetary tightening in a homothetic environment compared to the nonhomothetic benchmark.[35]

[35]The foreign-currency Fisher channel potentially amplifies the consumption decline by even more in the homothetic model, as the product between endogenous response of real exchange rate and MPC covariance with liquid dollar wealth is -1.32 in the homothetic model, and -1.17 in the non-homothetic specification.

Variable/Statistic	(1) Nonhomothetic	(2) Homothetic
Average MPC	0.642	0.645
Aggregate dollar wealth	0.220	0.220
Aggregate tradable expenditure	0.646	0.724
Cov($MPC_{i,b}$, Tradable Expenditure$_i$)	-0.068	-0.085
Cov($MPC_{i,b}$, Liquid Saving$_i^{\$}$)	-0.137	-0.122
Cov($MPC_{i,a}$, Illiquid Debt$_i^{\$}$)	0.003	0.002
Time-0 deviation from steady state (bps):		
Consumption (C)	-25.93	-25.34
Tradable consumption (C^T)	-7.17	-7.25
Nontradable consumption (C^N)	-17.62	-11.96
RER (q)	8.55	10.82

Table 11: Quantitative impact of consumption expenditure channel

4.5 "Fear of floating" and aggregate stabilization policies

My final quantitative exercise studies stabilization policies against external shocks. Through the lens of my quantitative model, I focus on the significant question faced by monetary authorities of emerging open economies – the calibration of monetary policy sensitivity to exchange rate fluctuations. In response to foreign monetary tightening, the standard Mundell-Fleming framework prescribes exchange rate depreciation based on the stimulating effect of expenditure-switching mechanism. In practice, however, the extent of exchange rate float and the associated easing in monetary policy stance is often limited by central banks' concern about the contractionary impact of depreciation (Calvo and Reinhart, 2002; Gourinchas, 2017; Ilzetzki, Reinhart and Rogoff, 2019; Kalemli-Özcan, 2019), even if domestic monetary tightening needs to be deployed to limit depreciation.

In my model, the domestic central bank sets nominal interest rate as a response to current inflation and nominal exchange rate (NER) fluctuations (Equation (PR)). I analyze whether stabilization could be better achieved by tying monetary policy more tightly with the exchange rate by tracing the instantaneous responses of interest rate, inflation, real exchange rate (RER) and consumption as I increase the weight attached to NER (the "fear of floating" parameter ϕ_e) in the monetary policy rule. Figure 5 reports my finding based on the "high dollar liability" economy with large imbalance in dollar insurance across agents, analyzed in Section 4.4. In this setting, putting more weight on NER is able to stabilize aggregate consumption. As ϕ_e is increased from 0 to 2, the real rate goes up moderately. The real exchange rate depreciates by a lower amount, while the drop in consumption is narrowed by more than 10 basis points. Meanwhile, inflation pressure declines sharply despite a relative improvement in consumption, partly driven by complete exchange rate pass-through to tradable goods. Like Auclert, Rognlie, Souchier and Straub

(2021), I find through this exercise that the appropriate policy response to foreign monetary tightening is complicated by the potential contractionary impact of depreciation on consumption or output featured in heterogeneous-agent open economy models. Meanwhile, exchange rate stabilization may result in a weaker decline in aggregate consumption without experiencing significiant inflation-output tradeoffs.

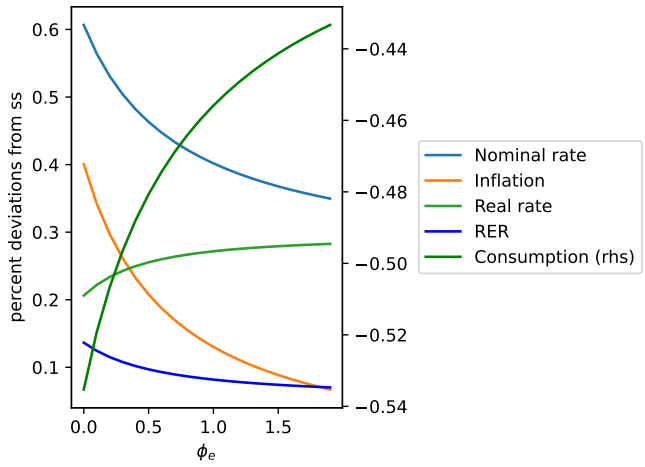


Figure 5: Instantaneous responses to external shocks and policy weight on nominal exchange rate (ϕ_e)

5 Discussion and conclusion

This paper is a first step towards understanding the role of household heterogeneity in transmitting and propagating external shocks. I identify a number of redistribution channels in which MPC heterogeneity interacts with household balance sheets, exchange rate pass-through to tradable goods, and sector-specific earnings fluctuations, to amplify or dampen the response of aggregate consumption. These channels can be summarized using MPC covariances as simple sufficient statistics in partial equilibrium. Measured using Uruguayan household microdata, the covariance with the largest magnitude is associated with the foreign-currency Fisher channel, through which wealth revaluation redistributes from dollar debtors to creditors and amplifies the contractionary impact of depreciation. My quantitative exploration in general equilibrium suggests that the foreign-currency Fisher channel could have a significant amplifying or dampening effect on aggregate consumption. This mechanism is especially relevant for countries with heavy deposit and credit dollarization. The consumption expenditure channel also affects the impact of external shocks. Working mainly through nontradable consumption, models with nonhomothetic preference increase the relative exposure of high-MPC households' consumption

basket to the exchange rate, so as to quantitatively amplify the consumption response compared to homothetic models.

