

Hidden Debt

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The share of non-Paris Club lending in international capital markets has risen in recent decades, most notably in the financing of emerging and developing economies. Unlike typical international financial instruments, the amount and conditions of this financing are not disclosed in detail, which has recently sparked a heated debate about the role of transparency in the debt and default dynamics of sovereign borrowing.

This paper studies a quantitative sovereign debt/default model that is augmented with asymmetric information setup between lenders and borrowers. The borrower has access to two debt instruments: a standard sovereign bond, whose level is publicly visible, and a collateralized debt instrument, which is not disclosed to the lenders. This information asymmetry in the model aims to capture the lack of detailed reporting, a major concern for debt sustainability in low income countries as stated in IMF and WB (2020).

To shed light on the effects of asymmetric information on the equilibrium debt and default dynamics, we solve two versions of the model: a full information economy in which both debt instruments are assumed to be reported transparently, therefore observed by lenders, and an asymmetric information economy in which the collateral debt is not disclosed to counterpart.

I. The Model

The model is an extension of quantitative sovereign default models presented in Eaton and Gersovitz (1981) and Arellano (2008).

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We assume a small open economy model inhabited by a continuum of infinitely lived, identical households, risk-neutral international lenders, and a sovereign government. The sovereign is assumed to maximize the life-time expected utility of households. The domestic economy's output (y) is subject to endowment shocks under incomplete markets.

The sovereign has options to issue one-period defaultable non-state contingent asset in international bond markets (b) and to borrow from a non-defaultable collateralized short-term debt market (b^c).¹ Equilibrium price of the defaultable bond is determined under a competitive international capital market with a large number of lenders taking the default risk into account. The investors discount future at the risk free rate, r , are assumed to be risk neutral, and constrained by a zero-expected-profit condition. Non-defaultable debt's price, on the other hand, is assumed to be constant.

In each period, after observing the income shock, the sovereign decides whether to repay its debt or default on it. Conditional on repaying debt, consumption is defined as $c_t = y_t + q_t b_{t+1} - b_t + q_c b_{t+1}^c - b_t^c$. The terms q^c and q_t denote the asset prices of collateralized and non-contingent debt, respectively.

The sovereign loses access to both foreign capital markets for a stochastic number of periods if it chooses to default on its debt (b). In autarky, households can consume only the domestic endowment (y) and has to honor its obligations for collateralized debt, and it is subject to a default cost represented by $\phi(y_t)$, resulting in $c_t = y_t - \phi(y_t) - b_c$.

We solve two versions of this model, Full Information (FI) and Asymmetric Informa-

¹See Guler et al. (2022) for a quantitative sovereign debt model featuring both asymmetric information and long-term debt.

tion (AI) economies. The main difference between the two is what lenders know about the sovereign's state variables at the time of lending. In the FI economy, we assume lenders observe the debt portfolio and the current output of the sovereign, which is the relevant full information to price the bonds under Markov Perfect Equilibrium. However, in the AI Economy, we assume that lenders cannot observe the level of collateralized debt whereas they can still observe the level of defaultable debt and output. This informational asymmetry distorts the pricing of the bonds.²

In the FI economy, the defaultable bond price is given by:

$$(1) \quad q^{FI}(b', b^c, y) = \frac{E_{y'|y}[1 - d'(b', b^c, y')]}{1 + r}$$

where d is the default decision and E is the expectation operator over the stochastic income.

In the AI economy, we assume that lenders pool sovereigns with different levels of collateralized debt into one contract, conditional on their observables b and y . We use Wilson (1980) equilibrium concept, which assumes lenders can withdraw their contracts upon observing other lenders offering contracts which cream-skim safer borrowers. The only contract that survives in this equilibrium is the one offered to the sovereign with the lowest risk of default. This corresponds to the sovereign with the lowest collateral debt ($b^c = 0$) in our AI economy.

Under these assumptions, the equilibrium price in the AI economy equals the following:

$$(2) \quad q^{AI}(\theta) = \frac{\int q^{FI}(b', b^c(b, b^c, y), y) f^\mu(b^c|\theta) db^c}{1 + r},$$

where $\theta \equiv (b', b, y)$ and f^μ is the lender's belief of the conditional collateral debt distribution of sovereign. Equilibrium beliefs

are defined as

$$f^\mu(\theta) = \begin{cases} f^*(b^c|b, y) & \text{if } b' = b'(\tilde{\theta}) \\ 0 & \text{if } b' \neq b'(\tilde{\theta}) \& b^c < \bar{b}^c \\ 1 & \text{o.w.} \end{cases}$$

where $\tilde{\theta} \equiv (b, b^c = 0, y)$ and f^* is the equilibrium conditional distribution of collateral debt in the economy and \bar{b}^c is the maximum hidden debt level.

II. Results

In this section, we present simulation results of our model economies. In doing so, we discuss the implications of information asymmetry (between lenders and government) for public debt, borrowing costs, default rates, and business cycle properties.

