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Excess Asset Returns with Limited Enforcement *

Costas Azariadis, UCLA†
and
Luisa Lambertini, UCLA‡

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Abstract

This paper investigates the effect of limited enforcement of contracts on asset returns in a three-period pure-exchange overlapping generations economy. We consider a life-cycle setting with a safe and a risky asset and find that lack of commitment can significantly affect the rate of returns of these assets and possibly generate large equity premia.

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†Costas Azariadis, Department of Economics, University of California, Los Angeles, CA 90095–1477, USA. E-mail: azariadi@ucla.edu

‡Luisa Lambertini, Department of Economics, University of California, Los Angeles, CA 90095–1477, USA. E-mail: luisa@econ.ucla.edu

1 Introduction

In economies with infinitely-lived consumers and uncertainty, endogenous debt constraints describe how markets respond when sellers of future claims are unable to commit to loan or insurance contracts they can afford. Recent research has found much use for this concept in investigating the fundamental theorems of welfare economics (Kehoe and Levine [10]), anomalies in asset returns (Alvarez and Jermann [1]), and international risk sharing (Kehoe and Perri [9]). This paper examines the question of whether endogenous debt constraints in a model with finite lives are consistent with the anomalies – namely a large equity premium – in asset returns observed in the data.

We investigate a pure-exchange deterministic economy with perfect information, one perishable consumption good and one risky asset (a tree) that delivers i.i.d. dividend. This economy is inhabited by overlapping generations of homogeneous households who live for three periods. There is no fiat money or storage technology; however, individuals can buy or sell contingent claims on future consumption and they can buy or sell the risky asset. Individuals also have private endowments; with hump-shaped endowment profiles, young agents want to borrow and middle-aged ones want to lend.

A crucial feature of our setting is that individuals cannot commit to their contracts. Following default, the harmed creditor can garnish the debtor's assets but cannot seize her private endowments. Under perfect information, creditors know how much debtors will voluntarily repay and will not enter a contract implies a repayment in excess of that. Therefore, equilibrium allocations will be constrained to remove all incentives to default.

In this economy, agents may face binding debt constraints that tie consumption to income. If the endowment profile is rising, young agents may be constrained and consumption is tied to income early in life.

More importantly, binding constraints on young agents limit their ability to borrow with the safe asset and therefore reduce their investment in the risky asset. As a result, middle-age individuals are forced to invest more heavily in the risky asset, which will deliver a stochastic dividend in the following period when the investors are old. In an environment without commitment, old individuals have no incentive to repay their contracts and cannot therefore insure against the dividend risk.

This economy can potentially generate a large equity premium. Middle-age individuals must hold a larger-than-desired fraction of the risky asset and cannot insure the dividend risk away. The equity premium arises because they must be remunerated for taking such risk.

The key feature of our work is that households are finitely lived. This feature has two important implications. First, it greatly reduces the space of contracts that old individual can engage in, as old individuals cannot be punished by future exclusion from trading. Second, credit market exclusion is *temporary*.

Azariadis and Lambertini [5] study borrowing and lending in a three period overlapping generation model without commitment and without uncertainty. They find that the consumption pattern of credit-rationed traders is very sensitive to market yields prevailing during the time of exclusion from market activity. This particular feature generates multiple equilibria, complex dynamics and recursive indeterminacy. This work extends the analysis of Azariadis and Lambertini [5] to a setting with a risky asset.

The two features above distinguishe our work from related research in environments with infinitely lived agents and limited contract enforceability. In Kehoe and Levine [10], [11] and Alvarez and Jermann [1], the punishment for default lasts forever so that changes in any single future market yield are unlikely to change borrowing limits significantly. On the other hand, in Bewley [6] and Bulow and Rogoff [7], default does not preclude future lending; hence, there is no punishment for default and, in either case, borrowing is zero in equilibrium.

The rest of the paper is organized as follows. Section 2 lays out the economic environment. Equilibria with commitment are reviewed in section 3. Section 4 describes a lifecycle economy without commitment. Section 5 presents a simple numerical simulation; Section 6 connects our findings with related literature and Section 7 concludes.

2 The economic environment

We study a closed, pure-exchange economy of overlapping cohorts with a typical lifecycle $L = 3$ periods. For simplicity, we abstract from production, population growth and finite lifecycles of length $L > 3$. Time is indexed by $t = 1, 2, \ldots$ and cohorts by $v = -1, 0, 1, \ldots$. Members of cohort v are identical, and are double-indexed by a cohort superscript and a calendar-time subscript. There are $N_v = (1+n)^v$ individuals in cohort $v \geq 1$, with $n > -1$. Cohorts $v = -1, 0$ are transitional with lifecycles of 1 and 2 periods respectively. All subsequent cohorts $v \geq 1$ live three periods: youth at $t = v$, middle age at $t = v + 1$, old age at $t = v + 2$.

