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Inequality and asset prices during Sudden Stops*

Sergio Villalvazo[a,*]

[a]*Division of Financial Stability, Federal Reserve Board, 20th Street and Constitution Avenue NW, Washington, DC, 20551, United States of America*

Abstract

This paper studies the cross-sectional dimension of Fisher's debt-deflation mechanism that triggers endogenous Sudden Stop crises—i.e., episodes with large reversals in the current account. Analyzing microdata from Mexico, we show that this dimension has macroeconomic implications that operate via opposing effects. First, an amplifying effect by which households with high leverage fire-sale their assets during crises, increasing downward pressure on asset prices. Second, a dampening effect by which wealthy households with low leverage buy depressed assets, relieving downward pressure on asset prices. As a result, the role of inequality during crises is ambiguous. We conduct a quantitative analysis using a calibrated small open economy, asset-pricing model with heterogeneous agents and aggregate risk to measure the effects of inequality during crises. The model suggests that economies with lower inequality, whether due to reduced idiosyncratic risk or wealth redistribution across agents, experience less severe crises, as observed in the data.

Keywords: Inequality, Sudden Stops, Debt-deflation, Asset-pricing, Household leverage

JEL: D31, E21, E44, F32, F41, G01

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*Corresponding author
Email address: `sergio.villalvazo-martin@frb.gov` (Sergio Villalvazo)

1. Introduction

Over the past four decades, 58 financial crises of the Sudden Stop type have occurred across both emerging and developed economies.[1] These episodes have sparked a substantial literature studying Sudden Stops through the lens of models with financial frictions—typically within representative agent frameworks. However, such models miss a critical aspect of financial crises: they do not account for the heterogeneity in households' balance sheets and financial positions. In this paper, we argue that the distribution of wealth and leverage across households plays a central role in shaping the macroeconomic effects of financial crises.

This paper examines the cross-sectional dimension of the debt-deflation mechanism introduced by Fisher (1933), which works as follows. After a negative aggregate shock that tightens the financial conditions, financially constrained agents sell part of their collateralizable assets, triggering a decline in asset prices. This price drop further deteriorates financial conditions, pushing more agents into binding credit constraints (extensive margin) and forcing already-constrained agents to liquidate larger asset positions (intensive margin). This feedback loop deepens the asset price collapse and tightens financial conditions even more.[2] Our main insight is that the cross-sectional dimension of the debt-deflation mechanism plays a key role in the macroeconomic dynamics of Sudden Stops through two opposing channels: (1) a crisis-dampening effect, where unconstrained wealthy households buy depressed assets fire-sold by financially constrained households, mitigating the decline in prices and weakening the debt-deflation spiral; and (2) a crisis-amplifying effect, where indebted households, once constrained following asset price declines, must also fire-sell assets, further depressing prices and tightening financial conditions. The net impact of inequality on crisis severity is thus ambiguous due to the tension between these forces.

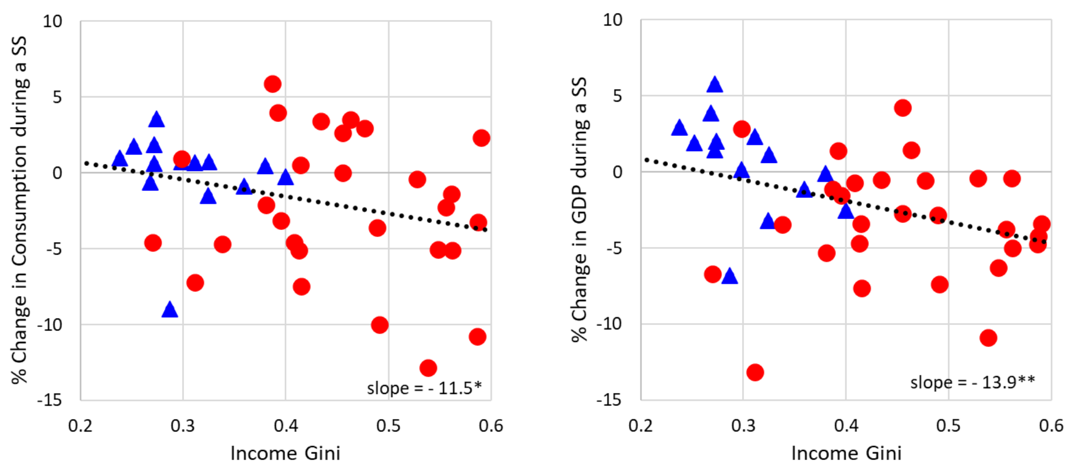
Empirical evidence supports this perspective. Panel micro-data from Mexico during the 2009 crisis reveal that wealthy households with low leverage increased their asset holdings

[1] Sudden Stops are episodes with large reversals in the current account. See Bianchi and Mendoza (2020) for a recent survey and review of the stylized facts of Sudden Stops.

[2] This mechanism is quantitatively significant. In the calibrated stationary model, 10 percent of the households are constrained and own 7.7 percent of the assets with a consumption share of 9.0 percent, while 75.9 percent of the household are unconstrained indebted and hold 88.1 percent of the assets with a consumption share of 78.1 percent.

by 61.4 percent, while similarly wealthy but highly leveraged households saw their assets fall by 36.6 percent—highlighting the sharply divergent dynamics across households during crises. Furthermore, Figure 1 shows descriptive evidence that Sudden Stop crises are more severe in economies with higher income inequality. Hence, cross-country data show larger contractions in consumption and GDP during crises in more unequal economies.

Figure 1: Severity of Sudden Stops and inequality



(a) Change in consumption (b) Change in GDP

Note: Triangle (circle) markers correspond to advanced (emerging) economies. Dates of Sudden Stop episodes come from Bianchi and Mendoza (2020). Gini index measures income inequality; larger numbers mean larger inequality. $^{**}p < 0.05, ^{*}p < 0.1$. Source: Own calculations with data from the World Bank.

To examine these dynamics quantitatively, we develop a small open economy model with heterogeneous agents, incomplete markets, aggregate risk, and occasionally-binding collateral constraints. The model includes risk-free bonds and collateralizable risky assets, with households facing persistent idiosyncratic risk in both labor income and dividends. A key feature is the *risk-wealth tradeoff*: holding more risky assets relaxes borrowing constraints and smooths consumption, but also increases exposure to income volatility, creating incentives for precautionary savings in safer instruments. This dynamic gives rise to a realistic wealth and leverage distribution, where some households accumulate assets and transition from borrowing to saving.

In a version of the model calibrated to an emerging economy (Mexico), the crisis-dampening effect dominates relative to the representative agent model: unconstrained households absorb fire-sales, helping to stabilize asset prices. However, the model with heterogeneity generates deeper and more persistent declines in consumption, along with prolonged current account reversals. In contrast, when comparing two economies with different non-degenerate levels of inequality—the baseline emerging economy and a more equal advanced economy calibration in which idiosyncratic dividend risk is removed but labor income risk remains—crises are milder and less frequent in the more equal economy. Moreover, an impulse response analysis, comparing the effects of simultaneous interest rate and total factor productivity shocks, reveals that in the baseline emerging economy calibration with a perfectly equal initial distribution (perfect redistribution) generates declines in consumption and asset prices that are approximately 0.5 percentage points smaller than in the baseline emerging economy with the stationary distribution as initial condition. Overall, the model suggests that economies with lower inequality, whether due to reduced idiosyncratic risk (as seen in advanced versus emerging economy calibrations) or wealth redistribution across agents (with identical idiosyncratic risk processes but different initial conditions), experience less severe Sudden Stop crises, findings that align with empirical observations.

Finally, the paper examines how a redistributive tax policy affects the dynamics of financial crises. Implementing a constant tax on dividend income, aimed at reducing wealth inequality, leads to less severe Sudden Stops through a general equilibrium effect. The tax lowers dividend returns and weakens households' incentives for precautionary savings by reducing their exposure to dividend risk. As a result, households demand fewer assets, pushing down equilibrium asset prices and reducing debt capacity. With smaller debt positions in normal times, crises involve milder bond adjustments and smaller consumption drops. A welfare analysis further shows that the dividend tax not only mitigates crisis severity but also improves welfare on average, generating a gain equivalent to 2.8 percent of consumption. However, the effects are heterogeneous: about three-quarters of households benefit, while the more leveraged and wealthier households experience welfare losses due to lower asset prices, declines in net worth, and tighter financial conditions.

After reviewing the literature in Section 2, in Section 3 we describe the empirical descriptive evidence on the cross-sectional effects of the debt-deflation mechanism. The proposed model is described in Section 4. Section 5 describes the cross-sectional effects through the lens of the model. Section 6 presents the quantitative analysis, and Section 7 concludes.

2. Related Literature

This paper contributes to several strands in the economics literature. Firstly, in the broader literature on financial crises, representative agent models with occasionally-binding credit constraints, as pioneered by Mendoza (2010), have been crucial in understanding the dynamics of Sudden Stops and economic downturns. Further work, such as Mendoza and Smith (2006), Bianchi and Mendoza (2018) and Jeanne and Korinek (2018), explores pecuniary externalities in financial crises, while Lorenzoni (2008), Bianchi (2011), and Benigno et al. (2013) examine the impact of collateral constraints on over-borrowing and the design of optimal macroprudential policies. Our paper extends this literature by focusing on the cross-sectional effects of the debt-deflation mechanism. Unlike previous models, we introduce market incompleteness at the individual level in a model with aggregate risk and analyze how household distributions of bonds, assets, and individual productivity influence asset prices, portfolio choices, and consumption dynamics during crises.

A second strand of the literature explores asset prices in closed economies with incomplete individual markets. Aiyagari and Gertler (1991), Heaton and Lucas (1996), Aiyagari and Gertler (1999) and Storesletten, Telmer, and Yaron (2007) examine the equity premium puzzle (Mehra and Prescott 1985) in a closed economy with bonds, stocks, adjustment costs, and labor income risk. More recently, Gomez (2025) studies the interplay between asset prices and wealth inequality in a model with two types of agents with different exposures to shocks. Our paper complements this literature by proposing a model with financial frictions and heterogeneous agents that can generate a high equity premium. Additionally, we derive a cross-sectional decomposition of the equity premium into constraint, individual risk, risk persistence, trading cost, and short-sales effects.

A third line of research explores macroeconomic models with individual heterogeneity, starting with Krusell and Smith (1997), who developed quantitative tools to analyze economies where market prices depend on the distribution of agents, not just on the mean aggregate state. Mendoza, Quadrini, and Rios-Rull (2009), Kaplan and Violante (2014), Guerrieri and Lorenzoni (2017) and Kaplan, Mitman, and Violante (2020) study the role of heterogeneity in models with financial frictions.[3] Extending this literature, this paper develops a small open economy model with heterogeneous agents facing a loan-to-value credit constraint. Unlike the wealthy hand-to-mouth framework introduced by Kaplan and Violante (2014), due to the LtV constraint, households in our model can become credit-constrained at varying levels of asset holdings, depending on their leverage. Moreover, this constraint generates a pecuniary externality, as households fail to internalize how their decisions influence both their own borrowing limits and those of others through changes in the endogenous aggregate asset price. This feature of the model generates a debt-deflation spiral during financial crises and allows us to study Sudden Stops.

Finally, in a series of empirical papers that study the relationship between income inequality, capital flows and crises, Bordo and Meissner (2012), Morelli and Atkinson (2015), Liu, Spiegel, and Zhang (2023), and Paul (2023) examine the predictive power of rising income inequality for financial crises with mixed conclusions. Lastly, Guntin, Ottonello, and Perez (2023) use microdata to show that, in line with the permanent income hypothesis, high-income households with liquid assets sharply reduce consumption during large aggregate consumption adjustments.[4] The present paper adds to the literature by using the proposed model to study the responses on asset prices and macroeconomic aggregates for economies with different degrees of inequality whether due to reduced idiosyncratic risk or wealth redistribution across agents.

[3] On a related literature that studies exchange rates, De Ferra, Mitman, and Romei (2020), Auclert et al. (2021), and Ferrante and Gornemann (2022) study how depreciation amplifies household spending via the real income channel and its distributional effects. Biljanovska and Vardoulakis (2024) show that distinguishing between workers and entrepreneurs introduces a distributive externality in macroprudential policy. Empirically, ? find that mortgage revaluations during exchange rate depreciation raise household default rates and reduce consumption, based on Hungarian data.

[4] On the modeling side, Kumhof, Rancière, and Winant (2015) examine how changes in the top income distribution affect household leverage and crises. Additionally, Hong (2023) examine excess consumption volatility in emerging economies, Roldán (2020) analyzes how income inequality influences sovereign spreads, Guo, Ottonello, and Perez (2023) explore monetary policy's distributional effects in open economies with heterogeneous households, Berger, Bocola, and Dovis (2023) quantify the impact of imperfect risk sharing on aggregate fluctuations, Bayer, Born, and Luetticke (2024) analyze how much inequality in the U.S. matters for business cycles. Regarding heterogeneity on the firm side, Benguria, Matsumoto, and Saffie (2022) explore the creative destruction framework to jointly study productivity and trade dynamics during financial crisis, and Lanteri and Rampini (2023) study capital allocation efficiency in economies with pecuniary externalities and heterogeneous firms.

3. The Cross-Sectional Effects in the Data

This section first describes the data used to show descriptive evidence that the cross-sectional effects of the debt-deflation mechanism are empirically relevant. Then, sorting households according to their net wealth and leverage ratio, we obtain the changes in their individual asset values during the 2009 Sudden Stop. The findings indicate that households in the highest decile of both wealth and leverage ratio experienced the largest decline in asset holdings, while low-leverage households exhibited the greatest accumulation of assets.

3.1. Description of the Data

We use data from the Mexican Family Life Survey (MxFLS) for the three available waves: 2002, 2005, and 2009. The MxFLS is a longitudinal household survey that collected information from a representative sample of approximately 8,400 households in 150 localities throughout Mexico. The survey covers information on expenditures, income, assets, and liabilities. The MxFLS is representative at the national, urban-rural, and regional levels. The sample selection criterion we use corresponds to households that answered the survey in all three waves. The resulting subsample includes 78 percent of the households in 2005. The next subsection will analyze the asset holding dynamics for households grouped by their level of leverage ratio, defined as the household's total debt over the sum of the household's total assets, and net wealth, defined as the household's total assets minus the household's total debt.[5]

3.2. Differentiated Individual Effects

In 2008-09, the Mexican economy, like many small open economies, faced a severe Sudden Stop. Aggregate data indicate a current account reversal of 1.5 percentage points relative to GDP, a 7 percent decline in per capita consumption, and housing prices falling 4 percent below their pre-crisis trend by 2010.[6] Additionally, data from the MxFLS survey reveal that between 2005 and 2009, the total value of households' gross assets decreased at an

[5] As a representativeness check, per capita private consumption declined by 5.1 percent in the National Accounts and by 5.7 percent in the household survey between 2005 and 2009. See the Online Appendix for more details on the distribution of households in 2005 and for a detailed description of the survey, see Rubalcava and Teruel (2003, 2006, 2013).

[6] For a detailed overview of the aggregate time series, refer to the Online Appendix.

annualized rate of 0.5 percent. However, the impact of the crisis varied across households, largely depending on the composition of their balance sheets.

Regarding the evolution of the household leverage ratio distribution before, during, and after the crisis. We classify households as financial savers if they report positive holdings of financial assets, as indebted but unconstrained if their leverage ratio falls below the 90th percentile (0.168 in 2005), and as financially constrained if their leverage ratio exceeds this threshold. We use the 90th percentile following that from 2004 to 2008, the average delinquency rate for commercial bank household credit is 10.3 percent. Between 2002 and 2005, prior to the crisis, the share of financial savers rose by 1.7 percentage points, while the share of financially constrained households declined by 2.3 percentage points. However, from 2005 to 2009, as the crisis unfolded and aggregate liquidity contracted, the share of financial savers dropped significantly by 5.0 percentage points likely reflecting the need to draw down savings to smooth consumption. Over the same period, the share of financially constrained households increased by 1.7 percentage points, consistent with tightening financial conditions.