The moments of the model are calibrated to match the business cycle and debt statistics of Bolivia, a lower-middle income country with significant amounts of both Paris club and non-Paris club borrowing according to Horn et al. (2021). A period is set to one year, and the constant relative risk aversion is set to 2, in line with the quantitative business cycle and sovereign default studies (e.g. García-Cicco et al., 2010).

Parameters of the income process are estimated using annual real GDP data of Bolivia, covering the period between 2000 and 2020. Autocorrelation coefficient of AR(1) income process is estimated 0.85, and the standard deviation of the i.i.d shocks to income is estimated 0.024. The stochastic exclusion parameter upon default is set to 0.5 to match the number of years of exclusion from international capital markets upon default. Following Chatterjee and Eyigungor (2012), the income cost of defaulting is assumed to be $\phi(y) = \max\{0, d_0 y + d_1 y^2\}$. The parameters d_0 and d_1 , the discount factor β and the price of hidden debt q_c are calibrated jointly to match the mean debt service to GDP ratio, mean hidden debt service to GDP ratio, default rate and mean EMBI spread over the sample period.

A. Key statistics: model vs data

As presented in Table 1, the benchmark model returns a non-state contingent debt

²Our FI economy is similar to the set-up in Hatchondo et al., 2017 except that non-defaultable debt cannot be rolled over in our setting.

service to GDP ratio slightly above 8 percent which is roughly equal to the debt service to GDP ratio in Bolivia. Hidden debt service to GDP ratio converges to 2.24 percent of GDP, matching roughly the share of hidden debt service in total external debt service (close to 20 percent as of 2016), approximated by Horn et al. (2021). The sovereign spread averages 180 basis points in the baseline economy which falls short of matching 257 basis points in the data.

B. Transition from AI to FI economy

In this section, we discuss the macroeconomic dynamics following the government's debt transparency policy change, i.e. moving from the AI economy to the FI economy.³ Figure 2 illustrates the evolution of key economic variables during the simulated transitions under these alternative scenarios.

When the economy moves from the AI regime to the FI regime, as shown in Figure 1, the price of the non-contingent debt increases. This encourages the government to increase its holding of the non-contingent debt. As shown in the the upper left chart of the Figure 2 the non-contingent debt gradually starts increasing and reaches a level around 20% higher than the AI economy. Even though in the FI economy the government initially reduces its reliance on collateralized debt (hidden debt), in about 6 years, both debt levels converge to the same level of collateral debt as in the AI economy. The overall increase in the debt increases default likelihood of the government, and in equilibrium, the defaults increase by almost 40% as the economy transitions from the AI regime to the FI regime. This fact is also reflected in the overall

³The benchmark economy (AI) is initiated from 100,000 observations at period 21 after it attained its long-run averages for debt levels (collateralized and non-state contingent). Given the distribution of income shock along with the distribution of debt levels (collateralized and non-state contingent), borrowing and default decisions determine the evolution of key variables in period 1 and onward. Each simulation path is conducted twice, one with the assumption of remaining in the AI economy, and another one under the assumption that the government switches to the FI economy.

spreads, which increase almost by 63 basis points.

Switching to the FI economy also generates non-trivial consumption dynamics. The government initially front-loads consumption by issuing more non-contingent debt. So, in the early years of the transition, consumption increases thanks to the better prices of the non-contingent debt. However, over time this results in higher defaults and the government's consumption levels become lower relative to the AI economy. Overall, although the government benefits from an increase in consumption of about 0.6% in early periods, consumption drops slightly below its AI level in the long-run.

C. Welfare implications

We measure consumption-equivalent welfare gains denoted by η as

$$(3) \quad E_0 \sum_{t=0}^{\infty} \beta^t u(\tilde{c}_t[1 + \eta]) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_t),$$

in which the consumption streams $\{\tilde{c}_t\}_{t=0}^{\infty}$ and $\{c_t\}_{t=0}^{\infty}$ are attained in the AI and FI economies, respectively. Welfare gain measure η is evaluated at the triplet of initial non-contingent debt, hidden debt and endowment, and is derived from equilibrium value functions with

$$(4) \quad \eta(b^c, b, y) = \left(\frac{V^{FI}(b^c, b, y)}{V^{AI}(b^c, b, y)} \right)^{\frac{1}{1-\gamma}} - 1,$$

utilizing the CRRA form for household preferences. $V^{FI}(b^c, b, y)$ and $V^{AI}(b^c, b, y)$ are value functions evaluated for triplets of hidden debt b^c non-contingent debt b and output in the AI and FI economies, respectively. Positive values for η imply that the benevolent government would prefer to make its hidden debt information public. The bottom right chart in Figure 2 displays the evolution of the welfare. As reflected in the evolution of the consumption, the government initially enjoys welfare gains after switching to the FI economy because of consumption front-loading. However, with increased default frequency, the government