I show that for partially dollarized emerging market economies such as Uruguay, individual households exposed to exchange rate risk may ultimately bear the incidence of depreciation. With a highly concentrated distribution of hedges against depreciation, revaluation of wealth may have important aggregate implications. Moreover, as more than one type of redistribution channel may be active in emerging market economies, the quantitative importance of these forces should be evaluated simultaneously. Further interaction with other amplification mechanisms and frictions may lead to even larger redistribution and, as a result, a bigger role for the redistribution channels. Both my analytical and quantitative exercises abstract away from surprise revaluation of firms' foreign-currency borrowing. From a policy perspective, I show that in the presence of substantial currency mismatches and unequal distribution of hedges against revaluation, monetary policy that manages the exchange rate to a higher extent could do a better job in stabilizing aggregate consumption while achieving inflation control. To contain the negative impact of redistribution channels, targeted measures that reduce the exchange rate exposure of high-MPC, liquidity-constrained households, such as macroprudential restrictions on foreign-currency borrowing and de-dollarization measures in the goods market could be helpful.

This paper motivates empirical work that will explicitly incorporate distribution into the analysis of international shock spillovers and calls for more theoretical work to identify mechanisms that could help generate large aggregate effects of redistribution. Are countries with a larger share of liquidity-constrained households and a systematic cross-sectional relationship between MPC and household exposure to exchange rates more responsive to U.S. monetary policy shocks? Can the methodology in this paper be extended to analyze the aggregate implications of firm and bank heterogeneity in exchange rate exposure? What is the optimal policy in responding to redistributive foreign shocks? I leave these important questions to future work.

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Appendix

A Proof of propositions

In this section, I present a streamlined proof of Proposition 1 and 2 in Section 2, closely following Clayton, Jaravel and Schaab (2018) and Auclert (2019). I also prove Proposition 3 on the ex-post return of illiquid wealth in Section 4.

A.1 Proof of Proposition 1

Under the proposed perturbation $\{\mathrm{d}q, \mathrm{d}p, \mathrm{d}R, \mathrm{d}y_0^N, \mathrm{d}y_0^T\}$, given the definition of lifetime income y_i we have

$$\mathrm{d}y_i = \gamma_i^N \mathrm{d}y_0^N + q\gamma_i^T \mathrm{d}y_0^T + q \cdot \left(\gamma_i^T y_0^T + \frac{\gamma_i^T y_1^T}{R} + b_{i0}\right)\frac{\mathrm{d}q}{q} - \left(\frac{\gamma_i^N y_1^N}{R} + q \cdot \frac{\gamma_i^T y_1^T}{R}\right)\frac{\mathrm{d}R}{R} - \frac{a_{i0}}{p} \cdot \frac{\mathrm{d}p}{p}.$$

From the Cobb-Douglas structure of consumption bundle, individual CPI at time 0 is given by

$$p_{i0} = \frac{q_0^{1-\alpha_i}}{(1-\alpha_i)^{1-\alpha_i}\alpha_i^{\alpha_i}} p_0.$$

By definition, we have $c_{i0}^N + q_0 c_{i0}^T = \frac{q_0^{1-\alpha_i}}{(1-\alpha_i)^{1-\alpha_i}\alpha_i^{\alpha_i}} c_{i0}$.

Define $\kappa_i = (1-\alpha_i)^{1-\alpha_i}\alpha_i^{\alpha_i}$ and $\tilde{y}_i = \kappa_i y_i$. Following Auclert (2019) and CJS, we look for Marshallian and Hicksian demand functions from the consumer's problem.

Marshallian demand The Marshallian demand function is the policy function associated with the problem

$$\begin{aligned} V_i \equiv V(R, q; \tilde{y}_i) = \max_{\{c_{i0}, c_{i1}\}} \; & u(c_{i0}) + \beta u(c_i) \\ \text{s.t. } & q^{1-\alpha_i}(c_{i0} + R^{-1}c_{i1}) = \tilde{y}_i. \end{aligned}$$

The first-order conditions and the envelope theorem yield the following partial derivatives with respect to the value function:

$$\begin{aligned} \frac{\partial V_i}{\partial R} &= \frac{u'(c_{i0})c_{i1}}{R^2} \\ \frac{\partial V_i}{\partial q} &= -q^{-1}(1-\alpha_i)u'(c_{i0}) \cdot (c_{i0} + R^{-1}c_{i1}) \\ \frac{\partial V_i}{\partial \tilde{y}_i} &= q^{\alpha_i - 1}u'(c_{i0}). \end{aligned}$$

Hicksian demand The Hicksian demand function is the solution to the following expenditure-minimization problem:

$$E_i \equiv E(R, q, U_i) = \min_{\{c_{i0}^c, c_{i1}^c\}} q^{1-\alpha_i}(c_{i0}^c + R^{-1}c_{i1}^c)$$
$$\text{s.t. } u(c_{i0}^c) + \beta u(c_{i1}^c) \geq U_i.$$

Similar to the utility-maximization problem, the partial derivatives are given by

$$\frac{\partial E_i}{\partial R} = -\frac{q^{1-\alpha_i}c_{i1}^c}{R^2}$$
$$\frac{\partial E_i}{\partial q} = (1-\alpha_i)q^{-\alpha_i} \cdot (c_{i0}^c + R^{-1}c_{i1}^c)$$
$$\frac{\partial E_i}{\partial U_i} = [q^{\alpha_i - 1}u'(c_{i0}^c)]^{-1}.$$

By duality, $c_{i0}^c(R, q, U_i) = c_{i0}(R, q, E_i(R, q, U_i))$. By Slutsky's theorem,

$$\frac{\partial c_{i0}^c}{\partial R} = \frac{\partial c_{i0}}{\partial R} + \frac{\partial c_{i0}}{\partial \tilde{y}_i}E_{iR}$$
$$\frac{\partial c_{i0}^c}{\partial q} = \frac{\partial c_{i0}}{\partial q} + \frac{\partial c_{i0}}{\partial \tilde{y}_i}E_{iq}$$

where we use the shorthand notation E_{iR} and E_{iq} to denote the corresponding partial derivatives.