Additionally, Table 1 shows descriptive evidence of the differentiated individual effects. Specifically, it shows the annualized median percent change in the real value of real estate (deflated with an aggregate house price index) owned by households from 2005 to 2009 relative to the average and sorted according to their net wealth and leverage ratio in 2009.[7] Wealthy households correspond to the top decile of net wealth, and the financially constrained households correspond to the top decile of the leverage ratio. As shown in the table, the real estate held by wealthy households declines as leverage increases. Specifically, the wealthy low-leveraged households (top-right cell) increased their real estate the most, by 61.4 percent. This descriptive evidence supports the dampening effects from the cross-sectional dimension, where declining asset prices allow wealthy, unconstrained agents to increase their asset positions.

Assuming no creation or destruction of real estate, the increase in assets held by uncon-

[7]The survey data correspond to the value of real estate. To obtain the quantity change, we deflated the value change with an aggregate house price index. To sort the households with zero leverage we defined an auxiliary financial negative savings leverage variable where we replaced the zero debt with the negative financial savings. In the Online Appendix we show evidence that these dynamics are not driven by a mean reversion mechanism using the surveys from 2002 and 2005.

strained wealthy households implies that they were purchasing assets from other households, who were therefore selling. Hence, the amplifying effect originates from households nearing financial constraints; once triggered, these households become financially constrained and further exacerbate the downward pressure on asset prices. The right column in Table 1 suggests that wealthy, financially constrained households—those in the top deciles of both net wealth and leverage ratio—experienced the largest asset fire-sales, reducing their holdings by 36.6 percent, thus intensifying the downward pressure on prices. Additionally, wealthy but financially vulnerable households—those in the top decile of net wealth and the ninth decile of leverage ratio—also engaged in fire-sales as financial conditions worsened, though to a lesser extent. This descriptive evidence supports the amplifying effects from the cross-sectional dimension, where wealthy, highly leveraged households reduce their asset positions, further driving down asset prices.

Table 1: Median annualized percent change in real value of real estate by deciles, 2005–09

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	0.0	61.4
VIII	1.5	31.9
IX	-1.7	-15.0
X	0.0	-36.6

Source: MxFLS.

Having documented stylized facts about households' cross-section, we describe the proposed model that accounts for households' balance sheet heterogeneity in the next section.

4. Model

The proposed framework is a Bewley model of a small open economy with international bonds, domestic equity, an endogenous occasionally-binding constraint and aggregate risk.

4.1. Environment

Time is discrete and infinite: $t = 0, ..., \infty$. The economy is populated by a unit measure of households. There are two financial assets: a one-period risk-free international bond that households can trade with the rest of the world and a risky domestic asset (land) that is tradable only between households and is subject to a trading cost.[8] Borrowing is subject to an LtV collateral constraint by which households' international debt cannot exceed a fraction of the market value of their assets—i.e., the domestic asset is collateralizable (see the Online Appendix for a micro-foundation of the collateral constraint).

Regarding the financial market's structure in the economy, markets are incomplete at the aggregate and individual levels. With respect to aggregate risk, the economy is subject to aggregate shocks that determine the international interest rate and total factor productivity. Concerning individual risk, households face non-insurable idiosyncratic labor income risk and dividend income risk. The latter risk means that households buy ex-ante identical shares of the risky domestic asset but get ex-post heterogeneity in the return.[9]

4.2. Households

There is a continuum unit measure of households. Each household $i \in [0,1]$ maximizes

$$\mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_t^i) \right], \tag{1}$$

where c_t^i is the consumption of household i, $\beta \in (0,1)$ is the common discount factor, and the utility function, $u(\cdot)$, has a common constant relative risk aversion (CRRA) form. Households have access to the international bond market and the domestic asset market. However, since debt markets are imperfect, only secured debt is available, and households' domestic assets serve as collateral. At the beginning of the period, each household holds b_t^i risk-free international bonds and a_t^i shares of the risky domestic asset that has an endogenous price q_t and pays a dividend $A_t d_t^i$. The household receives labor endowment income $A_t w_t^i$ and uses funds to buy consumption goods c_t^i, bonds to carry for the next period at an exogenous price equal to the inverse of the gross international rate R_t, and asset holdings to carry for the

[8] The assumption of only domestic trading follows the representative agent literature (see Bianchi and Mendoza (2018) and Jeanne and Korinek (2018)) but could be relaxed to allow foreign ownership up to a certain percentage of the shares in the economy. With an exogenous foreign demand for domestic shares, asset prices could become more volatile. See the Online Appendix for an impulse response analysis after a permanent shock in which foreigners sell domestic asset holdings.

[9] Evidence of a similar individual return on wealth is documented by Fagereng et al. (2020), and related individual capital income risk has been used by Angeletos (2007), Mendoza, Quadrini, and Rios-Rull (2009), Benhabib, Bisin, and Zhu (2011), and Hubmer, Krusell, and Smith Jr (2020).

next period, subject to a quadratic trading cost of the form $\Phi(a^i_{t+1}, a^i_t) = \frac{\phi}{2}(a^i_{t+1} - a^i_t)^2$. This cost reflects that trading the domestic asset requires a higher level of financial knowledge relative to the bond market and that physical assets are relatively less liquid than bonds.[10] Lastly, A_t corresponds to the aggregate level of total factor productivity. The household's budget constraint is

$$c^i_t + R^{-1}_t b^i_{t+1} + q_t(a^i_{t+1} + \Phi(a^i_{t+1}, a^i_t)) = A_t w^i_t + a^i_t(q_t + A_t d^i_t) + b^i_t. \tag{2}$$

Households face an LtV constraint that limits their ability to leverage foreign debt on domestic asset holdings. Next-period debt (negative bonds) cannot exceed a constant fraction κ of the market value of asset holdings. The collateral constraint is

$$R^{-1}_t b^i_{t+1} \geq -\kappa q_t a^i_{t+1}. \tag{3}$$

In addition, there is a short-sales constraint on the risky asset $a^i_{t+1} \geq 0$.[11] Note that the portfolio choice problem is well defined, given the combination of the trading costs in the asset market and the LtV debt constraint.

Lastly, the income of households is composed of an idiosyncratic and an aggregate part, as in Benhabib, Bisin, and Zhu (2015). The individual wage takes the form $w^i_t = \epsilon^{i,w}_t \bar{w}$, and the individual rate of return $d^i_t = \epsilon^{i,d}_t \bar{d}$, where $\{\epsilon^{i,w}_t, \epsilon^{i,d}_t\}$ correspond to the idiosyncratic risk components, which will be specified in the next subsection, and $\{\bar{w}, \bar{d}\}$ correspond to the aggregate, exogenous, and constant components.

[10] Similar to the wealthy hand-to-mouth literature introduced by Kaplan and Violante (2014), the households in our model have access to two assets that differ in their liquidity. However, in our framework the LtV constraint generates an additional margin by which each household can affect their debt capacity by choosing different asset positions. This constraint generates a pecuniary externality, as households fail to internalize how their decisions influence both their own borrowing limits and those of others through changes in the aggregate asset price. This feature of the model generates a debt-deflation spiral during financial crises.

[11] The short-sales constraint is needed to ensure that the state space of asset holdings is compact and that the LtV constraint is not irrelevant. If unlimited short selling of assets were possible, households could always undo the effect of Equation 3.

4.3. Exogenous Stochastic Processes

The economy is exposed to two aggregate shocks. The process for the international interest rate is $R_t = \epsilon_t^R \bar{R}$ and $\log(\epsilon_t^R) = \rho_R \log(\epsilon_{t-1}^R) + \eta_t^R$, with $\eta_t^R \sim \mathcal{N}(0, \sigma_R^2)$, and the process for the total factor productivity is $A_t = \epsilon_t^A \bar{A}$ and $\log(\epsilon_t^A) = \rho_A \log(\epsilon_{t-1}^A) + \eta_t^A$, with $\eta_t^A \sim \mathcal{N}(0, \sigma_A^2)$. Regarding the individual shocks, the individual wage takes the form $w_t^i = \epsilon_t^{i,w} \bar{w}$ and $\log(\epsilon_t^{i,w}) = \rho_w \log(\epsilon_{t-1}^{i,w}) + \eta_t^{i,w}$, with $\eta_t^{i,w} \sim \mathcal{N}(0, \sigma_w^2)$, and the individual dividend takes the form $d_t^i = \epsilon_t^{i,d} \bar{d}$ and $\log(\epsilon_t^{i,d}) = \rho_d \log(\epsilon_{t-1}^{i,d}) + \eta_t^{i,d}$, with $\eta_t^{i,d} \sim \mathcal{N}(0, \sigma_d^2)$. Note that the idiosyncratic labor and dividend risk that households face does not have aggregate implications on the returns:[12] $\int_0^1 d_t^i \, \mathrm{d}i = \int_0^1 \epsilon_t^{i,d} \bar{d} \, \mathrm{d}i = \bar{d}$ and $\int_0^1 w_t^i \, \mathrm{d}i = \int_0^1 \epsilon_t^{i,w} \bar{w} \, \mathrm{d}i = \bar{w}$.

4.4. Closing the Domestic Asset Market

The domestic asset is in constant positive net supply equal to $\bar{K}$, and in equilibrium, it is equal to the total asset holdings (demand) of households. Hence, market clearing in the asset market requires $\int_0^1 a_t^i \, \mathrm{d}i = \bar{K}$ for every t.

4.5. Recursive Formulation

To characterize the problem of the agents and the equilibrium in recursive form, we start by defining the states of the economy. Households are heterogeneous in their current holding of bonds, assets, idiosyncratic labor, and dividend productivity. The individual states are $(b, a, \epsilon^w, \epsilon^d)$. We need to keep track of both the individual bonds and assets, given the asset trading costs and the imperfect debt market. Let $\Omega(b, a, \epsilon^w, \epsilon^d)$ be the endogenous distribution of households according to their bonds, assets, and individual productivities. Regarding aggregate states, to forecast asset prices, households need to know the distribution of wealth. Hence, the aggregate states correspond to the endogenous distribution Ω, the exogenous shock to the international interest rate ϵ^R, and the exogenous shock to the total factor productivity ϵ^A. Letting the superscript $\prime$ correspond to the variables in the next

[12] However, as noted in Hubmer, Krusell, and Smith Jr (2020), the idiosyncratic dividend risk will impact the aggregate endowment, which will be a function of households' distribution of assets and dividend returns.

period, the recursive problem of a household becomes

$$
\begin{aligned}
v(b, a, \epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A, \Omega) = & \max_{\{c, b', a' \geq 0\}} \quad u(c) + \beta \mathbb{E}[v(b', a', \epsilon^{w'}, \epsilon^{d'}, \epsilon^{R'}, \epsilon^{A'}, \Omega')] \ s.t. \\
c + (\epsilon^R \bar{R})^{-1} b' + q(\Omega, \epsilon^R, \epsilon^A)(a' + \Phi(a', a)) = & \ \epsilon^A \bar{A} \epsilon^w \bar{w} + a(q(\Omega, \epsilon^R, \epsilon^A) + \epsilon^A \bar{A} \epsilon^d \bar{d}) + b, \\
(\epsilon^R \bar{R})^{-1} b' \geq & - \kappa q(\Omega, \epsilon^R, \epsilon^A) a', \\
\Phi(a', a) = & \ \frac{\phi}{2}(a' - a)^2, \\
\Omega' = & \ H^{\Omega}(\Omega, \epsilon^R, \epsilon^A), \qquad (4)
\end{aligned}
$$

where $H^{\Omega}(\cdot)$ corresponds to the aggregate law of motion of the distribution of households, and the individual multipliers on the budget constraint, the collateral constraint and the short sales constraint are $\lambda(\cdot)$, $\mu(\cdot)$ and $\psi(\cdot)$, respectively. The definition of the recursive competitive equilibrium can be found in the Online Appendix.

5. The Cross-Sectional Effects in the Model

In this section, we study the cross-sectional effects on the credit and equity channel of the economy. For tractability, we will abstract from aggregate risk and keep the interest rate and the total factor productivity constant at their average levels, $\bar{R}$ and $\bar{A}$, respectively.

5.1. Market Incompleteness and Risk Exposure

Households are exposed to two sources of non-insurable idiosyncratic risk that have different equilibrium implications. Note that the standard Bewley non-insurable persistent labor income risk, ϵ^w, together with the constant aggregate labor income endowment assumption implies a fixed labor risk exposure, which means that the exposure to labor earnings risk is independent of households' decisions. In contrast, the idiosyncratic persistent dividend productivity, ϵ^d, allows households to change future risk exposure by changing the next-period holdings of the asset.

This endogenous dividend risk exposure, combined with the LtV collateral constraint, generates a *risk-wealth tradeoff*. To see this point, first, note that when households are in an adverse individual state, they can smooth consumption in two ways—by lowering their bond holdings b' (if these are already negative, this means borrow more) or by reducing their asset holdings a'. Given the financial frictions in the debt market (see Equation 3), to have credit capacity and hence borrow, the household needs first to buy domestic assets. Note that although the current dividend return is given since the current asset holdings are fixed (they are an individual state variable), the household chooses how much future exposure to have by choosing the next-period asset holdings a'. Because the flow income of the household is given by $FI(a, \epsilon^w, \epsilon^d) = \bar{A}\epsilon^w \bar{w} + a\bar{A}\epsilon^d \bar{d}$, with independent idiosyncratic risks its variance is $\mathbb{V}[FI(a, \epsilon^w, \epsilon^d)] = (\bar{A}\bar{w})^2\sigma^2_{\epsilon^w} + a^2(\bar{A}\bar{d})^2\sigma^2_{\epsilon^d}$, which is a convex function with respect to asset holdings. This convexity translates into more income volatility for asset-rich households.

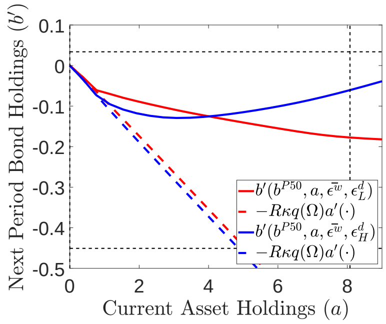
This property of flow income gives rise to the *risk-wealth tradeoff* associated with acquiring more assets. On one hand, households benefit from a higher debt capacity (Equation 3), which facilitates greater consumption smoothing and reduces consumption volatility. This allows for lower precautionary savings. On the other hand, accumulating assets also exposes households to greater future income risk, increasing consumption volatility and thereby strengthening the incentive for precautionary savings. In equilibrium, asset-poor households with debt tend to increase their borrowing as they acquire more assets. In contrast, households earning high dividend returns begin to deleverage once they become asset-rich, as precautionary saving motives become more prominent, and some households eventually transition into net savers due to the rising income risk.

To better understand this mechanism, Figure 2 shows the policy functions and the nonlinearities generated in the model. In the upper row of Figure 2, the solid lines correspond to the bond policy for the high- (low-) dividend shock in blue (red) and the average labor income shock as a function of the current asset holdings in panel (a) and current bond holdings in panel (b). Additionally, the colored dashed lines represent the corresponding debt limits, and the black dashed lines correspond to the bottom 1 and top 99 percentiles of bond and asset holdings obtained from the model's simulated cross-section. Panel (a) shows that for low-dividend shocks (red lines), a household lowers its bond holdings (or gets more debt) as it increases its asset holdings. In contrast, the *risk-wealth tradeoff* generates the convex form of the bond policy for high-dividend shocks (blue lines). For asset-poor households, as they increase their assets, they also lower their bond holdings (or get more debt if the holdings are negative), and there is a certain level for which the dividend risk exposure overcomes the benefit from more debt capacity that makes households increase their bond holdings. This behavior generates unconstrained wealthy households, which endogenously have a diversified portfolio, whereby asset-rich households end up holding both positive international bonds and domestic assets.[13] In panel (b) we can see the standard bond policies under an occasionally-binding debt limit: the LtV constraint becomes binding when households accumulate enough debt. Regarding the middle row of the figure, in panel (c) we can see the asset policy function that is highly linear and behaves as expected: for high-dividend shocks, households accumulate more assets, and for low-dividend shocks, households decumulate assets. With respect to the cross-sectional fire-sales in the model, in panel (d) we can see that households accumulate less assets as they increase their debt holdings. However, this relation is highly strengthened (households incur fire-sales) when the debt limit becomes binding.