Table 1—: Long-run properties of the benchmark model and data

	Data	Benchmark (AI)	FI
Targeted moments			
Non-contingent debt service/GDP, percent	8.94	8.17	9.94
Hidden debt service/GDP, percent	2.43	2.24	2.24
Interest rate, $E(R_s)$, percent	2.57	1.8	2.43
Default rate, percent	5	3.27	4.6
Non-targeted moments			
$\sigma(c) / \sigma(y)$	1.22	1.41	1.45
$\rho(c, y)$	0.81	0.92	0.92

Notes: AI and FI stand for Asymmetric Information and Full Information, respectively. For calibration, we set $d_0 = -1.2$ and $d_1 = 1.255$, the discount factor $\beta = 0.88$ and the price of hidden debt $q_c = 0.92$.

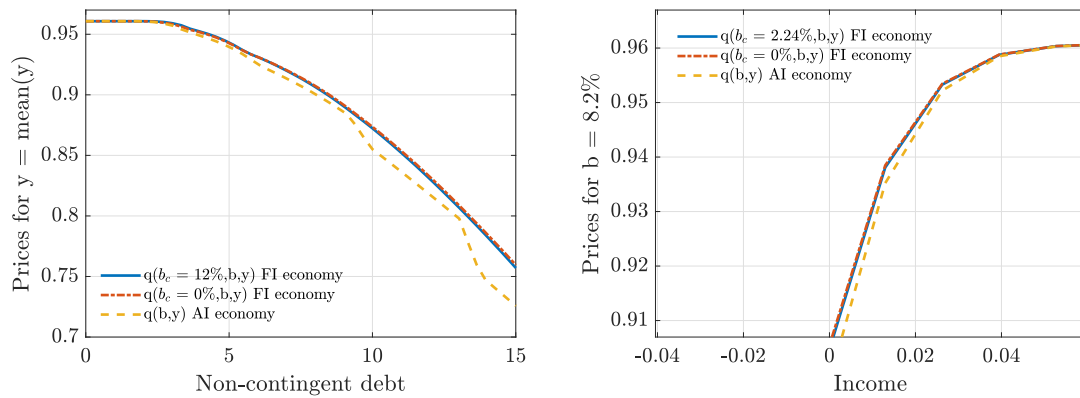


Figure 1. : Price of Non-contingent Debt.

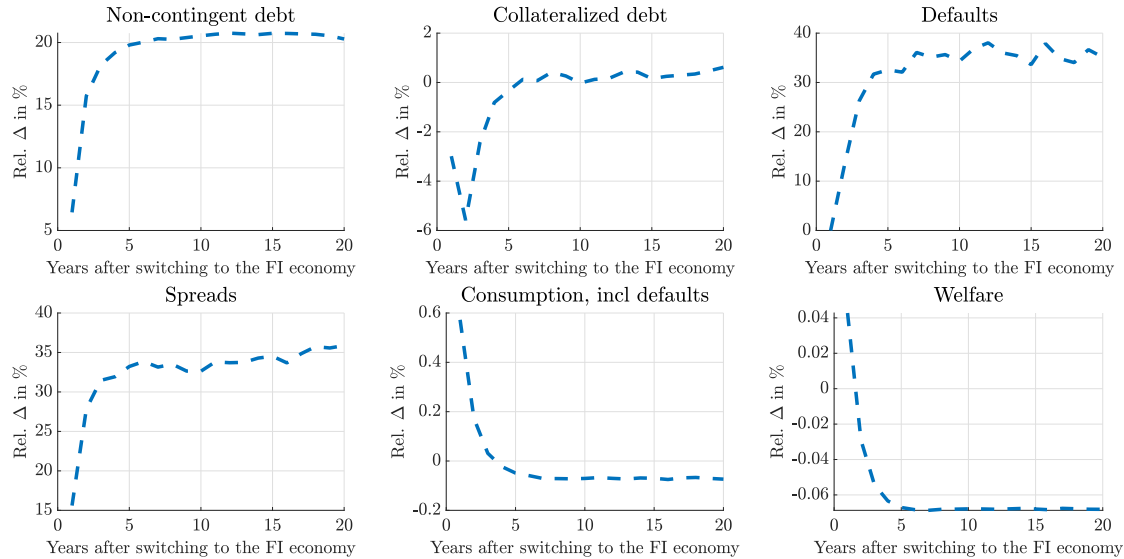


Figure 2. : Transitions from the AI economy to the FI economy.

ends up having a lower welfare relative to the AI economy.

III. Conclusion

We provide a quantitative default model of hidden debt. Lenders know how much non-contingent debt the government has and form beliefs about the government's hidden debt holdings which are collateralized. We show that, with one-period debt, the AI economy holds lower non-contingent debt in its debt balances relative to the FI economy while holding similar collateralized debt. While increased indebtedness front-loads consumption, it raises default frequencies.

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