Marginal propensity to consume Combine the Euler equation with the budget constraint from the utility-maximization problem, we have

$$c_{i0} + R^{-1}(u')^{-1}\Big[\frac{u'(c_{i0})}{\beta R}\Big] = q^{\alpha_i - 1}\tilde{y}_i$$

Define $\widetilde{MPC}_{i0} = \frac{\partial c_{i0}}{\partial \tilde{y}_i}$, $\widetilde{MPC}_{i0}$ can be expressed as

$$\widetilde{MPC}_{i0} = q^{\alpha_i - 1} \cdot \Big[1 + \frac{1}{\beta R^2}\frac{u''(c_{i0})}{u''(c_{i1})}\Big]^{-1}.$$

If utility is CRRA with relative risk-aversion coefficient equal to σ, then $\widetilde{MPC}_{i0}$ is further simplied to

$$\widetilde{MPC}_{i0} = q^{\alpha_i - 1} \cdot \Big[1 + \frac{c_{i1}}{Rc_{i0}}\Big]^{-1}.$$

Hicksian elasticities The next step is to compute Hicksian elasticities $\mathcal{E}_{c,R}^c \equiv \frac{\partial c_{i0}^c}{\partial R}\frac{R}{c_{i0}}$ and $\mathcal{E}_{c,q}^c \equiv \frac{\partial c_{i0}^c}{\partial q}\frac{q}{c_{i0}}$. From the Euler equation associated with the expenditure-minimization problem

$$U_i = u(c_{i0}^c) + \beta u\Big[(u')^{-1}\Big(\frac{u'(c_{i0}^c)}{R}\Big)\Big],$$

first differentiate with respect to R and invoke CRRA. After some algebra, we have

$$\mathcal{E}^c_{c,R} = -\sigma^{-1}(1 - \widetilde{MPC}_{i0} q^{1-\alpha_i}).$$

On the other hand, differentiate the Euler equation with respect to q, we have

$$0 = \frac{\partial c^c_{i0}}{\partial q}\Big[u'(c^c_{i0}) + \beta u'(c^c_{i1})\Big[\frac{u''(c^c_{i0})}{u''(c^c_{i1})} \cdot \frac{1}{\beta R}\Big]\Big].$$

By standard assumptions for the utility function, the term inside the outer bracket is strictly positive, therefore, $\frac{\partial c^c_{i0}}{\partial q} = 0$ and thus $\mathcal{E}^c_{c,q} = 0$.

Combine: consumption response The change in individual consumption at period 0 is obtained by differentiating Marshallian demand and simplifying using the budget constraint, Hicksian elasticities calculated above, and Slutsky theorem. More specifically, we have

$$\begin{aligned} \mathrm{d}c_{i0} &= \frac{\partial c_{i0}}{\partial R}\mathrm{d}R + \frac{\partial c_{i0}}{\partial q}\mathrm{d}q + \frac{\partial c_{i0}}{\partial \tilde{y}_i}\mathrm{d}\tilde{y}_i \\ &= \Big(\frac{\partial c^c_{i0}}{\partial R} - \frac{\partial c_{i0}}{\partial \tilde{y}_i}E_{iR}\Big)\mathrm{d}R + \Big(\frac{\partial c^c_{i0}}{\partial q} - \frac{\partial c_{i0}}{\partial \tilde{y}_i}E_{iq}\Big)\mathrm{d}q + \frac{\partial c_{i0}}{\partial \tilde{y}_i}\mathrm{d}\tilde{y}_i. \end{aligned}$$

Equation (2) is obtained by plugging in expressions for E_{iR}, E_{iq} and $\mathrm{d}\tilde{y}_i$, simplifying, and noting that $MPC_{i0} = \widetilde{MPC}_{i0} \cdot \kappa_i$, $\frac{\partial c^c_{i0}}{\partial R}\mathrm{d}R = c_{i0}\mathcal{E}^c_{c,R}\frac{\mathrm{d}R}{R}$, and $\frac{\partial c^c_{i0}}{\partial q}\mathrm{d}q = c_{i0}\mathcal{E}^c_{c,q}\frac{\mathrm{d}q}{q}$.

A.2 Proof of Proposition 2

Equation (3) is obtained by integrating over the space of households I. Equation (4) is obtained by integrating over the relation $\mathrm{d}c^N_{i0} = \alpha_i\kappa_i^{-1}q^{1-\alpha_i}\mathrm{d}c_{i0} + \alpha_i(1-\alpha_i)\kappa_i^{-1}q^{1-\alpha_i}c_{i0}\frac{\mathrm{d}q}{q}$ and rearrange.

A.3 Proof of Proposition 3

We start from the no-arbitrage equilibrium condition between dollar and peso debt:

$$\begin{aligned} (1 + r^{a*}_{t+1})\frac{q_{t+1}}{q_t} &= 1 + r^a_{t+1} \\ &= (1 + r^*_{t+1})\frac{q_{t+1}}{q_t} - r^b_{t+1} + r^a_{t+1}. \end{aligned}$$

where the second equation follows by adding zero to the right-hand side of the no-arbitrage condition and utilizing Equation (11).