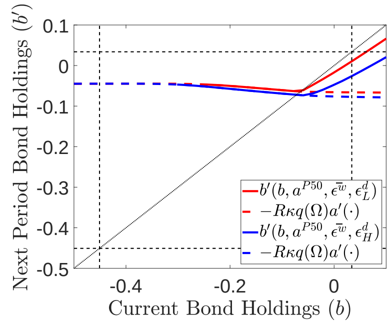
In Figure 2(e), we show the dynamics of the portfolio choices of a hypothetical household that has zero assets and bonds in period one and draws low dividend and wage shocks for 20 periods, then draws high dividend and wage shocks from period 21 to 180 and draws low shocks from period 181 onward. The figure shows that in the first 20 periods, the household is asset-poor and hand-to-mouth, then from period 21 to period 100, the household transitions to being wealthy hand-to-mouth as they begin accumulating assets while simultaneously taking on debt, keeping their debt at the maximum level (the debt limit). From period 100 onward, the precautionary savings motives becomes stronger and the household starts accumulating more debt but at a lower pace than the accumulation of assets, hence they become unconstrained. This behavior continuous and eventually the household starts to deleverage and by period 150 becomes a saver in bonds. In period 181, the household gets the low idiosyncratic shocks and starts to decrease both asset and bond positions, with a faster bond decline due to the asset transaction costs. At around period 190, the household hits

[13] Similar tradeoffs have been examined in the literature, notably by Mendoza, Quadrini, and Rios-Rull (2009) and Benhabib, Bisin, and Zhu (2011), but through different mechanisms. Our approach departs from these studies by combining persistent dividend risk with a loan-to-value constraint, enabling the stationary model to produce an empirically plausible distribution of constrained households, financially vulnerable borrowers, and savers holding positive bond positions. A graphical analysis of the remaining policy functions for the calibrated stationary model is provided in the Online Appendix.

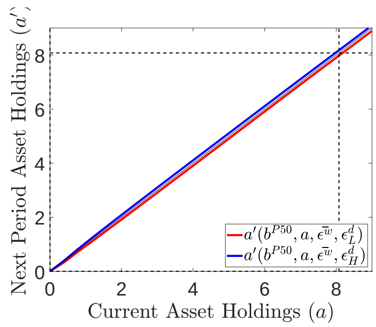
Figure 2: Stationary Bond and Asset Policies and Simulated Dynamics



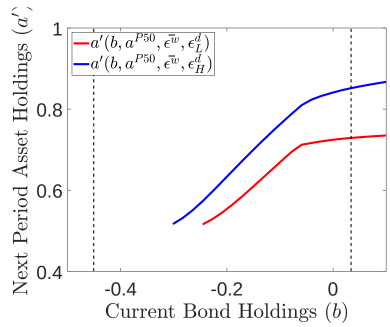
(a) Bond Decision Rule



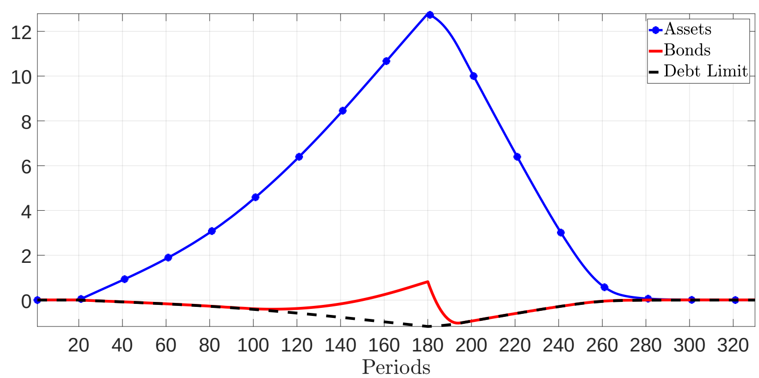
(b) Bond Decision Rule



(c) Asset Decision Rule



(d) Asset Decision Rule



(e) Simulated Dynamics

Note: The upper (middle) row corresponds to the bond (asset) policies given median asset (bond) holding and mean labor shock $\epsilon^{\bar{w}}$. The solid blue (red) line corresponds to the policy function with the high- (low-) dividend shock, and the dashed blue (red) line corresponds to the debt limit with the high- (low-) dividend shock. Dashed black lines correspond to the bottom 1% and top 99% of bond and asset holdings obtained from the model's simulated cross-section. Dotted black lines correspond to the 45-degree line. The missing values across the state space correspond to the infeasible individual states that would imply a negative consumption. The bottom row, panel (e), shows the simulated dynamics for a household that has zero assets and bonds in period one and draws low dividend and wage shocks for 20 periods, then draws high dividend and wage shocks from period 21 to 180 and draws low shocks from period 181 onward.

the debt constraint and again becomes wealthy hand-to-mouth that keeps on selling assets at a faster pace (fire-selling) which in turn decrease their debt capacity. Around period 280, the household has depleted their asset position and becomes asset-poor hand-to-mouth.

In summary, this subsection showed the cross-sectional behavior of households through the lens of our model. Households with high-dividend shocks will accumulate more assets, and, while they are still asset poor, they decumulate bonds. Once they become asset rich, because of the *risk-wealth tradeoff*, they start accumulating more bonds. This behavior generates wealthy unconstrained households that drive the dampening cross-sectional effect. Moreover, low-dividend households decumulate assets as they increase their debts, and this relation strengthens (households incur fire-sales) when the debt limit is reached, driving the strength of the amplifying effect. Note that the representative agent model misses both key effects. First, in the absence of idiosyncratic shocks, all households behave identically—either wanting to buy or sell assets—but actual asset holdings remain unchanged. Second, in the representative agent model, the average debt constraint multiplier will be the same as the individual debt multiplier. In contrast, in the heterogeneous agents model, even if only a small fraction of households are constrained, their individual multipliers can be much larger due to their individual states, amplifying the aggregate effect.

5.2. Financial Premia

In this subsection, we study the effects that households' balance sheet heterogeneity introduces to financial premia. Specifically, we analyze the cross-sectional dimension of the debt-deflation mechanism in terms of the external financing premium and equity premium at the individual and aggregate levels. For simplicity, we omit state variables and reintroduce the superscript i to identify household-specific variables. Let λ^i, μ^i, and ψ^i be the individual multipliers on the budget constraint, the collateral constraint, and the short-sales constraint, respectively, and let $\tilde{\mu}^i = \frac{\mu^i}{\lambda^i}$ and $\tilde{\psi}^i = \frac{\psi^i}{\lambda^i}$. Lastly, let the fraction $\bar{I} \in [0, 1]$ refer to the households that are credit constrained and, without loss of generality, sort by $\tilde{\mu}^i$ the constrained households from 0 to $\bar{I}$.

Similar to the analysis done by Mendoza and Smith (2006) but for an economy with heterogeneous agents, the first-order conditions of household i's problem imply an Euler equation for individual bonds, $\lambda^i \bar{R}^{-1} - \mu^i \bar{R}^{-1} = \beta \mathbb{E}[\lambda^{i\prime}]$, where $\mu^i \geq 0$ and $\tilde{\mu}^i = \frac{\mu^i}{\lambda^i} \in$

$[0,1)$. Let the individual expected effective interest rate be the inverse of the individual stochastic discount factor $\mathbb{E}[R^{i,eff}] = \mathbb{E}[SDF^i]^{-1} = \mathbb{E}\left[\beta\frac{\lambda^{i\prime}}{\lambda^i}\right]^{-1}$. Then, from the previous Euler equation, we get an individual expected external financing premium on debt:

$$\mathbb{E}[R^{i,eff}] - \bar{R} = \bar{R}\frac{\tilde{\mu}^i}{1-\tilde{\mu}^i} \geq 0. \tag{5}$$

This individual premium reflects the fact that when the constraint binds ($\tilde{\mu}^i > 0$), the household would want to borrow more than what the collateral constraint allows. Also, note that the individual premium is increasing in $\tilde{\mu}^i$, which means that as the constraint tightens, the household would be willing to pay an interest rate higher than $\bar{R}$ for more debt.

Similarly, from the first-order conditions of household i's problem, we obtain the Euler equation for individual assets, $q(\lambda^i(1+\Phi_1^i) - \kappa\mu^i) - \psi^i = \beta\mathbb{E}[\lambda^{i\prime}(q' + d^{i\prime} - q'\Phi_2^{i\prime})]$, where Φ_j^i corresponds to the partial derivative with respect to argument j. Let $\tilde{d}^{i,\prime} = d^{i\prime} - q'\Phi_2^{i\prime}$ and the individual return on the risky asset be $\tilde{R}^{i,q} = \left(\frac{q'+\tilde{d}^{i,\prime}}{q}\right)$. Then, from the aforementioned Euler equation, we get an individual expected equity premium:

$$\mathbb{E}[\tilde{R}^{i,q}] - \bar{R} = \frac{\bar{R}\left((1-\kappa)\tilde{\mu}^i - \mathbb{COV}[SDF^i, \tilde{R}^{i,q}] + \Phi_1^i - \tilde{\psi}^i\right)}{1-\tilde{\mu}^i}. \tag{6}$$

In Equation 6, we see a direct positive effect on the individual equity premium coming from the collateral constraint: as $\tilde{\mu}^i$ increases, the individual equity premium increases by an additive term that multiplies $\bar{R}(1-\kappa)$ and by a multiplicative factor $(1/(1-\tilde{\mu}^i))$. When the collateral constraint binds, a larger equity premium reflects that buying an extra unit of the asset provides an additional benefit since this additional unit also relaxes the constraint. However, this additional benefit is imperfect, since only κ fraction of the assets is pledgeable as collateral. Additionally, there is a positive risk effect coming from the covariance term, which will become more negative due to the precautionary savings.[14] There is an ambiguous effect coming from the marginal trading costs, Φ_1^i. This effect is expected to be negative for

[14] This risk effect also includes the next period's marginal trading cost effect that is expected to increase the precautionary motives. The intuition for this finding is the following. Note that the household that, next period, gets a high dividend return will buy more shares. Hence, $a^{i\prime\prime} > a^{i\prime} \Rightarrow \Phi_2^{i\prime} < 0 \Rightarrow \tilde{d}^{i,\prime} > d^{i\prime}$. That is, effectively, the individual dividend risk increases because of the trading costs.

financially constrained households, because when $\tilde{\mu}^i > 0$, the household will sell assets to smooth consumption and $a^{i\prime} < a^i$ implies $\Phi_1^i < 0$. Lastly, there is a negligible effect coming from the no short-sales constraint, $\tilde{\psi}^i$.

The aggregate expected equity rate of return, $\mathbb{E}\left[R^q\right] = \mathbb{E}\left[\frac{q' + \int a^{i\prime} d^{i\prime}\, \mathrm{d}i}{q}\right]$, can be obtained by first integrating the individual expected asset returns over all households. Then we use the expected returns derived in Equation 6 to obtain a decomposition of the aggregate expected equity premium:

$$\mathbb{E}[R^q] - \bar{R} = \underbrace{\bar{R}(1-\kappa)\int_0^{\bar{I}} \frac{\tilde{\mu}^i}{1-\tilde{\mu}^i}\,\mathrm{d}i}_{\text{Constraint Effect: } +\bar{I} \text{ and } +\tilde{\mu}} + \underbrace{\bar{R}\int_0^1 \frac{-\mathbb{COV}[SDF^i, \tilde{R}^{i,q}]}{1-\tilde{\mu}^i}\,\mathrm{d}i}_{\text{Risk Effect: ``+''}}$$
$$+ \underbrace{\int_0^1 \frac{\mathbb{COV}[a^{i\prime}, d^{i\prime}]\,\mathrm{d}i}{q}}_{\text{Persistence Effect: ``+''}} + \underbrace{\bar{R}\int_0^1 \frac{\Phi_1^i}{1-\tilde{\mu}^i}\,\mathrm{d}i}_{\text{Trading Cost Effect: ``}\approx 0\text{''}} + \underbrace{\frac{\bar{R}}{q}\int_0^1 \frac{-\tilde{\psi}^i}{1-\tilde{\mu}^i}\,\mathrm{d}i.}_{\text{No Short-Sales Effect: ``}-\text{''}} \tag{7}$$

Equation 7 shows that aggregate excess returns can be decomposed into different effects. First, a positive direct effect coming from the measure of constrained households and from how "strongly" the constraint binds. Second, the risk effect coming from the covariance between the individual stochastic discount factor and the individual return on equity (note that the integral becomes a weighted average of the covariances, with larger weights on constrained households since $\tilde{\mu}^i > 0$ implies $1/(1-\tilde{\mu}^i) > 1$). Since constrained households are expected to have more negative covariances because of their increased individual consumption volatility and the implied precautionary savings behavior, we expect a positive risk effect. Third, a positive persistence effect coming from the covariance between the idiosyncratic dividend return and the asset holdings. Since there is persistence in the idiosyncratic shocks and after a positive dividend shock households are expected to accumulate more assets, we expect this effect to be positive. Fourth, there is the trading cost effect—again, the weighted average puts more weight on constrained households, and since $\int_0^1 \Phi_1^i\,\mathrm{d}i = 0$, we can expect the aggregate effect to be close to zero and decreasing with respect to ϕ. Fifth, we observe a no short-sales effect that decreases the equity premium, since households with a binding short-sales constraint contribute to the aggregate demand for assets, with no effect on the marginal benefit of saving in assets.

Finally, the debt-deflation cross-sectional effects on risk premia operate through two opposing channels. First, the dampening effect arises when a greater proportion of unconstrained wealthy households are present, reducing the equity premium by mitigating the risk effect, as these households can better smooth consumption. Conversely, the amplifying effect occurs when financially constrained households become more prevalent, leading to a higher equity premium. This increase results from both a larger constraint effect, driven by a higher $\bar{I}$ and a larger risk effect, as these constrained households experience greater consumption volatility. In the next section, we use the model as a measurement device to quantitatively study the cross-sectional effects of a Sudden Stop episode.

6. Quantitative Analysis

This section presents the quantitative results of the model. Because of the computational intensity of the solution method, we calibrate the parameters using the stationary model without aggregate risk.[15]

6.1. Calibration

To calibrate the model, we use data for Mexico. Table 2 shows the calibrated parameters. Regarding the set of parameters that are calibrated outside of the model, we set the households' risk aversion, ν, equal to 2, which is standard, and the collateral debt fraction, κ, equal to 0.168, which is the 90th percentile of the leverage ratio distribution in 2005, following that from 2004 to 2008, the average delinquency rate for commercial bank household credit is 10 percent. Lastly, the net asset supply is normalized at 1. Then we calibrate by simulation the discount factor $\beta = 0.90$ to match the average net foreign asset position relative to GDP for Mexico, equal to -35 percent, and we also calibrate the trading cost parameter $\phi = 3.0$ to obtain an average transaction cost of 5 percent, which is consistent with the estimates from Aiyagari and Gertler (1999) and Kaplan and Violante (2014).

[15] Since the economy has an endogenous occasionally-binding constraint, the household's policy functions are highly nonlinear, a global solution method is needed. We use the *FiPIt* algorithm proposed by Mendoza and Villalvazo (2020) to solve the household's problem combined, with the stochastic-simulation approach by Maliar, Maliar, and Valli (2010) and Krusell and Smith (1997) to solve the aggregate uncertainty problem.