Individuals have deterministic endowments; moreover, there is one non-depreciating tree with stochastic dividend. Agents can trade contingent claims on next period consumption and they can buy, sell and go short in the tree. Endowments and preferences are common knowledge. In particular, for a generation-t household the endowment profile is

$$y^t = \begin{cases} (0, 1, n) & \text{if in the market} \\ (0, 1, m) & \text{if autarkic} \end{cases} \tag{1}$$

with $0 \leq n < m < 1$. In words, individuals have no endowment in youth and high endowment in middle-age. Hence, they must borrow when young and lend when middle-aged to keep a flat consumption profile. For simplicity, we also assume that the endowment in the last period of life is higher after default, as an autarkic agent engages in home-production activity. This assumption will be important when we study the economy without commitment, as home-production will give agents a stronger incentive to default on their loans.

As for the assets, the non-depreciating tree has i.i.d. dividend

$$d_t = \begin{cases} d_h > 0 & \text{with probability } \alpha_h = \alpha \in (0,1) \\ 0 \leq d_l < d_h & \text{with probability } \alpha_l = 1 - \alpha \end{cases} \tag{2}$$

The tree has price π, which is independent of the state.

In addition to the tree, individuals can trade contingent claims on next period consumption at prices

$$(p_h, p_l)$$

The rate of return on the safe and risky assets are, respectively,

$$R_f = \frac{1}{p_h + p_l} \qquad R_s = 1 + \frac{d_s}{\pi} \tag{3}$$

and the equity premium is therefore given by

$$q = ER_s - R_f \tag{4}$$

where E is the expectation operator with respect to the state s. All prices $(\pi, p_s), s \in \{h, l\}$, are expressed in units of current consumption. All trading occurs ex-dividend, namely current trades take place after the current state is revealed.

The utility function at the beginning of economic life for the generation t individual is

$$V_t^t = u(c_0^t) + \beta E u(c_{1s}^t) + \beta^2 E u(c_{2s}^t) \tag{5}$$

where $c^t = (c_0^t, c_{1s}^t, c_{2s'}^t) \in \mathcal{R}_+^3$ is the household life-cycle consumption vector, $\beta > 0$ is the subjective discount factor, and $u : \mathcal{R}_+ \to \mathcal{R}$ is a twice continuously differentiable, strictly increasing concave function. (s, s') are the states in middle and old age.

Households of generation $t = -1, 0, 1, \ldots$ maximize lifetime utility (5). For simplicity, henceforth we will use the generation superscript only when necessary. Let (x_{is}) denote the holdings of continent claims for $i = 0, 1$ and $s = h, l$; let (k_0, k_1) denote the holding of trees by young and middle-age individuals, respectively. The budget constraints for young, middle- and old-age individuals are, respectively

$$c_0 + \sum_s p_s x_{0s} + \pi k_0 = 0 \tag{6}$$

$$c_{1s} + \sum_{s'} p_{s'} x_{1s'} + \pi k_1 = x_{0s} + (\pi + d_s) k_0 + 1, \quad s = h, l \tag{7}$$

$$c_{2s'} = \begin{cases} n + x_{1s'} + (\pi + d_{s'})k_1, & s' = h, l \text{ if in the market} \\ m, & s' = h, l \text{ if in autarky} \end{cases} \tag{8}$$

Individual asset demands $(x_{0s}, x_{1s}, k_), k_1)$ are influenced by the discount factor β, the utility function u, the endowment profile and the enforcement mechanism for loan contracts. If endowments consist of collateral goods, then a relatively inexpensive legal mechanism creates an environment of commitment in which households do not default on any loans they can afford to repay. For example, a mechanism that allows creditors to seize publicly known endowments of individual debtors reduces the debtors' incentive to default. Environments without collateral income cannot set up this enforcement technology; they must rely instead on the self-interest of borrowers to enforce repayment promises. In this setting, individual rationality constraints (IRC's henceforth) on borrowers must supplement lifecycle budget constraints.

3 Commitment equilibria

We consider first an environment in which all contracts are enforceable by a costless technology based on collateral income. A competitive equilibrium is a list $(c_0, c_{1s}, c_{2s}, p_s, \pi)_{t=1}^{\infty}$ which satisfies the budget constraints (6) - (8) and the market clearing conditions

$$x_{0s} + x_{1s} = 0, \quad s = h, l \tag{9}$$

$$k_0 + k_1 = 1. \tag{10}$$

The consumer's first-order conditions with respect to x_{0s}, x_{1s}, k_0, k_1, respectively, are

$$p_s u'(c_0) = \beta\alpha_s u'(c_{1s}), \quad s = h, l \tag{11}$$

$$p_{s'} u'(c_{1s}) = \beta\alpha_{s'} u'(c_{2s'}), \quad (s, s') \in \{h, l\} \times \{h, l\} \tag{12}$$

$$\pi u'(c_0) = \beta E\left[u'(c_{1s})(\pi + d_s)\right] \tag{13}$$

$$\pi u'(c_{1s}) = \beta E\left[u'(c_{2s'})(\pi + d_{s'})\right], \quad s = h, l. \tag{14}$$

From (12) for $s = h$ and $s = l$, for a given s', it follows that $c_{1h} = c_{1l} = c_1$, i.e. consumption in middle-age is independent of state. Hence, the consumer's first-order conditions in (12) reduce from four to two; moreover, the first-order conditions (14) reduce from two to one.