Meanwhile, ignoring the non-negativity constraint and maintaining the assumption that the real value of illiquid asset v_{t+1} does not jump as the shock hits, so that the gross return on v_{t+1} is equal to $1 + r^a_{t+1}$, the ex-post return on illiquid wealth is given by

$$\begin{aligned} 1 + r^{a,p}_{t+1}(a) &= (1 + r^a_{t+1})(1 + s^\$(a)) - (1 + r^{a*}_{t+1})\frac{q_{t+1}}{q_t}s^\$(a) \\ &= (1 + r^a_{t+1})(1 + s^\$(a)) - \Big[\Big((1 + r^*_{t+1})\frac{q_{t+1}}{q_t} - r^b_{t+1}\Big) + r^a_{t+1}\Big]s^\$(a). \end{aligned}$$

B More on data and empirical strategy

B.1 Analyzing Uruguayan household survey data

In this section, I provide more details on the processing and analysis of survey datasets from Uruguay.

Sample selection Sample selection largely follows Kaplan, Violante and Weidner (2014). For both the ECH-EFHU and the ENGIH dataset, I use two criteria to restrict the sample: 1) at least one member of the household answers the survey, as there are cases where a qualified member of another household answers the survey; 2) the household head's age is between 25 and 79. As the survey does not explicitly identify a household head, I assign household head status to a member if the member answers the survey on behalf of all members, and its personal identification number (variable `nper` or `pernro` in the dataset) is the smallest. There is no household in my datasets reporting negative labor income. As the EFHU dataset oversamples wealthy households, I use sample weights throughout the calculation of summary statistics and cross-sectional moments. After sample selection, 8340 households remain in the ECH-EFHU dataset, while the ENGIH dataset contains 6197 households.

Definition of income I use total income of households, including rental value (variable name `ht11`) across all datasets, except when computing moments related to income exposure to tradable and nontradable industries. In this case, I use total income from the primary jobs only.

Calculating assets and liabilities I define illiquid debt as including mortgage, debt associated with other real estates, debt owed to banks and non-bank institutions, loans for durable and auto purchases, as well as debt due to other persons. Liquid debt is equivalent to credit card debt, assumed to be denominated in peso.

One unique challenge when computing the amount of assets and liabilities in dollars and pesos is that the EFHU-3 survey question on currency composition does not direct ask for a number. Except for the case of primary mortgage debt, in which the currency denomination is entirely known, households are given choices in the form of intervals. For instance, households can select one of the following for the question on the share of peso-denominated debt other than primary mortgage[36]: 1) less than 25%; 2) 26%-50%; 3) 51%-75%; 4) 76%-90%; 5) more than 90%; 6) none; 7) don't know. This also applies to the question on the currency breakdown of liquid assets. For these cases, I take the midpoint. For instance, a peso share of "less than 25%" is translated to 12.5%.

[36]The original Spanish version of the question is "De todo lo que indicó anteriormente que debe este hogar, qué porcentaje se encuentra en pesos uruguayos (incluyendo unidades indexadas y unidades reajustables)?"

A similar issue is found in the question on the amount of liquid savings. Instead of asking households to write down a specific amount, the question provides a range of intervals to choose: 1) smaller than 1000 dollars; 2) between 1001 to 5000 dollars; 3) between 5001-15000 dollars; 4) between 15001-30000 dollars; 5) more than 30000 dollars; 6) none; 7) don't know. I also take the midpoint to be the amount owned by households (and fix the maximum value of liquid assets to 50000 dollars), so that in this case, liquid assets are bunched around 500, 3,000, 10,000, 22,500 and 50,000 dollars.

Imputation of HtM status in ENGIH The main challenge of working with ENGIH dataset is that it lacks financial information on households, making it impossible to infer hand-to-mouth status. However, the ENGIH dataset contains a number of subjective questions in which interviewees are explicitly asked to describe if their current financial situation is sufficient for various categories of expenses (such as food, clothing, housing and child raising), as well as to provide an estimated lower bound of hypothetical income at which the households could make ends meet. To label households in a data-driven manner, fully utilizing the information from both the EFHU and ENGIH datasets, I adopt the following two-step imputation strategy:

1. Fit a multinomial logit model to the EFHU data (with households categorized in non-HtM, poor-HtM and wealthy-HtM), on a set of household characteristics[37] and use the model to generate first-step predicted probabilities of being in each category in the ENGIH data. Assign each household to the category with the highest predicted probability. This step is similar to the treatment of Guntin, Ottonello and Perez (2020) for Spanish data. The first step has an in-sample pseudo R^2 of 21.96%.

2. The imputation procedure using the multinomial logit model in step 1 is refined by exploiting the information contained in the subjective questions of ENGIH survey:

    - Reassign HtM households to non-HtM if they self-report that their monthly expenses on all categories of consumption are sufficient or more than sufficient for household needs.
    - Reassign non-HtM households to poor-HtM if their monthly expenses on all categories of consumption are insufficient to meet household needs.
    - Reassign HtM households to non-HtM if the gap between actual income and lower-bound of estimated income that satisfy household needs is more than one half of the actual income (in the spirit of Kaplan, Violante and Weidner (2014)), while no category-specific expenses are insufficient.

[37] Regressors include department dummy, age of household head, homeownership, rooms in home, number of household members older and younger than 14, owning other real estates, businesses or farms, holding letters or bonds, and income level.