Table 2: Parameters

Parameter		Value	Source or Target
Calibrated outside of the model			
ν	Risk aversion	2	Common in the literature
κ	Debt fraction of collateral	0.168	90th percentile lev. ratio in 2005
$\bar{K}$	Net asset supply	1	Normalization
Calibrated by simulation			
β	Discount factor	0.90	Average NFA/GDP ratio of -35%
ϕ	Trading cost	3.0	Average transaction cost of 5%
Individual labor income risk			
$\bar{w}$	Average wage	0.17	See Section 6.1
ρ_w	Autocorrelation	0.906	
σ_w	Std. dev. (%)	19.8	
Individual dividend income risk			
$\bar{d}$	Average dividend yield	0.0425	See Section 6.1
ρ_d	Autocorrelation	0.905	
σ_d	Std. dev. (%)	69.4	
Aggregate interest rate risk and TFP			
$\bar{R}$	Average interest rate	1.047	See Section 6.1
ρ_R	Autocorrelation	0.81	
σ_R	Std. dev. (%)	1.9	
σ_A	Std. dev. (%)	0.5	

To estimate the exogenous earning process, we apply the methodology described in Krueger, Mitman, and Perri (2016) using Mexican data. First, we estimate a Mincer log-earnings equation with time fixed effects: $\log(Y^i_{a,t}) = \beta' X^i_{a,t} + D_t + y^i_{a,t}$, where each observation corresponds to an individual i, with quarterly age a and in quarter t. $Y^i_{a,t}$ corresponds to the annual income of the person, and the vector of controls $X^i_{a,t}$ includes a cubic polynomial on age, dummy variables for the education level, and a dummy variable that identifies whether the worker is in the informal sector. Finally, D_t corresponds to the time fixed effects. After running the regression, we obtain the residuals $y^i_{a,t}$ and assume the income risk follows a stationary process with a persistent and transitory component. The stationarity assumption allows us to drop the time dimension, and the income risk model becomes

$$y^i_a = z^i_a + \epsilon^i_a, \quad z^i_a = \rho_w z^i_{a-1} + \eta^{i,w}_a, \quad \eta^{i,w}_a \sim (0, \sigma^2_w), \quad z^i_0 \sim (0, \sigma^2_{z_0}), \quad \epsilon^i_a \sim (0, \sigma^2_\epsilon). \tag{8}$$

In section 6.2.1 we do a model validation for both the stationary and aggregate risk models.

Now the objective is to estimate the vector of parameters $\theta = (\rho_w, \sigma_w^2, \sigma_{z_0}^2, \sigma_\epsilon^2)$. These parameters are identified with the following theoretical moments:

$$\begin{aligned}
\rho_w =& \frac{\mathbb{COV}[y_a^i, y_{a-2}^i]}{\mathbb{COV}[y_{a-1}^i, y_{a-2}^i]}, \\
\sigma_\epsilon^2 =& \mathbb{V}[y_{a-1}^i] - \rho^{-1}\mathbb{COV}[y_a^i, y_{a-1}^i], \\
\sigma_w^2 =& \mathbb{V}[y_{a-1}^i] - \mathbb{COV}[y_a^i, y_{a-2}^i] - \sigma_\epsilon^2, \\
\sigma_{z_0}^2 =& \mathbb{V}[y_0^i] - \sigma_\epsilon^2 \ .
\end{aligned} \tag{9}$$

We use data from the National Survey of Employment and Occupation (ENOE) to do an over-identified GMM estimation with an identity weighting matrix.[16] The ENOE survey is a quarterly household rotating panel with a representative sample of 120,000 households that started in 2005:Q1. Every household is interviewed for five consecutive quarters, and, each quarter, 20 percent of the sample is replaced. Consistent with the standard practice in the literature, our sample selection criteria are male individuals with ages between 20 and 60 and with positive earnings. We find that the persistence and variance of the income risk are 0.906 and 0.039, respectively. The estimated persistence is smaller, and the variance is larger, for Mexico compared with the U.S. A reason for this difference could come from the informal market structure that is common in emerging economies (Leyva and Urrutia 2020). The Mexican labor market is characterized by a high informality rate—more than 50 percent informal employment. Since the informal sector is relatively more flexible than the formal sector, it could create a less permanent effect of idiosyncratic shocks. Moreover, Gomes, Iachan, and Santos (2020) find that informality is associated with more volatile earnings. Finally, the combination of a large informal sector and the lack of unemployment insurance could also cause a higher income risk.[17] To explore this reason, we re-estimate the income process with a subsample of only formal employment. As expected, the difference narrows, although the change is small, with a persistence and variance of 0.922 and 0.038, respectively.

[16] Note that to just-identify the parameters, we need data only for ages $(a, a-1, a-2)$. Since we are using data for 160 quarterly ages, the system is over-identified.

[17] Bosch and Esteban-Pretel (2015) study the consequences for the labor market of implementing an unemployment benefit system in economies with large informal sectors and find that an unemployment benefit could increase the formality rate.

Given that in the model we do not explore specific heterogeneity in the labor, we still use as a benchmark the results from the estimates that include all the employment. Lastly, the discrete labor income risk process is approximated using a symmetric two-state Markov chain that employs a simple persistence rule following Mendoza (2010). The discretized risk takes the values $\epsilon^w \in \{\epsilon^w_L = 0.80, \epsilon^w_H = 1.20\}$, and the probability that the next-period realization of the shock is the same as that of the current period is $Pr[\epsilon^{w'} = \epsilon^w_j | \epsilon^w = \epsilon^w_j] = 0.953$ for $j \in \{L, H\}$.

The dividend income risk plays a key role in the decision rules of households and drives the *risk-wealth tradeoff* discussed in Section 5.1. However, a proper estimation of this process is infeasible due to the lack of available data in most economies.[18] Because of the restrictions of the available data for Mexico, we take the following estimation strategy. We jointly estimate the three parameters that characterize the dividend income risk $(\bar{d}, \rho_d, \sigma_d)$ to match the leverage ratio distribution of households in 2005. Specifically, we focus on three distribution statistics: the measure of savers who have financial assets and no debt, indebted households that have positive debts but are not close to their debt limit, and financially constrained households that have a leverage ratio above 0.168, which corresponds to the 90th percentile. The model (data) distribution for the three statistics is 14.1 (14.2), 75.9 (75.8), 10.0 (10.0), respectively, and the calibrated parameters are $\bar{d} = 0.0425$, $\rho_d = 0.905$ and $\sigma_d = 0.694$. Similarly to the labor risk, the discrete dividend risk process is approximated using a symmetric two-state Markov chain that employs a simple persistence rule. Hence, the discretized risk takes the values $\epsilon^d \in \{\epsilon^d_L = 0.31, \epsilon^d_H = 1.69\}$, and the probability that the next-period realization of the shock is the same as that of the current period is $Pr[\epsilon^{d'} = \epsilon^d_j | \epsilon^d = \epsilon^d_j] = 0.9525$ for $j \in \{L, H\}$. These estimates imply that the effective dividend yield $(\epsilon^d \bar{d})$ households will face can take the following two values in percent: $\{1.3, 7.2\}$. Lastly, the aggregate wage level, $\bar{w}$, is set equal to $4\bar{d}\bar{K}$ such that the average household has a total flow income that corresponds to four-fifths labor income and one-fifth dividend income.

The last exogenous process that needs to be estimated corresponds to the international

[18] One exception is the work by Fagereng et al. (2020), who estimate the wealth risk using administrative data from Norway and find that there is high heterogeneity in the wealth returns and that these differences are highly persistent.

interest rate. This process was estimated using data from Kehoe and Ruhl (2009) and Uribe and Schmitt-Grohé (2017). The parameter estimates are ($\bar{R} = 1.047, \rho_R = 0.81, \sigma_R = 0.023$). Similarly, the interest rate process is approximated using a symmetric two-state Markov chain that employs a simple persistence rule. Hence, the discretized interest rate takes the values $R \in \{R_H = 1.070,\ R_L = 1.024\}$, and the probability that the next-period realization of the interest rate is the same as that of the current period is $Pr[R' = R_j | R = R_j] = 0.905$ for $j \in \{L, H\}$. The total factor productivity (TFP) shock is assumed to have a perfect negative correlation with the interest rate shock and standard deviation $\sigma_A = 0.005$. Hence, whenever the interest rate takes the value R_H (R_L), the TFP will take the value of $A_L = 0.995$ ($A_H = 1.005$). These values are common in the literature of small open economies and are close to the estimates obtained in studies of the Mexican economy (see Mendoza 2010 and Bianchi 2016, among others).

6.2. Aggregate Risk Model

To solve the aggregate risk model, we adapt the *nontrivial* market clearing algorithm proposed by Krusell and Smith (1997) to a small open economy framework. Specifically, we use the current aggregate net foreign asset position, $B = \int_0^1 b^i \, \mathrm{d}i$, and a dummy variable that indicates the current value, high or low, of the interest rate, D_R, to forecast the next period's net foreign asset position, B'. Additionally, to forecast the domestic asset price, q, we also use last period's asset price, q_{-1}. This algorithm is computationally intensive since the current market clearing asset price depends on the whole distribution of asset holdings and not only on the aggregate holdings (which are constant). Hence, to obtain a simulated time series, each period we use the aggregate law of motion to forecast the next period's aggregate net foreign asset position and the next period's asset price. With these forecasts, we then solve a fixed-point problem for every period, which gives as a solution the current equilibrium market clearing price. The solution of the aggregate law of motion is as follows, with all the coefficients statistically significant at 1 percent confidence:[19]

$$
\begin{aligned}
B' &= -0.015 + 0.807\ B + 0.004\ D_R, \quad R^2 = 0.99, \\
q &= 0.509 + 0.229\ B - 0.008\ D_R + 0.059\ q_{-1}, \quad R^2 = 0.93.
\end{aligned} \tag{10}
$$

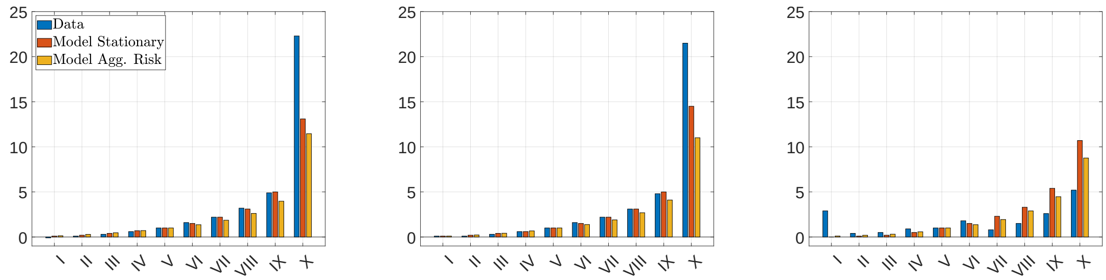
6.2.1. Model Validation

In this subsection, we analyze the stationary equilibrium for an economy in which the interest rate is constant at its steady state value of 4.7 percent and TFP is equal to 1—i.e., a Bewley economy without aggregate risk, as well as moments from the ergodic distribution from the the model with aggregate risk. In Figure 3, we show the average net wealth, assets, and debts by deciles relative to the median level of each variable for simulated data and observed data in 2005. As we can see in panels (a) and (b), the net wealth and assets distributions generated by the model are very close to the ones obtained from the MxFLS in 2005—with the exception of the top deciles. Although, in the model with aggregate risk, the precautionary savings motives deliver slightly lower wealth inequality. Regarding the total debt shown in panel (c), the only decile that is significantly different is the bottom decile. One possible reason for this difference is that we do not allow households to default in the model, and households cannot hold more debt than the collateral limit—in contrast to the observed data, where households in the bottom decile have negative net wealth. However, for the rest of the deciles, the model does a good job of capturing the inequality in terms of net wealth, total assets, and debt.

Moreover, notice that the debt-deflation mechanism affects a household's consumption when two things happen. First, the household must be highly leveraged, so when the collateral constraint tightens, the household is close to (or at) the binding region and needs to adjust its asset holdings. Second, the household must have a large debt-to-expenditure ratio, so when it has to deleverage, there is a significant effect on their consumption. As a model validation exercise, Figure 4 shows how well the model replicates the distribution of

[19] We validate our results using an alternative accuracy measure for the aggregate laws of motion proposed by Den Haan (2010), we find that the max (percentile 95) forecast error is 2.8 (1.6) and 1.1 (0.5) for the current account and asset price aggregate laws of motion, respectively. See the Online Appendix for a description of the solution algorithm.

Figure 3: Variables relative to the median



(a) Net wealth (b) Assets (c) Debt

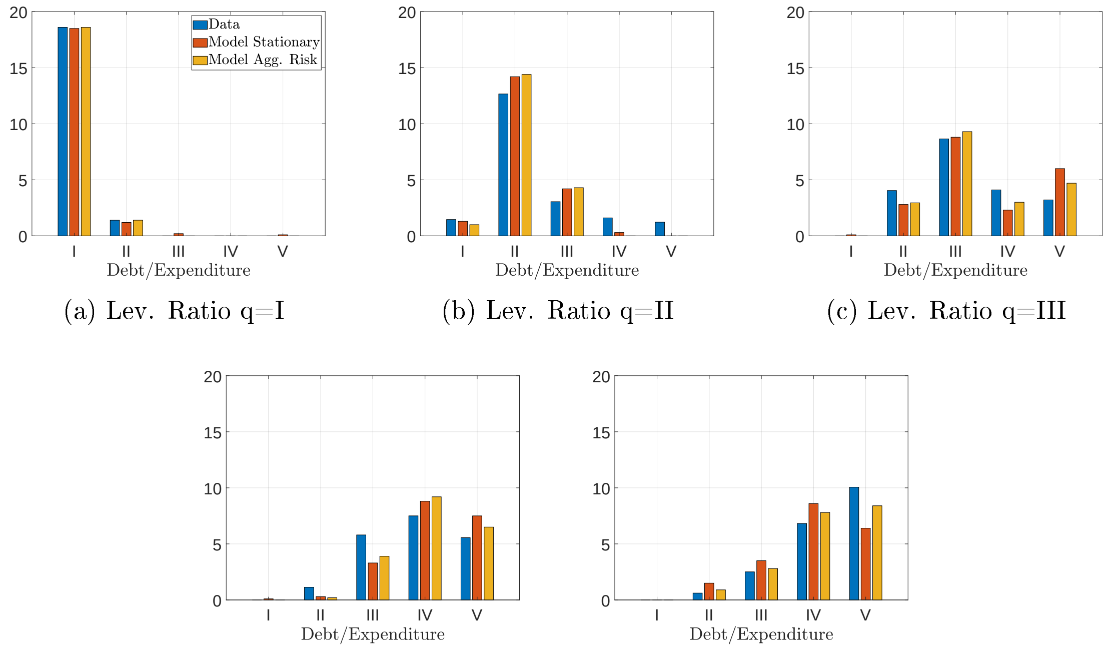
Note: Deciles ordered by net wealth. Blue bars correspond to the distribution of Mexican households in 2005. Red bars correspond to the simulated distribution of the stationary model, while yellow bars correspond to the simulation from the model with aggregate risk. Source: MxFLS.

financially included households (with positive financial savings and/or debts) with respect to the joint leverage ratio and debt-to-expenditure ratio. In overall terms, the model does a good job of replicating the joint distribution, with a slight underestimation of the measure of households in the top quintile for the leverage ratio and debt-to-expenditure ratio.