- Finally, reassign non-HtM households to wealthy-HtM households if the gap between actual and estimated lower bound is negative.

Identification of tradable and nontradable industries and goods To assign industries and product categories into tradable and nontradable groups maintaining close connections with the interpretation of the redistribution channels with which these groups are associated, I adopt the following strategies.

- My concept of tradability of industries is aligned with industries' openness to trade. Therefore, the tradable sectors in the data are identified using export volumes. More specifically, I classify industries as belonging to the tradable sector if these industries appear in sector-specific export statistics, as they comprise the majority of Uruguay's exports.[38]
- My classification of tradable goods largely follows Cravino and Levchenko (2017). In addition, tradable goods in my model could broadly refer to product categories with relatively high dollar pass-through. For this reason, I manually assign CIIU 4-digit products into the tradable group, including products that are likely to be priced in dollars domestically according to Drenik and Perez (2021). Table B1 reports the goods classified into the tradable group. Finally, I report the expenditure share by income decile at the one-digit level in Table B2, the Uruguayan counterpart to Cravino and Levchenko's (2017) Table A5.

[38]Data is available at https://www.bcu.gub.uy/Estadisticas-e-Indicadores/ComercioExterior_ICB/exp_ciiu_val.xls.

Code	Description	Code	Description
0111	Bread	0531	Large household appliances (such as refrigerators)
0112	Meat	0532	Small household electrical appliances
0113	Fish	0541	Kitchenware
0114	Diary product	0551	Large tools and equipment (electric drill, lawn-mower etc.)
0115	Oil	0552	Small tools and miscellaneous accessories
0116	Fruit	0561	Non-durable household goods
0117	Vegetables	0611	Various medications
0118	Sugar, chocolates, sweetened snacks	0612	Glasses, lenses, wheelchairs, dental devices
0119	Seasoning	0711	Car/truck
0121	Coffee	0712	Motorcycle
0122	Tea	0713	Bicycle
0123	Cocoa and chocolate powder	0714	Other vehicle
0124	Refreshments, soft drinks	0721	Accessories
0125	Water	0722	Gas and oil
0126	Juices/beverages	0821	Telephone set, answering machine
0127	Ice	0822	Cellphone accesories
0211	Tobacco and alcohol (code 0211-0231)	0911	Audio equipment, home theaters
0212		0912	DVD players, satellite TV
0213		0913	Camera and camera accessories
0221		0914	Computer and computer accessories
0222		0915	Typewriters, calculators
0231		0916	CDs, memory sticks, printer toners
0311	Leather, wool, fabrics	0921	Outdoor recreation, boats
0312	Clothing	0922	Musical instruments, pool table
0313	Clothing accessories	0931	Non-durable recreation (such as toys and video games)
0314	Dressmaker, dry cleaner, clothing rental	0932	Sports, outdoor camping equipment
0321	Men's footwear	0933	Flowers, plants, seeds, soil, fertilizers
0322	Women's footwear	0934	Pet-related spending
0323	Children's footwear	0954	Office supplies
0324	Sandals	1111	Restaurant meals
0431	Materials for home maintenance and repair	1112	Meals in schools and education centers
0454	Coal, firewood	1212	Electrical appliances for personal care (shavers, dryers)
0511	Furnitures and accessories	1213	Other appliances, articles and products for personal care
0512	Carpets, etc.	1231	Jewelry, wall clocks and wrist watches
0521	Home textile products (such as tablecloths and doormats)	1232	Other personal effects

Table B1: Goods labeled as tradable (4-digit CIIU code)

Decile	1	2	3	4	5	6	7	8	9	10
Food and Non-alcoholic beverages	26.03	23.93	23.16	20.86	21.10	20.70	18.70	18.29	17.12	13.65
Alcoholic beverages and tobacco	1.38	1.16	1.32	1.14	1.27	1.04	1.27	1.17	1.15	0.85
Apparel	3.16	3.25	3.24	3.06	3.23	3.27	3.45	3.57	3.17	2.99
Housing and utilities	35.24	34.76	31.60	29.89	29.65	29.09	27.62	27.10	25.78	25.48
Furniture and home appliances	2.70	3.01	2.72	3.28	2.82	3.25	2.95	3.26	3.76	5.95
Medical care	8.40	11.24	12.71	13.29	13.82	13.68	12.48	12.23	11.60	9.62
Transportation	6.08	5.88	7.06	7.44	9.55	9.16	11.40	11.93	13.90	14.85
Communications	3.55	3.61	3.94	3.80	4.11	3.86	4.00	3.77	3.60	2.85
Culture and recreation	5.40	4.66	5.19	5.73	5.51	5.90	6.51	6.27	6.84	7.38
Education	0.38	0.51	0.97	0.86	1.13	1.67	2.45	2.87	3.06	6.29
Hotels and restaurants	2.83	2.80	2.86	2.90	3.19	2.84	3.60	4.06	4.50	5.07
Other goods and services	4.85	5.21	5.24	7.77	4.62	5.54	5.58	5.47	5.53	5.03

Table B2: Expenditure share (%) by income decile

B.2 The Fisher channel in other countries: Evidence from Poland

I use the latest two waves (2013, 2015) of the Polish "Social Diagnosis" panel survey to investigate the relationship between hand-to-mouth households and foreign-currency leverage. The case of Poland is interesting because a substantial amount of mortgage is denominated in Swiss francs, instead of Zloty, the domestic currency. The 2015 surprise appreciation of Swiss francs significantly raised the value of debt borned by households with Swiss franc leverage, leading to anecdotal reports of litigations and mandated conversion of loans into domestic currency.[39]

Limited by data (particularly by the fact that the survey does not provide a figure for individuals' savings or homeownership information. It expresses savings only as multiples of monthly/annual income), I define four types of HtM measures based on relevant information in the data, without distinguishing between poor and wealth hand-to-mouth households. Table B3 reports key statistics by HtM type from this exercise. The general takeaway is as follows: 1) In Poland, the share of hand-to-mouth households might be smaller than that in Uruguay; 2) These hand-to-mouth households are more likely to borrow, but in the case of a mortgage, these households' liability exposure to foreign currency is roughly similar to non-HtM households. In the case of general loans and credit, the share of HtM households with exposure to Swiss francs is smaller; 3) Few households have savings in foreign currency to hedge against depreciation, particularly the hand-to-mouth.