6.2.2. Simulation and Event Study of Sudden Stops

Using the solution to the aggregate laws of motion, we simulate a panel of 1,000 households for 2,100 periods and drop the first 100 periods. Table 3 columns (1) and (2) report moments of the main macro aggregates from both the benchmark model with heterogeneous agents and a representative agent version without idiosyncratic risk and a lower leverage limit, κ, which matches the average leverage ratio of 0.12 obtained in the model with heterogeneity. Regarding variable means, the current account as a percentage of GDP ($CA/GDP_t = (B_{t+1} - B_t)/GDP_t$) is zero and aggregate consumption is the same for both models. In the heterogeneous agents model, the net foreign asset position relative to GDP is 5.5 percentage points larger in absolute value, and the asset price is 12 percent higher. Since households do not need to self-insure against idiosyncratic shocks in the representative agent model, there is less precautionary savings and lower demand for the domestic asset. This equilibrium effect lowers the average asset price, tightening aggregate financial conditions and lowering the total debt. Regarding standard deviations, consumption volatility is higher, and the asset price is about one-third as volatile, in the benchmark heterogeneous agents economy compared with the representative agent economy. This result comes from the larger

Figure 4: Joint leverage ratio and debt-to-expenditure ratio distribution



(a) Lev. Ratio q=I (b) Lev. Ratio q=II (c) Lev. Ratio q=III

(d) Lev. Ratio q=IV (e) Lev. Ratio q=V

Note: Joint distribution by quintile. Blue bars correspond to the distribution of Mexican households in 2005. Red bars correspond to the simulated distribution of the stationary model, while yellow bars correspond to the simulation from the model with aggregate risk. Source: MxFLS.

consumption adjustments that high-leveraged households have to make in the model with heterogeneity when they get hit by a negative idiosyncratic shock.

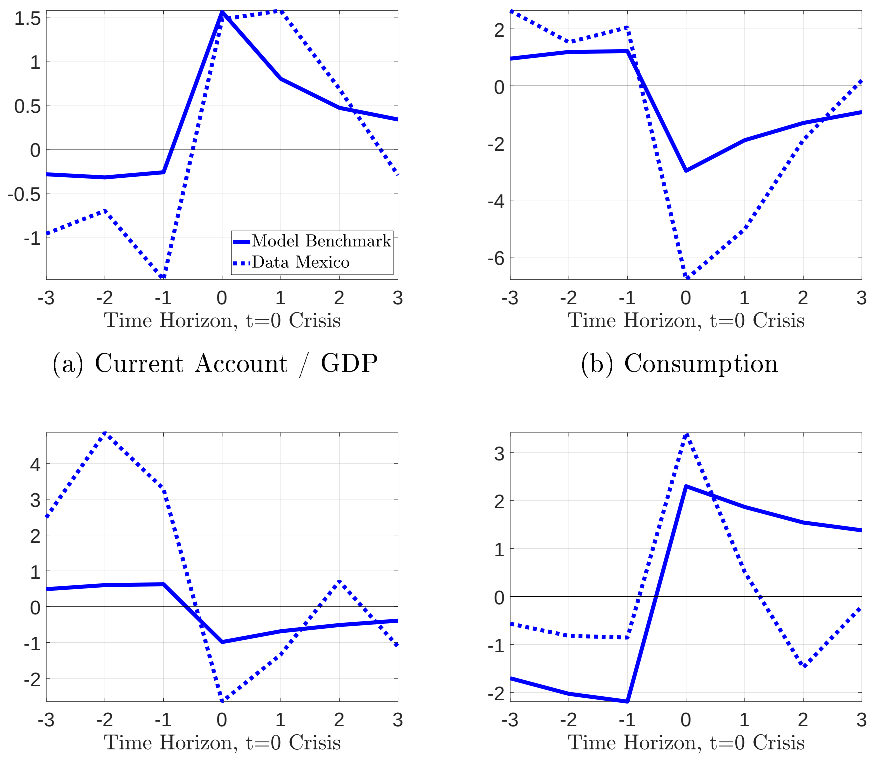
Because of the *risk-wealth tradeoff* described in Section 5.1, the model does a good job of capturing wealth inequality. The wealth Gini index is 0.61, which is close to the untargeted 2005 estimate for Mexico at 0.73. With respect to the aggregate equity premium, the model generates a high premium of 5.1 percent, which is close to the 6.5 percent estimated in the data by Damodaran (2013). As expected, the risk component contributes the most to the equity premium, about 55.3 percent, while the persistence effect accounts for 35.9 percent and 8.6 percent corresponds to the constraint effect. Note that the calibration was done to capture the measure of constrained households in 2005 in the stationary model, equal to 10 percent. Hence, even if only these households have an active debt constraint, there is a significant contribution to the aggregate equity premium. This is in contrast to the representative agent model where most of the equity premium is coming from the constraint effect.

Table 3: Simulated statistics

	(1) Het. Agents Benchmark Eme. Eco.	(2) Rep. Agent Same Mean Lev. Ratio	(3) Het. Agents ($\sigma^d = 0$) Adv. Eco.	(4) Het. Agents ($\tau^d = 0.30$) Eme. Eco.
Long-run mean				
CA/GDP (%)	0.00	0.00	0.00	0.00
Consumption	0.22	0.21	0.21	0.22
NFA/GDP (%)	-30.17	-24.72	-36.41	-34.51
Leverage ratio	0.123	0.123	0.160	0.146
Asset price	0.52	0.41	0.46	0.47
Standard deviation (%)				
CA/GDP	0.73	0.05	0.21	0.47
Consumption	1.81	1.03	1.48	1.58
NFA/GDP	3.11	0.10	0.31	1.76
Leverage ratio	1.44	0.00	0.45	0.98
Asset price	0.71	2.31	0.63	0.52
Inequality Measures				
Gini net wealth	0.61	-	0.29	0.55
Gini consumption	0.18	-	0.11	0.14
Equity premium decomposition (%)				
Equity Premium	5.12	5.63	4.35	5.05
Constraint Eff.	0.44	5.49	0.78	0.53
Risk Eff.	2.83	0.15	3.66	3.17
Persistence Eff.	1.84	-	-0.05	1.35
Trading Cost Eff.	0.01	-	-0.04	-0.01
No Short-Sales Eff.	0.00	-	0.00	0.00
Sudden Stop dynamics				
CA/GDP (p.p.)	1.56	0.09	0.54	1.02
Consumption (%)	-2.97	-1.17	-2.07	-2.34
Asset price (%)	-0.99	-2.57	-0.77	-0.61
Prob. of crisis (%)				
Benchmark threshold	4.30	0.00	0.00	1.83

To construct an event study of simulated Sudden Stops, we average across all identified crisis periods. Sudden Stop episodes are defined as the periods when the current account as a percentage of GDP is 1.5 standard deviations above its mean. Figure 5 shows the percent deviations from the steady state, where the crisis period corresponds to $t = 0$. The average of the simulated crisis episodes in the heterogeneous agents economy corresponds to the solid lines, and the average of the data for Mexico around the 1995 and 2009 Sudden Stops corresponds to the dashed line.

Figure 5: Event study of a Sudden Stop



(a) Current Account / GDP

(b) Consumption

(c) Asset Price

(d) Interest Rate Shock

Note: Solid lines correspond to the simulated data using the heterogeneous agents model calibrated to the Mexican economy, and dotted lines correspond to the average of the Mexican data around the 1995 and 2009 Sudden Stops. Panels (a) and (d) correspond to the level difference from the long-run mean in percent. Panels (b) and (c) correspond to percentage point deviations from the long-run average.

In Figure 5(a), we can see that a crisis episode is preceded by periods with the current account below its long-run average. Then, when the crisis happens ($t = 0$), there is a sharp reversal in the current account, which means that international capital stops flowing into the economy. Consistent with the data, the crisis is persistent, and it takes more than three years for international capital to flow back into the economy. Furthermore, in Figure 5(b), we can see that the model is able to generate a large and persistent aggregate consumption drop. Regarding the asset price drop, in Figure 5(c), we can see that the simulated price falls 1.0 percent below the steady state, which is less than the asset price drop observed for Mexico.[20]

[20]It is worth noting that while the model successfully reproduces the untargeted magnitude of current account dynamics, it underestimates the observed volatility and persistence of asset prices. As shown in the Online Appendix, introducing an ad-hoc tightening of the collateral constraint together with a sale of foreign asset holdings generates asset price movements that more closely resemble those observed in the data. This suggests that future work could endogenize these mechanisms, which amplify the pecuniary externality and

Lastly, Figure 5(d) shows that Sudden Stops occur when there is a negative aggregate shock. For simplicity, the figure displays only the interest rate; however, this is accompanied by a decline in TFP, which is perfectly negatively correlated with the interest rate. However, not all interest rate increases cause a crisis. Specifically, the long-run probability of a Sudden Stop in the simulated benchmark economy is 4.3 percent, while the probability of moving from a low to a high interest rate is 4.9 percent.

The bottom part of Table 3 reports Sudden Stop dynamics. Specifically, it shows the average percent deviations from the steady state for the current account as a percentage of GDP, consumption, and asset prices across the different simulated economies. In the benchmark calibration to an emerging economy (column 1), the asset price decline is smaller than the drop in consumption, aligning with empirical observations. In contrast, the representative agent model (column 2) shows a larger decline in asset prices than in consumption. Comparing these two columns reveals that in the heterogeneous agents economy, the crisis-dampening effect dominates, leading to a smaller asset price drop. However, there is a larger adjustment in aggregate consumption, driven mainly by the leveraged households.

Regarding the differentiated individual effects during a Sudden Stop, in Table 4 we show the dynamics of asset holdings according to the leverage ratio and wealth of households, as we did for the empirical results presented in Section 3.2 and reproduced in parenthesis. We can see that the model does a good job of capturing the dampening effect coming from the wealthy unconstrained households that buy assets during a crisis and relieve the downward pressure on the price. In particular, these households increase their asset holdings by 6.6 percent during a crisis. Moreover, in line with the empirical evidence on the amplifying effect, financially constrained wealthy households fire-sell their assets the most during the crisis, decreasing their asset holdings by 15.8 percent. Although in the model households in decile IX of the leverage ratio do not sell their assets, we can see that they increase their holdings by a smaller amount than households in deciles I through VIII. Hence, the model is able to capture both cross-sectional effects.

transmit shocks more strongly to asset prices, by incorporating richer preference structures, such as recursive Epstein–Zin preferences or non-homothetic preferences as in Rojas and Saffie (2022). Such extensions would enhance the feedback between asset prices, consumption, and borrowing, thereby improving the model's ability to replicate asset price dynamics.

Table 4: Median asset holdings percent change in a crisis

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	-0.7 (0.0)	6.6 (61.4)
VIII	4.7 (1.5)	5.3 (31.9)
IX	4.1 (-1.7)	2.9 (-15.0)
X	1.9 (0.0)	-15.8 (-36.6)

Note: To facilitate comparison between the model and data, empirical moments from Table 1 are reported in parenthesis.

6.2.3. Effect of Zero Variance in the Dividend Risk

In this subsection, we compare the severity of Sudden Stops in economies with different degrees of inequality. As described in the introduction, Figure 1 shows descriptive evidence suggesting that emerging economies are more unequal than advanced economies and that crises are more severe in more unequal economies. To quantitatively assess the effects of lower income inequality, we calibrate the model to an advanced economy in which the dividend risk has zero variance, resulting in a wealth Gini index of 0.29. The results, summarized in Table 3 column (3), show that in the model calibrated to an advanced economy, the long-run average net foreign debt relative to GDP position is 6.2 percentage points larger, and consumption drops 1.0 percentage points less, while asset prices drop 0.2 percentage point less, during crises. The implied slope coefficient from the relation between the severity of a Sudden Stop in terms of consumption declines and the income Gini in the data is -11.5 while the implied coefficient from the different calibrations of the model is -11.1. An economy with an income Gini index 0.10 points lower experiences a decline in consumption 1.1 percentage points smaller during a crisis. Hence, the model predicts that economies with less inequality have less severe Sudden Stop crises, as observed in the data.

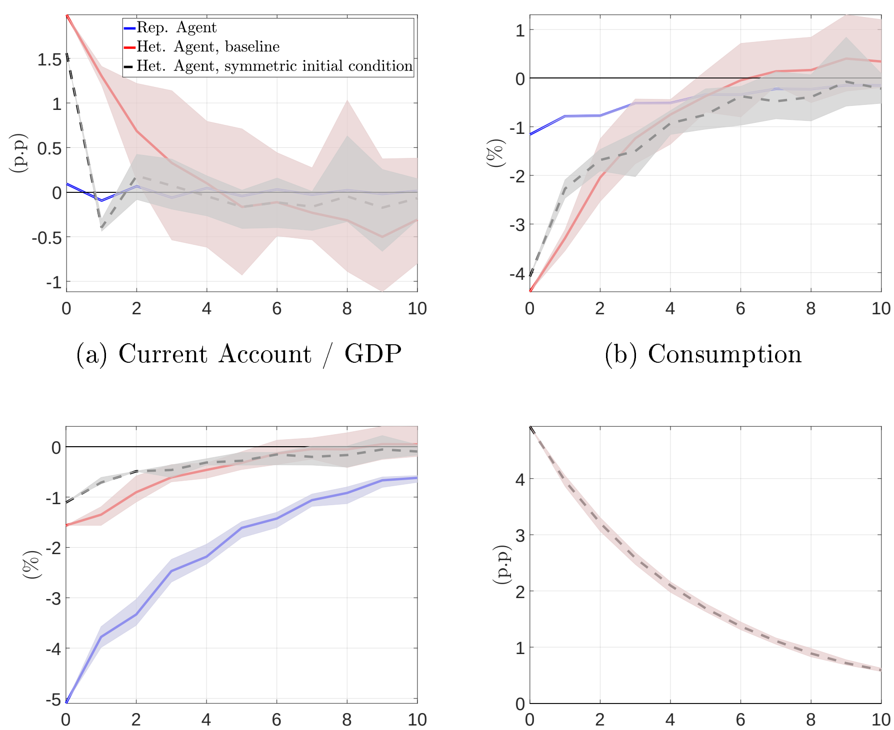
6.2.4. Impulse Response Analysis

Lastly, this subsection looks at the impulse response functions after a two standard deviations aggregate shock.[21] We compare the model with heterogeneity for different initial

[21] The aggregate shock consists of a simultaneous impact on the international interest rate and aggregate TFP, with the latter being perfectly negatively correlated with the interest rate. For simplicity, Figure 6(d) only shows the response in the interest rate.

distributions and the representative agent model. In the baseline model with heterogeneity, the responses are obtained by conditioning the economy to start at the stationary ergodic distribution when the aggregate interest rate is kept constant at its mean value. We also look at a heterogenous agent model in which the initial distribution is perfectly symmetric, so that all households initially hold the long-run average levels of bonds and the risky asset, but can then diverge as they receive idiosyncratic shocks going forward (a complete redistribution before the shock). The representative agent model results are obtained by conditioning the economy to start at the long-run mean bond position. All three simulations start at the long-run mean interest rate.

Figure 6: Impulse responses to an aggregate shock



(a) Current Account / GDP

(b) Consumption

(c) Asset Price

(d) Interest Rate Shock

Note: Impulse response functions after an interest rate (and simultaneous TFP) shock of two standard deviations. In the baseline model with heterogeneity (red line), the responses are obtained by conditioning the economy to start at the stationary ergodic distribution. In the symmetric initial condition model (black dashed line), the responses are obtained by conditioning the economy to start with all households holding the long-run average levels of bonds and the risky asset. In the representative agent model (blue line), results are obtained by conditioning the economy to start at the long-run average bond position. Bands represent 68% credible intervals, and solid lines are averages over 10 simulations.

In line with the results from the previous subsection, Figure 6(a) shows that the baseline model with heterogeneity (solid red line) generates persistent current account reversals, which are 1.9 percentage points larger than in the representative agent model (solid blue line), which produces a near-zero response in the current account. In panels (b) and (c), we see that the response of the model with heterogeneity is about four times larger for consumption, and about a third as large for asset prices, compared with the representative agent economy. Lastly, comparing both red solid and black dashed lines, we see that the effect of doing a perfect redistribution and starting with a perfectly symmetric initial distribution is relevant in the first three periods after the shock. Moreover, in line with the results of the previous subsection, under the perfectly symmetric initial conditions (dashed black line), the drops in consumption and the asset price are approximately 0.5 percentage points smaller compared to the ergodic distribution initial condition baseline. In the Online Appendix, we present two additional exercises that illustrate how to generate a more pronounced response in asset prices. The first introduces a permanent shock, while the second combines a permanent shock with an ad-hoc tightening of the LtV limit and an exogenous increase in asset supply, motivated by foreign investors selling off their asset holdings.

6.2.5. Effect of a Dividend Income Tax

According to OECD (2018), Mexico has one of the lowest tax rates among OECD countries. The marginal effective tax rate on bank deposits and dividends is close to zero compared to an OECD average of around 30 percent. In this subsection, we use the model to examine the effects of introducing a redistributive dividend income tax.[22] Specifically, the government taxes dividend income at a flat rate of $\tau^d = 0.30$ across all households and periods, and redistributes the revenue through lump-sum transfers T_t, maintaining a balanced budget each period. This policy results in a time-varying transfer function $T_t = \int_0^1 a_t^i A_t d_t^i \tau^d \, \mathrm{d}i$.

[22] We consider a simple policy rule that remains constant across households and over time. Implementing such a rule requires commitment from the tax authority and is known to be time-inconsistent in models with forward-looking asset prices. The source of this inconsistency comes from the fact that a benevolent social planner can influence current asset prices by announcing a future tax path that shapes expectations. However, once the future period arrives and asset holdings are predetermined, the planner may face incentives to deviate from the announced rule to achieve a welfare-improving outcome, thus breaking the initial commitment. A full characterization of the optimal, time-consistent policy is beyond the scope of this paper; see Bianchi and Mendoza (2018) for a detailed analysis of optimal time-consistent macroprudential policies.

The budget constraint of household i becomes

$$c_t^i + R_t^{-1} b_{t+1}^i + q_t(a_{t+1}^i + \Phi(a_{t+1}^i, a_t^i)) = A_t w_t^i + a_t^i(q_t + A_t d_t^i(1-\tau^d)) + b_t^i + T_t \ . \tag{11}$$

Implementing this tax reduces the severity of Sudden Stops. As shown in column (4) of Table 3, the average current account reversal during a crisis is 0.54 percentage points smaller. The underlying mechanism behind this result is the following: the dividend tax lowers the average dividend returns and reduces households' exposure to dividend risk, weakening the precautionary savings motive. As a result, households demand fewer bonds—leading to a more negative average net foreign asset (NFA) position—and reduce their demand for domestic assets. To clear the market under lower demand, the price of the domestic asset declines, on average, by 9.6 percent relative to the benchmark economy. This asset price decline tightens borrowing constraints economy-wide due to the pecuniary externality embedded in the collateral constraint, increasing the share of financially constrained households from 5.6 to 7.8 percent. Nevertheless, the overall contraction in domestic absorption is more moderate. Aggregate consumption falls by 0.63 percentage points less than in the benchmark economy. The reason is that lower asset prices reduce the effective debt of vulnerable households. Consequently, their bond adjustment in response to external shocks is more limited. Combined with the redistributive transfers from the lump-sum policy, this results in a milder decline in consumption.[23] Regarding the frequency of crises, it is worth noting that the probability of a crisis increases slightly because the reduced volatility of the current account lowers the threshold used to identify crisis episodes. However, as shown in the bottom row of Table 3, when the crisis thresholds from the benchmark economy are applied, the probability decreases to 1.83 percent—less than half of the benchmark value.

Finally, we conduct a welfare analysis using the simulated ergodic distribution from the model. We simulate 10 economies with 1,000 households over 220 periods, discarding the

[23] The Online Appendix provides further results, such as event studies and asset-holding dynamics, for both the no-dividend risk and dividend-tax economies. Additionally, it also shows that the policy is also effective, although in a lower magnitude, under a representative agent framework. The consumption and asset price change during a Sudden Stop are -0.95 and -2.39 percent, respectively. These declines are less severe than in the representative agent model however the dividend tax policy is less effective than in the benchmark heterogeneous agents framework because there is no role and hence no gain from redistribution.

first 20 periods, for both the baseline and the dividend tax economies. For each household, we compute the standard compensating consumption variation associated with the introduction of the dividend tax, accounting for the transition to the new tax policy. On average, households experience a welfare gain equivalent to 2.8 percent of consumption. However, this improvement is heterogeneous across the households: 73.3 percent of households experience welfare gains averaging 6.2 percent, while 26.7 percent experience welfare losses averaging 6.8 percent in consumption-equivalent terms. The households that experience welfare losses are more leveraged and three times wealthier than those that benefit. These results indicate that, on average, the dividend tax policy is welfare-improving, but its negative impact on asset prices disproportionately affects wealthy, leveraged households by reducing their net worth and tightening their financial constraints, leading to sizable welfare losses.

7. Conclusion

This paper studies the cross-sectional dimension of the debt-deflation mechanism that triggers endogenous financial crises of the Sudden Stop type. This dimension is relevant for the macroeconomy for two reasons. First, there is a dampening effect on the deflation of asset prices coming from the unconstrained wealthy households that buy distressed assets, relieving the downward pressure on asset prices. Second, there is an amplifying effect on the asset price deflation coming from the financially vulnerable households that fire-sell assets, generating a stronger downward pressure on asset prices. Because these two cross-sectional effects move asset prices in opposite directions, the role of inequality during crises is quantitatively ambiguous. Hence, this paper examines how the severity of Sudden Stop crises is affected by inequality in an economy.

First, with a panel microdata for Mexican households, we document descriptive evidence that supports both effects. Specifically, the 2009 crisis had different effects on households depending on the composition of their balance sheets. The real estate holdings of low-leveraged wealthy households increased 61.4 percent during the crisis, while wealthy households with high leverage fire-sold and decreased their assets the most during the crisis.

Then, using the proposed asset-pricing Bewley model of a small open economy, we find that a version of the model calibrated to an emerging economy (Mexico) can explain Sudden

Stops' key stylized facts. Regarding the cross-sectional forces, in contrast to the representative agent framework, the model with household heterogeneity produces an empirically plausible leverage ratio distribution and generates persistent current account reversals with larger drops in consumption driven by the most leveraged households, consistent with the data. Furthermore, when calibrated to an advanced economy with zero dividend risk, the model predicts that the average net foreign debt position relative to GDP is 6.2 percentage points higher, consumption declines are 1.0 percentage point smaller, and asset price drops are 0.2 percentage points less severe. An impulse response analysis reveals that a heterogeneous agent economy with a perfectly equal initial distribution (complete redistribution) generates declines in consumption and asset prices that are 0.5 percentage points smaller than in the baseline economy with the stationary distribution as initial condition. Lastly, we show that a constant tax on dividend income, designed to reduce wealth inequality, makes financial crises less severe by lowering asset prices and limiting debt accumulation in normal times. On average, the policy raises welfare, though wealthier and more leveraged households experience welfare losses due to declines in asset values and tighter financial conditions.

In summary, the model suggests that economies with lower inequality, whether due to reduced idiosyncratic risk (as seen in advanced versus emerging economy calibrations) or wealth redistribution across agents (with identical idiosyncratic risk but different initial conditions), experience less severe Sudden Stop crises, findings that align with empirical observations.

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For Online Publication Appendix to "Inequality and Asset Prices during Sudden Stops"

Sergio Villalvazo

This Online Appendix consists of the following sections:

A. Microdata for Mexico

B. The 2009 Mexican Sudden Stop at the Aggregate Level

C. Model Details

D. Solution Algorithm

E. Model Nonlinearities

F. Aggregate Risk Model: Event Studies

G. Aggregate Risk Model: Impulse Responses

Appendix A. Microdata for Mexico

In this Appendix we show the distribution of houeholds by deciles according to the Mexican Family Life Survey (MxFLS) for 2005. Table A-1 shows the mean net wealth, portfolio composition, and leverage ratio in 2005, ordered by deciles of the net wealth distribution. The leverage ratio is defined as the household's total debt over the sum of the household's total assets. As the second and third rows show, Mexican households' wealth is mostly in physical assets (real estate and other durable goods). Although the proportion of debt decreases as households amass higher net wealth, as we can see from the last two rows of the table, there are leveraged and non-leveraged households in each of the deciles.

Table A-1: Mean net wealth and its composition by deciles in 2005

	I	II	III	IV	V	VI	VII	VIII	IX	X
Net wealth ($)	-507	761	2,564	5,368	9,184	14,451	20,524	29,512	45,067	204,855
Assets										
Real estate (%)	-103.6	24.2	46.9	69.6	76.9	80.9	82.5	82.8	82.1	75.1
Other (%)	-68.5	88.3	49.5	30.7	23.4	19.8	15.8	14.2	14.2	9.3
Financial (%)	-10.7	9.7	12	7.5	4.5	4.9	3.4	5.3	6.3	16.8
Debt (%)	282.8	-22.2	-8.3	-7.7	-4.9	-5.6	-1.7	-2.3	-2.6	-1.2
Leverage ratio										
Mean	0.77	0.10	0.05	0.05	0.04	0.04	0.02	0.02	0.02	0.02
p90	1.69	0.38	0.17	0.16	0.12	0.09	0.04	0.05	0.06	0.04
p10	0	0	0	0	0	0	0	0	0	0

Note: Ordered by deciles of net wealth in 2005 dollars. Source: MxFLS.

Table A-2 and Figure A-1 present the evolution of the household leverage ratio distribution before and during the crisis. We classify households as financial savers if they report positive holdings of financial assets, as indebted but unconstrained if their leverage ratio falls below the 90th percentile (0.168 in 2005), and as financially constrained if their leverage ratio exceeds this threshold. Between 2002 and 2005, prior to the crisis, the share of financial savers rose by 1.7 percentage points, while the share of financially constrained households declined by 2.3 percentage points. However, from 2005 to 2009, as the crisis unfolded and aggregate liquidity contracted, the share of financial savers dropped significantly by 5 percentage points likely reflecting the need to draw down savings to smooth consumption. Over the same period, the share of financially constrained households increased by 1.7 percentage points, consistent with tightening financial conditions.

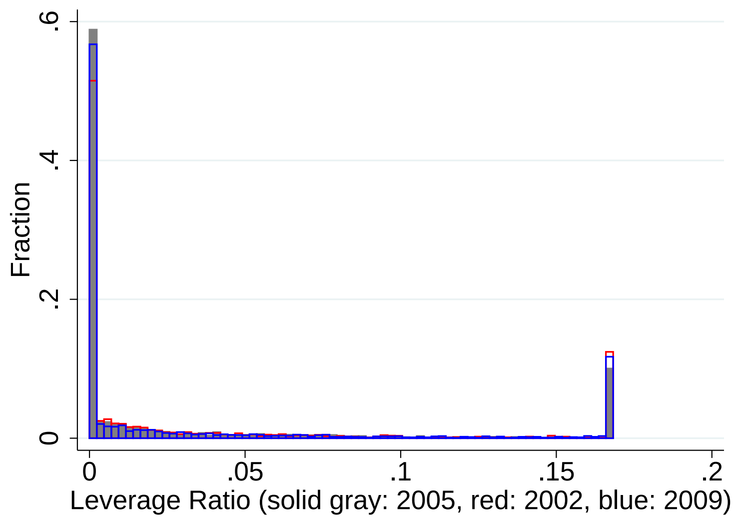
Additionally, Table A-3 shows descriptive evidence of the differentiated individual effects during a period of time outside of a Sudden Stop. Specifically, it shows the annualized median

Table A-2: Distribution of households (percent)

	2002	2005	2009
Financial savers	12.5	14.2	9.2
Unconstrained (leverage ratio $\in [0, 0.168)$)	75.2	75.8	79.1
Financially constrained (leverage ratio ≥ 0.168)	12.3	10.0	11.7

Source: MxFLS.

Figure A-1: Leverage Ratio Histogram



Note: The distribution is truncated at 0.168, which is the 90th percentile of the leverage ratio distribution in 2005. Source: MxFLS.

percent change in the real value of real estate (deflated with an aggregate house price index) owned by households from 2002 to 2005 relative to the average and sorted according to their net wealth and leverage ratio in 2005. Wealthy households correspond to the top decile of net wealth, and the financially constrained households correspond to the top decile of the leverage ratio. As shown in the table, the real estate held by wealthy households increases in large magnitudes for all leverage ratio deciles. Suggesting that prior to the crisis, the wealthy households were accumulating more assets and that the dynamics during the crisis are not necessarily driven by a mean reversion mechanism.

Table A-3: Median annualized percent change in real value of real estate by deciles, 2002–05

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	0.0	38.1
VIII	0.5	27.2
IX	0.0	35.5
X	-0.8	56.7

Source: MxFLS.

Appendix B. The 2009 Mexican Sudden Stop at the Aggregate Level

A Sudden Stop is a fast and large outflow of international capital. Hence, these types of episodes are characterized by large current account (CA) movements.[24] In this Appendix, we use aggregate data to show the Sudden Stop that the Mexican economy experienced in 2009.

In Figure A-2, we can see that the CA deficit reversed around 1.5 percentage points of GDP. Also, GDP and consumption declined, and there was a drop in consumer confidence and a decline in consumption credit, while firm and housing credit was not affected.

On the prices side, in Figure A-3, we see that there was a large decline in the stock market, house prices decelerated and remained constant for about four years after the crisis burst, the J.P. Morgan EMBI+ spread that measures the Mexican sovereign bond risk increased about 2 percentage points, and there was a large depreciation of the Mexican peso against the dollar.

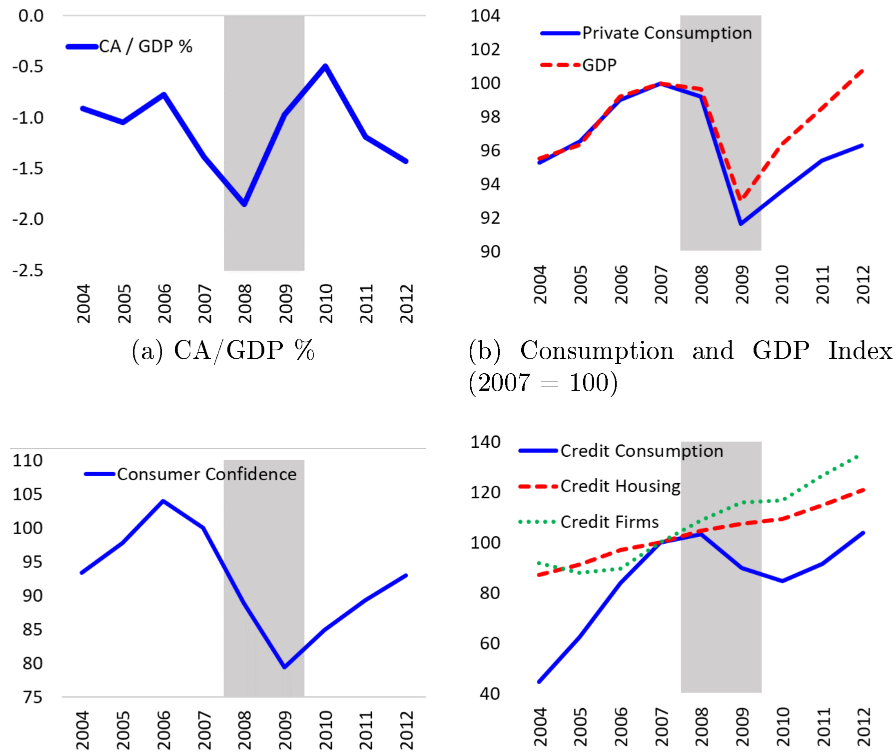
The aggregate dynamics shown in this Appendix are not particular to Mexico. See Bianchi and Mendoza (2020) for a recent survey of Sudden Stop episodes among both advanced and emerging economies.