[39] On the other hand, the data is not rich enough for me to investigate other redistribution channels, due to a lack of information on sectors of employment and consumption expenditure. The lack of consumption information also means that I cannot exploit the panel structure of the dataset to estimate MPC using a structural approach.

	Type 1	Type 2	Type 3	Type 4
Population share (%)	9.52	34.37	24.22	30.54
Average monthly income (PLN)	9136 (8574)	6436 (9789)	6431 (9335)	6757 (9452)
Have bank deposits in foreign currency (%)	0.65 (4.80)	3.72 (3.84)	2.44 (3.95)	4.69 (3.68)
Have loans or credit (%)	32.25 (37.08)	39.30 (35.22)	40.18 (35.49)	48.05 (31.60)
(If having loans or credit) some part is in CHF (%)	7.22 (8.32)	4.29 (10.52)	3.17 (10.06)	6.67 (9.27)

(a) 2013

	Type 1	Type 2	Type 3	Type 4
Population share (%)	18.23	28.18	18.91	27.06
Average monthly income (PLN)	3496 (3781)	2287 (4317)	2103 (4120)	3962 (3118)
Have bank deposits in foreign currency (%)	0.31 (2.57)	0.51 (2.81)	0.70 (2.50)	1.38 (2.45)
Have mortgage (%)	28.49 (30.18)	15.53 (36.05)	13.39 (34.19)	23.81 (33.29)
(If having mortgage) in CHF (%)	20.92 (23.54)	21.07 (23.37)	22.98 (23.01)	22.45 (23.24)
(If having mortgage) in PLN (%)	74.31 (70.98)	74.32 (71.15)	73.76 (71.43)	71.26 (71.81)

(b) 2015

Table B3: Polish data: Hand-to-mouth households and foreign currency exposure

Note: This table reports summary statistics of household groups classified as hand-to-mouth using different sets of criteria. "Type 1" is defined as households with savings up to one month's income; "Type 2" households report great difficulty or difficulty in making ends meet; "Type 3" households report that regular income is insufficient for expenses; "Type 4" is derived from a number of self-reports on income management. In particular, Type 4 households describe themselves as only able to afford the cheapest goods, or able to afford everything but are unable to save. Numbers in parentheses are the same statistics but for the corresponding non-HtM group for each type.

C Quantitative model: details

C.1 Equilibrium conditions

In this section, I list the equilibrium conditions for the quantitative model presented in Section 4.

- NKPC for prices of the nontradable sector:

$$\log(1+\pi_t^N) = \frac{\varepsilon_p}{\theta_p}\Big(\frac{w_t^N}{(p_t^N/p_t)\cdot\delta(N_t^N)^{\delta-1}} - \frac{\varepsilon_p-1}{\varepsilon_p}\Big) + \frac{1}{1+r_{t+1}^a}\frac{Y_{t+1}^N}{Y_t^N}\log(1+\pi_{t+1}^N).$$

- Labor demand for tradable sector:

$$\delta q_t \frac{Y_t^T}{N_t^T} = w_t^T.$$

- Wage Phillips curves:

$$\pi_t^{w,T} = k_w\left[\kappa\frac{(N_t^T)^\phi}{\frac{\varepsilon_w-1}{\varepsilon_w}w_t^T\mathcal{U}_t^T} - 1\right] + \beta\pi_{t+1}^{w,T}$$
$$\pi_t^{w,N} = k_w\left[(1-\kappa)\frac{(N_t^N)^\phi}{\frac{\varepsilon_w-1}{\varepsilon_w}w_t^N\mathcal{U}_t^N} - 1\right] + \beta\pi_{t+1}^{w,N}$$

- Dividends:

$$\Pi_t^T = q_t Y_t^T - w_t^T N_t^T$$
$$\Pi_t^N = \frac{p_t^N}{p_t}Y_t^N - w_t^N N_t^N - \frac{\theta_p}{2}[\log(1+\pi_t^N)]^2\frac{p_t^N}{p_t}Y_t^N$$

- Technology for $j \in \{T, N\}$:

$$Y_t^j = (N_t^j)^\delta.$$

- Monetary policy:

$$1+r_{t+1} = (1+\bar{r})(1+\pi_{t+1})^{-1}(1+\pi_t)^{\phi_\pi+\phi_e}(q_t/q_{t-1})^{\phi_e}.$$