Appendix C. Model Details

In this Appendix we first provide a micro-foundation for the collateral constraint and then define the recursive competitive equilibrium.

[24] Some Sudden Stop episodes have even registered CA reversals, meaning that the economy transitions from having a negative CA (foreign capital entering the economy) to having positive CA surpluses (capital leaving the economy).

Figure A-2: Quantities and Consumption Determinants



(a) CA/GDP %

(b) Consumption and GDP Index (2007 = 100)

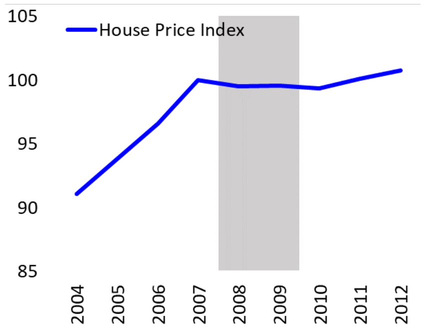
(c) Consumer Confidence Index (2007 = 100)

(d) Credit Index (2007 = 100)

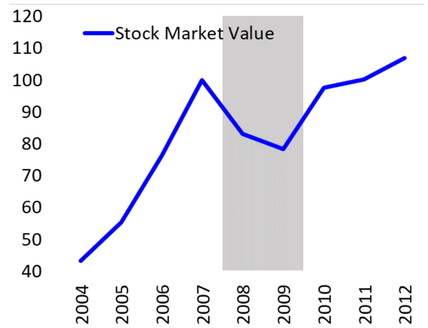
Note: The gray area corresponds to the crisis. Source: INEGI, World Bank, Banxico.

The micro-foundations of the collateral constraint are similar to the ones presented by Bianchi and Mendoza (2018) extended for an economy with non-insurable idiosyncratic risk. Specifically, the LtV constraint can be derived from an incentive compatibility constraint that arises due to a limited enforcement problem, in an economy where debt contracts are signed with competitive creditors, and households can switch to another creditor at any given point in time. At the beginning of the period, credit and asset markets open, production happens, and households choose b^i_{t+1} with price R_t^{-1} and a^i_{t+1} with price q_t. Then markets close, and households decide to divert resources from the credit and default. Local competitive financial intermediaries monitor costlessly who diverts resources and seize a fraction κ of the household asset holdings, which are $q_t a^i_{t+1}$. After defaulting, the household regains access to credit markets instantaneously and repurchases the assets that investors sell in open markets at a price q_t. In this environment, a household that borrows $-R_t^{-1} b^i_{t+1}$ and engages

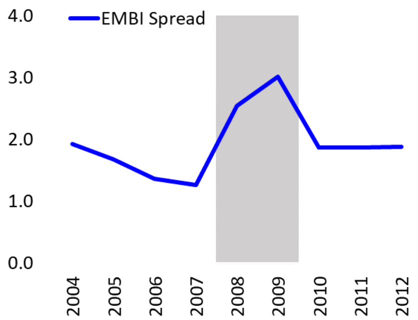
Figure A-3: Asset Prices



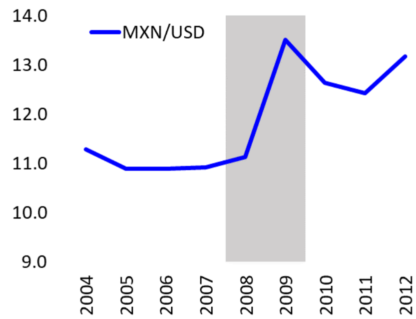
(a) House Price Index (2007 = 100)



(b) Stock Market Value Index (2007 = 100)



(c) J.P. Morgan EMBI Spread for Mexico in %



(d) Mexican Peso Exchange Rate for USD

Note: The gray area corresponds to the crisis. Source: Sociedad Hipotecaria Federal, Moody's Analytics, INEGI, World Bank.

in diversion activities gains $-R_t^{-1}b_{t+1}^i$ and loses $\kappa q_t a_{t+1}^i$. Hence, households repay if and only if $-R_t^{-1}b_{t+1}^i \leq \kappa q_t a_{t+1}^i$.

Now we are ready to define a recursive competitive equilibrium. Let the individual bond and asset holdings be elements $(b, a) \in [\underline{b}, \bar{b}] \times [0, \bar{a}] \equiv \mathcal{S}$, and let the individual productivities be elements $(\epsilon^w, \epsilon^d) \in \{\epsilon_1^w, ..., \epsilon_{N_w}^w\} \times \{\epsilon_1^d, ..., \epsilon_{N_d}^d\} \equiv \mathcal{E}^{Ind}$. In addition, let $\mathcal{M}$ be the set of probability measures of the set $\mathcal{S} \times \mathcal{E}^{Ind}$, and let the aggregate shocks be elements $(\epsilon^R, \epsilon^A) \in \{\epsilon_1^R, ..., \epsilon_{N_R}^R\} \times \{\epsilon_1^A, ..., \epsilon_{N_A}^A\} \equiv \mathcal{E}^{Agg}$. Finally, let the function $\pi(\epsilon'|\epsilon)$ be the exogenous Markov transition probability that the next-period shock takes the value ϵ' conditional on the shock in the current period being ϵ, where $\epsilon = (\epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A) \in \mathcal{E}^{Ind} \times \mathcal{E}^{Agg} = \mathcal{E}$.

Definition 1. *A recursive competitive equilibrium in this economy is given by a value function* $v : \mathcal{S} \times \mathcal{E} \times \mathcal{M} \to \mathbb{R}$*; policy functions for the household* $c : \mathcal{S} \times \mathcal{E} \times \mathcal{M} \to \mathbb{R}$, $b' : \mathcal{S} \times \mathcal{E} \times \mathcal{M} \to \mathbb{R}$, *and* $a' : \mathcal{S} \times \mathcal{E} \times \mathcal{M} \to \mathbb{R}$*; a domestic asset-pricing function*

$q : \mathcal{M} \times \mathcal{E}^{Agg} \to \mathbb{R}$; and an aggregate law of motion $H^{\Omega} : \mathcal{M} \times \mathcal{E}^{Agg} \to \mathcal{M}$ such that

1. *Given the asset-pricing function and the aggregate law of motion, the value function v satisfies the household's Bellman equation 4, and c, a', and b' are the associated policy functions.*
2. *For all $\Omega \in \mathcal{M}$ and all $(\epsilon^R, \epsilon^A) \in \mathcal{E}^{Agg}$, the asset market clears:*
$$\int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} a \,\mathrm{d}\Omega = \int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} a'(b, a, \epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A, \Omega) \,\mathrm{d}\Omega = \bar{K}.$$
3. *For all $\Omega \in \mathcal{M}$ and $(\epsilon^R, \epsilon^A) \in \mathcal{E}^{Agg}$, the aggregate resource constraint is satisfied:*
$$\int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} c(b, a, \epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A, \Omega) \,\mathrm{d}\Omega + (\epsilon^R \bar{R})^{-1} \int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} b'(b, a, \epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A, \Omega) \,\mathrm{d}\Omega$$
$$+ q(\Omega, \epsilon^R, \epsilon^A) \int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} \Phi(a'(b, a, \epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A, \Omega), a) \,\mathrm{d}\Omega$$
$$= \epsilon^A \bar{A} \bar{w} + \int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} a \epsilon^A \bar{A} \bar{\epsilon}^d \bar{d} \,\mathrm{d}\Omega + \int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} b \,\mathrm{d}\Omega.$$
4. *The aggregate law of motion is generated by the exogenous Markov process π and the policy functions b' and a' as described below:*
Let $(\epsilon^w, \epsilon^d) = \epsilon^{Ind}$ and $(\epsilon^R, \epsilon^A) = \epsilon^{Agg}$ and define the transition function $Q_{\Omega,\epsilon^{Agg}} : \mathcal{S} \times \mathcal{E}^{Ind} \times \mathcal{B}(\mathcal{S}) \times \mathcal{B}(\mathcal{E}^{Ind}) \to [0, 1]$, where $\mathcal{B}(\cdot)$ is the corresponding Borel set, by
$$Q_{\Omega,\epsilon^{Agg}}(b, a, \epsilon^{Ind}, \mathscr{S}, \mathscr{E}^{Ind}) = \begin{cases} \sum\limits_{\epsilon^{Ind\prime} \in \mathscr{E}^{Ind}, \epsilon^{Agg\prime} \in \mathcal{E}^{Agg}} \pi(\epsilon^{Ind\prime}, \epsilon^{Agg\prime} | \epsilon^{Ind}, \epsilon^{Agg}), & \text{if } (b'(\cdot), a'(\cdot)) \in \mathscr{S}. \\ 0, & \text{otherwise.} \end{cases}$$
Then, for any $\mathscr{S} \in \mathcal{B}(\mathcal{S})$ and any $\mathscr{E}^{Ind} \in \mathcal{B}(\mathcal{E}^{Ind})$ the aggregate law of motion is given by
$$\Omega'(\mathscr{S}, \mathscr{E}^{Ind}) = (H^{\Omega}(\Omega, \epsilon^{Agg}))(\mathscr{S}, \mathscr{E}^{Ind}) = \int\limits_{\mathcal{S}\times\mathcal{E}^{Ind}} Q_{\Omega,\epsilon^{Agg}}(b, a, \epsilon^{Ind}, \mathscr{S}, \mathscr{E}^{Ind}) \,\mathrm{d}\Omega.$$

Appendix D. Solution Algorithm

In this Appendix, we describe the solution method. Building from Krusell and Smith (1997) we adapt their *nontrivial* market clearing algorithm to a small open economy framework. In particular, instead of solving problem 4, we solve

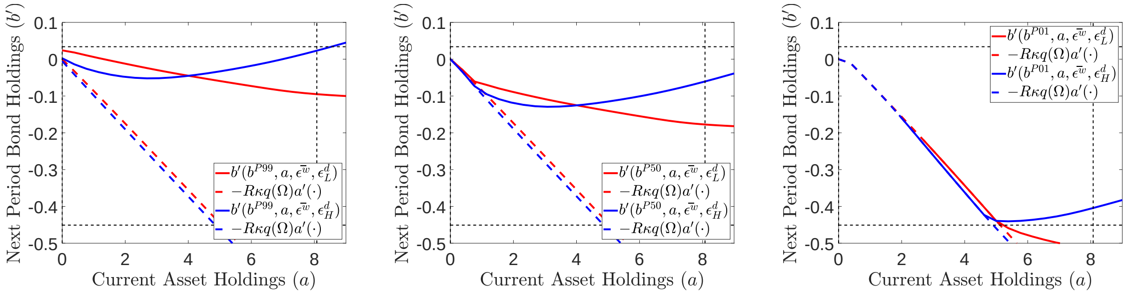
$$
\begin{aligned}
\tilde{v}(b, a, \epsilon^w, \epsilon^d, \epsilon^R, \epsilon^A, B, q) = & \max_{\{c, b', a' \geq 0\}} \quad u(c) + \beta \mathbb{E}[v(b', a', \epsilon^{w'}, \epsilon^{d'}, , \epsilon^{R'}, \epsilon^{A'}.B')] \quad s.t. \\
c + (\epsilon^R \bar{R})^{-1} b' + q(a' + \Phi(a', a)) = & \, \epsilon^A \bar{A} \epsilon^w \bar{w} + a(q + \epsilon^A \bar{A} \epsilon^d \bar{d}) + b, \\
(\epsilon^R \bar{R})^{-1} b' \geq & - \kappa q a', \\
\Phi(a', a) = & \, \frac{\phi}{2}(a' - a)^2, \\
B' = & \, \gamma_B^0 + \gamma_B^1 B + \gamma_B^2 D_R, \\
q = & \, \gamma_q^0 + \gamma_q^1 B + \gamma_q^2 D_R + \gamma_q^3 q_{-1}, \qquad \text{(A.1)}
\end{aligned}
$$

where we replaced the full household distribution Ω with the aggregate bond position $B = \int b \, \mathrm{d}\Omega$ and market clearing in the asset holdings is achieved using a fixed-point iteration on q such that $\bar{K} = \int a'(\cdot) \, \mathrm{d}\Omega$. Then the solution algorithm follows the simulation method described in Krusell and Smith (1997).

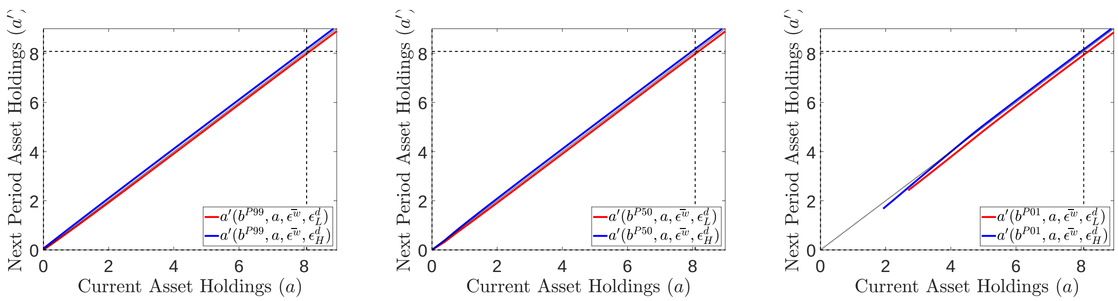
Appendix E. Model Nonlinearities

To better understand the mechanism and the *risk-wealth tradeoff*, Figures A-4 through A-7 show the policy functions and the nonlinearities generated in the stationary model. In the upper row of Figure A-4, the solid lines correspond to the bond policy for the high- (low-) dividend shock in blue (red) and the average labor income shock as a function of the current asset holdings for three different values of the current bond holding $b^{\#}$. Additionally, the dashed lines represent the corresponding debt limits, and the black dashed lines correspond to the bottom 1 and top 99 percentiles of bond and asset holdings obtained from the model's simulated cross-section. The figure shows that for low-dividend shocks (red lines), a household lowers its bond holdings (or gets more debt) as it increases its asset holdings. This effect is stronger for constrained households, as shown in panels (b) and (c). As described in Section 5.1, the *risk-wealth tradeoff* generates the convex form of the bond policy for high-dividend shocks (blue lines). For asset-poor households, as they increase their assets, they also lower their bond holdings (or get more debt if the holdings are negative), and there is a certain level for which the dividend risk exposure overcomes the benefit from more debt capacity that makes households increase their bond holdings. Regarding the bottom row of the figure, we can see the asset policy function that is highly linear and behaves as expected: for high-dividend shocks, households accumulate more assets, and for low-dividend shocks, households decumulate assets.

Figure A-4: Stationary Bond and Asset Policies as a Function of Current Asset Holdings



(a) p99 Current Bond Holding (b) p50 Current Bond Holding (c) p01 Current Bond Holding

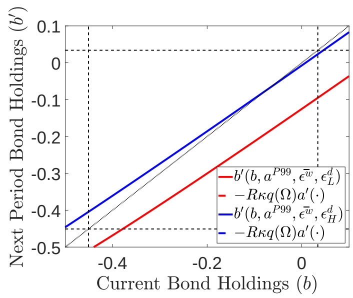


(d) p99 Current Bond Holding (e) p50 Current Bond Holding (f) p01 Current Bond Holding

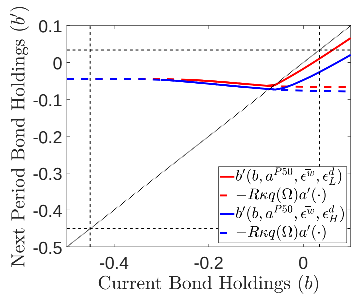
Note: For a current bond holding $b^{\#}$ and mean labor shock $\epsilon^{\bar{w}}$, the upper (lower) row corresponds to the bond (asset) policies, the solid blue (red) line corresponds to the policy function with the high- (low-) dividend shock, and the dashed blue (red) line corresponds to the debt limit with the high- (low-) dividend shock. Dashed black lines correspond to the bottom 1% and top 99% of bond and asset holdings obtained from the model's simulated cross-section. Dotted black lines correspond to the 45-degree line. The missing values across the state space correspond to the infeasible individual states that would imply a negative consumption.

Moreover, in Figure A-5, we show similar bond and asset policies but now as a function of the current bond holdings. In the upper row, we can see the standard bond policies under a binding debt limit. Panel (a) shows the policy for a high-asset holder. Here we can see that the debt limit is not binding for the states within the 1st and 99th percentiles. However, as we move to lower asset holdings, in panels (b) and (c), we can see that the LtV becomes binding when households accumulate enough debt. With respect to the cross-sectional fire-sales in the model, in the bottom row of the figure, we can see that households accumulate less assets as they increase their debt holdings. However, this relation is highly strengthened (households incur fire-sales) when the debt limit becomes binding, which can be seen using panels (b) and (e) and also panels (c) and (f). There are strong declines in asset holdings (panels (e) and (f)) in the states where bond holdings reach the debt limit (panels (b) and (c)).

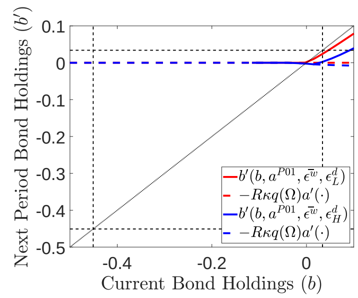
Figure A-5: Stationary Bond and Asset Policies as a Function of Current Bond Holdings



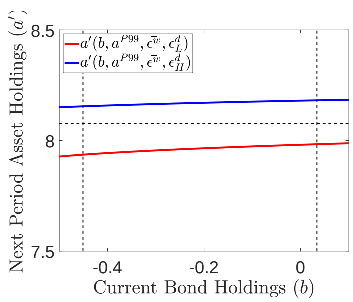
(a) p99 Current Asset Holding



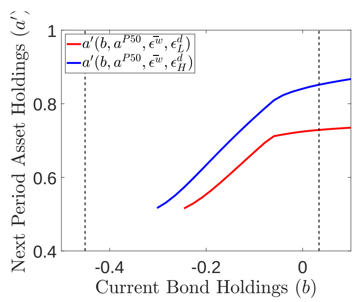
(b) p50 Current Asset Holding



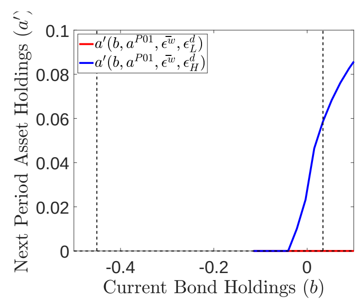
(c) p01 Current Asset Holding



(d) p99 Current Asset Holding



(e) p50 Current Asset Holding

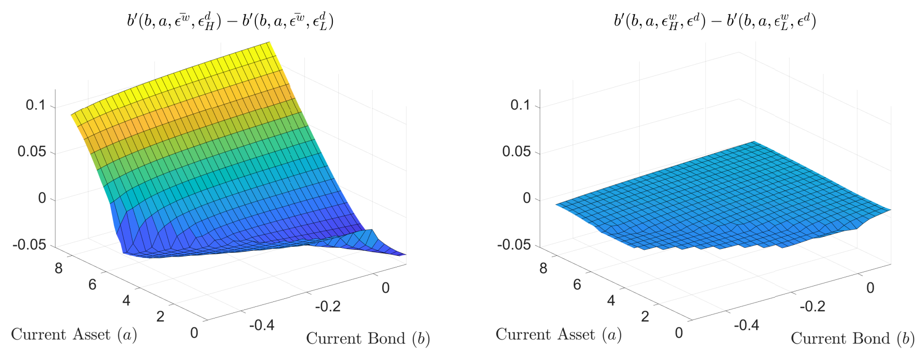


(f) p01 Current Asset Holding

Note: For a current bond holding $b^{\#}$ and mean labor shock $\epsilon^{\overline{w}}$, the upper (lower) row corresponds to the bond (asset) policies, the solid blue (red) line corresponds to the policy function with the high- (low-) dividend shock, and the dashed blue (red) line corresponds to the debt limit with the high- (low-) dividend shock. Dashed black lines correspond to the bottom 1% and top 99% of bond and asset holdings obtained from the model's simulated cross-section. Dotted black lines correspond to the 45-degree line. The missing values across the state space correspond to the infeasible individual states that would imply a negative consumption.

Additionally, in Figure A-6, we show the difference in the bond policy function for a high- and a low-dividend shock in panel (a) and a labor income shock in panel (b). We can see a positive and increasing difference in the next-period bond holdings between the high- and low-dividend productivities as we move to higher current asset holdings (Figure A-6(a)). This result means that when the idiosyncratic dividend realization is high, the household optimally chooses larger bond holdings for the next period. Moreover, this difference is kept almost constant (only increases close to the debt limit) across the current bond holdings. In contrast, in Figure A-6(b), we can see that the difference in the bond policy function between the high and low idiosyncratic labor productivity realization is positive but close to zero and constant throughout all the feasible state-space.

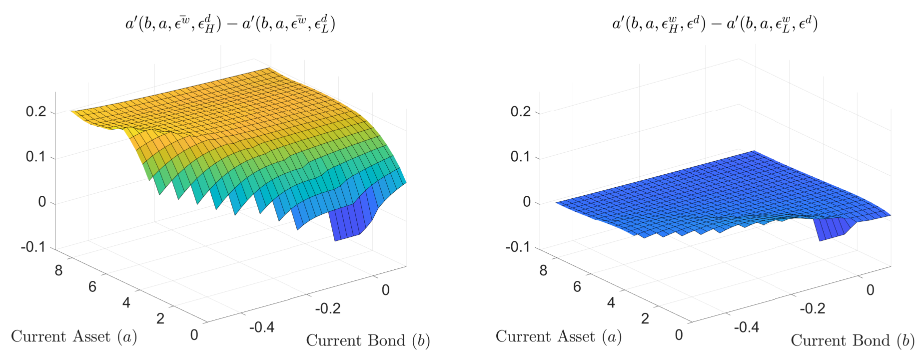
Figure A-6: Effect of Non-insurable Individual Shocks in the Bond Policy



(a) Difference in Dividend Shock (b) Difference in Labor Shock

Note: $\epsilon^{\overline{w}}$ and $\epsilon^{\bar{d}}$ correspond to the mean shock values. The missing values across the state space correspond to the infeasible individual states that would imply a negative consumption.

Figure A-7: Effect of Non-insurable Individual Shocks in the Asset Policy



(a) Difference in Dividend Shock (b) Difference in Labor Shock

Note: $\epsilon^{\overline{w}}$ and $\epsilon^{\bar{d}}$ correspond to the mean shock values. The missing values across the state space correspond to the infeasible individual states that would imply a negative consumption.

Similarly, in Figure A-7, we show the difference in the asset policy function for a high- and a low-dividend shock in panel (a) and a labor income shock in panel (b). We can see a positive and increasing difference in the next-period asset holdings between the high- and low-dividend productivities as we move to higher current asset holdings (Figure A-7(a)). However, for high enough asset values, this positive difference becomes relatively constant. Moreover, this difference is kept almost constant (only increases close to the debt limit) across the current bond holdings. Finally, similarly to the bond policy function, in Figure

A-7(b), we can see that the next-period asset holdings difference between the high and low idiosyncratic labor productivity realization is positive but close to zero and constant throughout all the feasible state-space.

Appendix F. Aggregate Risk Model: Event Studies

In Figure A-8 , we show the event study analysis for the same history of individual and aggregate shocks for the five calibrations: (1) the baseline emerging economy (in solid lines), (2) the advanced economy with the same calibration but with zero variance in the dividend risk (in dotted lines), (3) the benchmark economy with a redistributive dividend tax (in solid lines with cross marker), (4) the representative agent economy with a lower LtV limit such that the average leverage ratio is the same as in the baseline model (in dash-dotted lines), and (5) the representative agent economy with a dividend tax (in solid lines with circle marker).

Additionally, we compute the asset holding dynamics for the economy without dividend risk in Table A-4 and for the economy with a redistributive dividend tax in Table A-5. In the former, we can see that without the *risk-wealth tradeoff*, while the decumulation of assets during a Sudden Stop still happens for the wealthy leveraged households, this effect becomes highly muted. For the latter, the fire-selling of assets is still strong with a dividend tax but the aggregate effects are less severe, due to the general equilibrium effects and redistribution described in Section 6.2.5.

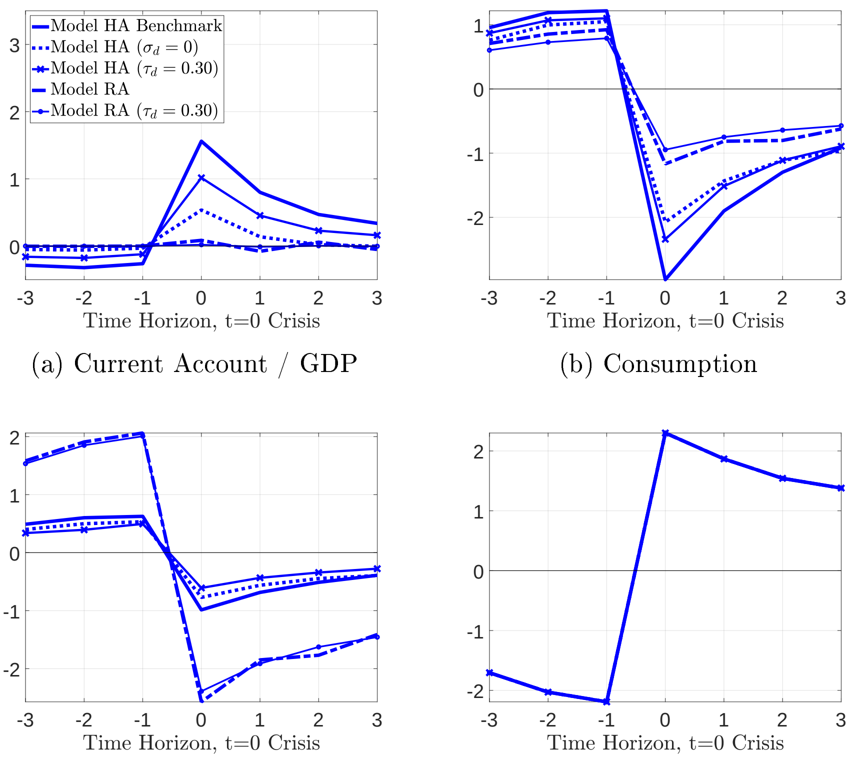
Table A-4: Median asset holdings percent change in a crisis in economy with zero dividend risk

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	1.5	1.1
VIII	-2.4	1.2
IX	-0.9	-2.3
X	-1.0	-2.1

Appendix G. Aggregate Risk Model: Impulse Responses

Lastly, in this Appendix we present two additional exercises that illustrate how to generate a more pronounced response in asset prices. The first introduces a permanent shock,

Figure A-8: Event Study of a Sudden Stop



(a) Current Account / GDP

(b) Consumption

(c) Asset Price

(d) Interest Rate Shock

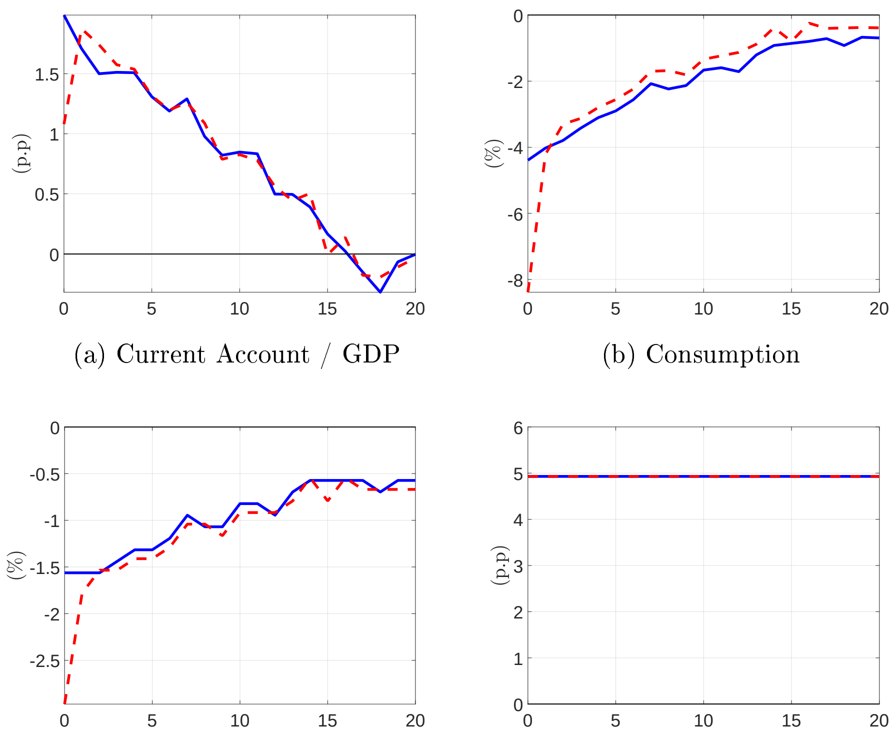
Note: Panels (a) and (d) correspond to the level difference from the long-run mean in percent. Panels (b) and (c) correspond to percentage point deviations from the long-run average.

while the second combines a permanent shock with an ad-hoc tightening of the LtV limit and an exogenous increase in asset supply, motivated by foreign investors selling off their asset holdings. In the latter case, the LtV limit (κ) is reduced by 2 percent to 0.1646 and the fix supply of the asset is increased by 2 percent to 1.02. In the blue solid lines of Figure A-9 we can see that introducing only a permanent shock increases the persistence of the shock and has permanent effect on consumption and the asset price of around 0.5 percent. Furthermore, the introduction of a permanent ad-hoc LtV limit tightening together with an increase in the asset supply (red dashed lines), double the size of the effect on impact on consumption and asset prices, while the long run effects are similar. However, an increase in the supply of the asset has a counterfactual effect on the current account since now more assets are available to domestic households and this increases their debt limits. For this reason we also introduced the ad-hoc LtV limit tightening to induce a current account reversal.

Table A-5: Median asset holdings percent change in a crisis in economy with dividend tax

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	-0.6	6.4
VIII	1.7	6.0
IX	1.1	2.2
X	1.3	-14.0

Figure A-9: Impulse responses to a permanent aggregate shock



(a) Current Account / GDP (b) Consumption

(c) Asset Price (d) Interest Rate Shock

Note: Impulse response functions after a permanent interest rate (and simultaneous TFP) shock of two standard deviations. The responses are obtained by conditioning the economy to start at the stationary ergodic distribution and at the long-run mean interest rate. The blue solid line corresponds to the permanent shock, while the red dashed line combines a permanent shock with an ad-hoc tightening of the LtV limit and an increase in asset supply.

Lastly, Tables A-6 and A-7 show the asset holding dynamics on impact following the permanent negative shocks. The introduction of an ad-hoc tightening of the LtV constraint combined with an increase in asset supply (Table A-7), amplifies asset accumulation among wealthy, low-leverage households—consistent with the empirical evidence. However, in the main paper, we follow the debt-deflation literature and assume that domestic assets remain closed to foreign ownership.

Table A-6: Median asset holdings percent change on impact after a permanent shock

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	-1.6	5.8
VIII	5.8	4.1
IX	3.0	-10.4
X	2.4	-14.5

Table A-7: Median asset holdings percent change on impact after a permanent shock with ad-hoc tightening of LtV and increase in asset supply

	Net Wealth	
Leverage Ratio	I–IX: Non-Wealthy	X: Wealthy
I–VII	-0.6	10.0
VIII	8.0	6.7
IX	8.1	6.2
X	4.6	-12.9