- Return on illiquid wealth:

$$1+r_t^a = \frac{\Pi_t^T + \Pi_t^N + Q_{t+1}}{Q_t}$$

- No-arbitrage on domestic/foreign-currency bond:

$$(1+r_{t+1}^*)\frac{q_{t+1}}{q_t} = (1+r_{t+1}).$$

- Choice between tradable and nontradable goods:

$$
\begin{aligned}
&q_t c_t^T + \frac{p_t^N}{p_t} c_t^N = c_t \\
&\frac{q_t}{p_t^N / p_t} = \left(\frac{\alpha}{1-\alpha}\right)^{\frac{1}{\eta}} \cdot \left(\frac{c_{it}^T - \underline{c}}{c_{it}^N}\right)^{-\frac{1}{\eta}} \\
&q_t \underline{c} + \left[(1-\alpha)(p_t^N / p_t)^{1-\eta} + \alpha (q_t)^{1-\eta}\right]^{\frac{1}{1-\eta}} = 1.
\end{aligned}
$$

- Market clearing conditions and balance-of-payment equation:

$$
\begin{aligned}
&Q_t = A_t \\
&C_t^N = Y_t^N \\
&q_t(C_t^T - Y_t^T + \Phi_t) + B_{t+1} = (1 + r_t^b) B_t + \underbrace{\int (r_t^{b,p}(b) - r_t^b) b \mathrm{d}\lambda_t(z,b,a) + \int (r_t^{a,p}(a) - r_t^a) a \mathrm{d}\lambda_t(z,b,a)}_{\text{Valuation effect}}.
\end{aligned}
$$

  with $r_t^{b,p}(b) = r_t^b$ and $r_t^{a,p}(a) = r_t^a$ for $t \geq 1$.

- Pricing identities:

$$
\begin{aligned}
1 + \pi_t^N &= (1 + \pi_t) \frac{p_t^N / p_t}{p_{t-1}^N / p_{t-1}} \\
1 + \pi_t^{j,w} &= (1 + \pi_t) \frac{w_t^j}{w_{t-1}^j}.
\end{aligned}
$$

C.2 Solution algorithm

Model solution consists of two steps. In the first step, I solve the steady state of the model using an extension of the endogenous grid point method (Carroll, 2006) by Auclert, Bardóczy, Rognlie and Straub (2021) to models with two endogenous states. The EGP algorithm starts with grids on future endogenous states and iterates over the derivative of value functions, including the Lagrange multipliers of the binding constraints as additional endogenous variables in the computation. The algorithm also utilizes the special property of models with no-borrowing constraints for both liquid and illiquid assets, as household would never hit the constraint on illiquid wealth without simultaneously hitting the constraint on liquid wealth. I solve the steady state of the model using 3 income states for each sector, 50 grid points for liquid wealth and 40 grid points for illiquid wealth. I find the steady state of the model by iterating over the market clearing conditions for illiquid assets, nontradable consumption and labor supply, and check that the steady-state balance-of-payment condition is verified (by Walras' law) at the implied steady-state real exchange rate. I declare convergence of each EGP step using a threshold of 10^{-10}, and convergence of steady state using a tolerance of 10^{-6}.

The second step of the solution algorithm is to use the sequence-space Jacobian technique proposed by Auclert, Bardóczy, Rognlie and Straub (2021) to solve for the first-order transition dynamics. I truncate the sequence space at $T = 500$. Equilibria of the model in sequence space can be computed by solving a nonlinear system of paths of endogenous variables and exogenous shocks, and they are equivalent to solutions from traditional perturbations methods. The impulse response functions are obtained by inverting the Jacobians of the nonlinear system with respect to endogenous variables and shocks.

C.3 Partial-equilibrium consumption response to revaluation: Validation

I assess whether the model can generate an empirically plausible consumption response to wealth revaluation by computing the aggregate change in consumption following a large devaluation. Gyöngyösi, Rariga and Verner (2021) analyze wealth revaluation and consumption dynamics during the devaluation episode of Hungary from 2008 to 2010. Households with foreign-currency mortgage cut consumption by 4.5 to 5.3 percent, relative to households with local-currency mortgage debt. Using their estimate as the benchmark, I compute the model counterpart Δ from the consumption policy function in the stationary equilibrium:

$$\Delta \equiv \frac{\int c(z, b, \xi \cdot a) \mathrm{d}\lambda}{C}$$

where C is aggregate steady-state consumption, λ is the stationary distribution, and ξ is the revaluation multiple on illiquid wealth. I make several assumptions in defining and computing ξ and Δ. I subject the economy to a real depreciation of 8.65 percent per quarter, corresponding to a 17.3 percent real depreciation of Hungarian Forint from September 2008 to March 2009[40]. FC debtor has their entire debt denominated in foreign currency. I compare their consumption to the original steady-state consumption, assuming zero exposure to exchange rate. In this way, my definition of Δ is comparable to a partial-equilibrium difference-in-differences estimate (as in Gyöngyösi, Rariga and Verner (2021)) that gives the relative consumption response between FC and LC debtors. Verner and Gyöngyösi (2020) shows that Hungarian households have little foreign-currency assets to hedge against devaluation. As a result, I assign zero revaluation effect to liquid wealth b and only focus on revaluation of illiquid wealth due to a higher real value of foreign-currency debt component.

As illiquid wealth is a net measure, information on the composition of net illiquid wealth is key for me to compute ξ based on a 8.65 percent revaluation of gross foreign-currency debt. Verner and Gyöngyösi (2020) report an average loan-to-value ratio of 0.62 from 2004 to 2008 using bank-level data, and find LTV has little correlation with currency denomination. With no

[40]Source: CEIC/IMF. During this period, Forint depreciated against Swiss Franc – the main foreign currency denominating mortgages – by 32.3 percent.

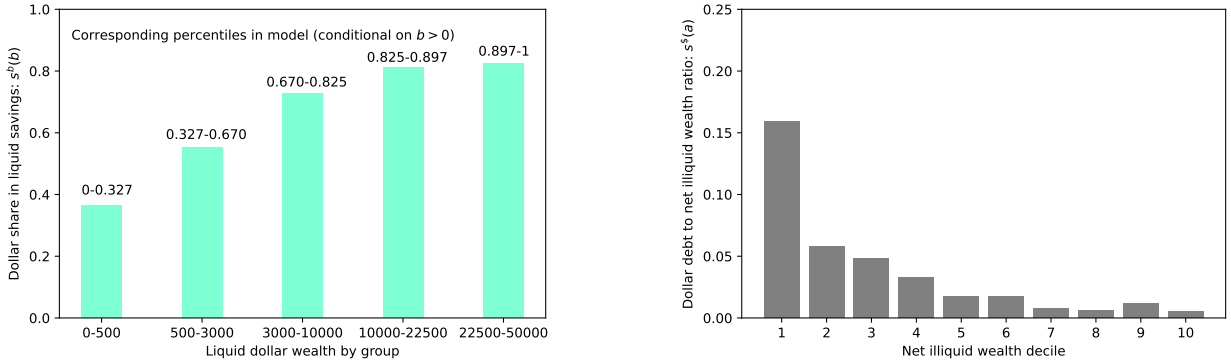
detailed cross-sectional data, I assume all households take out mortgages with an LTV of 0.62, so that the revaluation multiple ξ is uniform across households. I also maintain the assumption that the real value of the asset component v remains unchanged in response to depreciation. In my model, the LTV is expressed as $\frac{qa^\$}{v}$ for households with only foreign-currency debt: $a = v - qa^\$$. As a result, the revaluation multiple is given by

$$\xi = \frac{LTV^{-1} - q'/q}{LTV^{-1} - 1} = 0.859$$

with $q'/q = 1.0865$ and $LTV = 0.62$. Finally, $c(z, b, \xi \cdot a)$ is computed by interpolation.

C.4 Calibrating dollar shares: Detail

The step function approximation of dollar share s^b and $s^\$$ in my baseline analysis is implemented by first choosing a set of cutoff points that divides the empirical wealth distribution into groups.[41] For liquid wealth, the design of the EFHU-3 questionnaire (as multiple-choice questions) results in bunching of wealth around 500, 3,000, 10,000, 22,500 and 50,000 dollars (see Appendix B). I map this set of cutoff points to model-implied stationary distribution of liquid wealth. For illiquid wealth, the cutoff points are chosen to be the decile points. The dollar shares s^b and $s^\$$ are then computed for each group, based on the definition in Section 4.2.1. Figure C1 reports the calibrated step functions.



(a) Liquid wealth

(b) Illiquid wealth

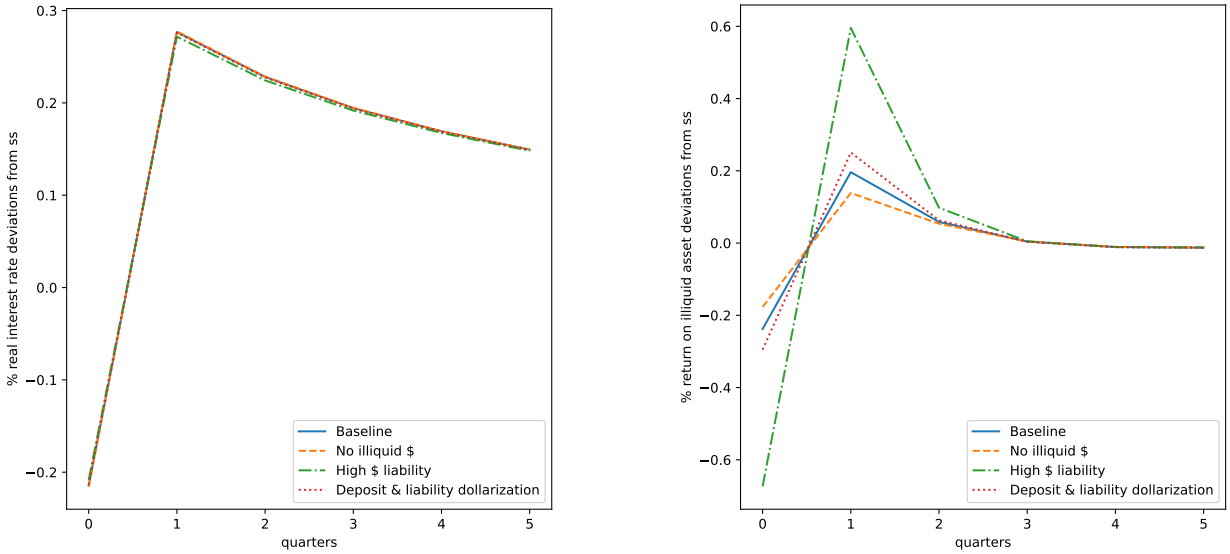
Figure C1: Step function calibration of s^b and $s^\$$

C.5 Additional quantitative findings

For the exercise on foreign-currency Fisher channel, Figure C2 compares the general-equilbrium paths of real returns on liquid and illiquid wealth across experiments by plotting the associated

[41] More accurately, the empirical wealth distribution is the condition distribution truncated at zero, as dollar shares at zero net wealth are indeterminate.

impulse responses from period zero to five. By merely reshuffling dollar wealth across agents, the exercise could generate substantial differences in instantaneous responses of endogenous returns, particularly for the illiquid wealth.



(a) Liquid wealth return

(b) Illiquid wealth return

Figure C2: General-equilibrium response of returns on wealth across specifications