The equilibrium consists of three market clearing equations (9)-(11) and six first-order conditions (11)-(14); these nine equations can be solved for the nine unknowns $(\pi, p_h, p_l, x_{0h}, x_{0l}, x_{1h}, x_{1l}, k_0, k_1)$.

From (13) and (14) it follows that $c_{2h} \neq c_{2l}$ in the commitment equilibrium, i.e. consumption in old-age is stochastic. In this equilibrium, young and middle-age agents engage in contracts that make their consumption non-stochastic; old agents, on the other hand, are in the last period of life and cannot sign further contracts to eliminate uncertainty in their consumption levels.

In this commitment equilibrium, agents can invest in a safe asset, which is the combination of the two contingent claims on future consumption, and in the tree, which is a risky asset delivering i.i.d. dividend. A simple arbitrage condition can be derived from (11) and (13)

$$\frac{u'(c_0)}{u'(c_1)} = \beta \frac{\alpha_s}{p_s} = \beta E R_s, \qquad s = h, l,$$

which guarantees that young individuals are indifferent between the risky and the safe asset. Similarly, from (12) and (14) we obtain

$$u'(c_1) = \frac{\alpha_s u'(c_{2s})}{p_s} = E\left[u'(c_{2s})\left(1 + \frac{d_s}{\pi}\right)\right],$$

which guarantees that middle-age individuals are indifferent between the two assets. Notice also that

$$\frac{p_h}{p_l} = \frac{\alpha}{1-\alpha},$$

namely, the higher the probability of the good state h, i.e. the higher α, the higher the price of the claim of unit of tomorrow's consumption in good state.

As a corollary to the results above, there is no equity premium in the commitment equilibrium. In fact,

$$E R_s = E\left[1 + \frac{d_s}{\pi}\right] = \frac{u'(c_0)}{\beta u'(c_1)}$$

from (13) and

$$R_f = \frac{1}{p_h + p_l} = \frac{u'(c_0)}{\beta u'(c_1)}$$

from (11).

In this commitment equilibrium, young individuals borrow from middle-age ones to finance consumption and, possibly, the purchase of assets. More precisely, young individuals can either sell contingent claims on future consumption ($\sum_s p_s x_{0s} < 0$) to finance current consumption and also purchase the tree ($k_0 > 0$); alternatively, they can go short on the tree ($\pi k_0 < 0$) and possibly purchase claims on future consumption ($\sum_s p_s x_{0s} > 0$). Section 5 gives a numerical example.

4 No-commitment equilibria

In this section, we remove commitment from our economic environment and investigate its effects on asset returns and the equity premium. More precisely, we now assume that individual endowments cannot be used as collateral and households cannot credibly commit to make good on their contracts. As in Kehoe and Levine [10] [11], the legal environment has the following characteristics: all information, including default, is public; there are no restrictions on asset transactions, as agents can purchase and sell assets at any point in life, even after default; in the event of a default, the defaulter's private endowments cannot be seized while all the assets of a defaulting debtor can be garnished by the harmed creditor. Hence, this rule of law is more sophisticated than bilateral punishment.

The assumption that endowments, such as labor and human capital, cannot be confiscated following default is justified by legal arguments (ban on involuntary servitude) as well as by incentives (labor supply would be strongly discouraged). For example, if wages above a certain minimum are attached to repay debts, the debtor has no incentive to supply labor in excess of that minimum. On the other hand, assets like stocks, bonds and the proceeds from loan contracts easily change ownership and may be seized in case of default.

The legal environment of our model means that the private cost of default is the forgone gain from trading in the intertemporal market for the rest of the agent's life. This feature does *not* rest on any restriction on asset transactions; rather, defaulters' cannot sell assets, which have been taken away from them, and have no incentive to purchase assets after default because public information and the rule of law make such assets vulnerable to claims by prior debtors. Similarly, a middle-age individual can sell contingent claims on future consumption after default, but she will have no incentive to comply with the contract when old; since everyone knows this, she will not find any taker in such transaction. In our environment, default does not occur in equilibrium because fully informed rational agents will never enter a contract that the other part is not willing to make good on.[1]

Formally, the optimal portfolio decision for a young agent who cannot credibly commit to her contracts is the solution to the following problem:

$$\{x_{0h}, x_{0l}, k_0\} = \arg\max E\left[u(c_0) + \beta u(c_{1s}) + \beta^2 u(c_{2s})\right], \tag{15}$$

given the vector (p_h, p_l, π) of prices, and subject to (6), to (8) and the IRC's:

$$u(c_{1s}) + \beta E u(c_{2s'}) \geq u(1) + \beta u(m), \quad s = h, l. \tag{16}$$

The individual rationality constraint (16) amounts to self-enforcement of contracts: it states that no contracts are signed that the agent expects to find preferable to autarky.

Similarly, the optimal portfolio decision for a middle-age agent who cannot credibly commit to her contracts is the solution to the following problem

$$\{x_{1h}, x_{1l}, k_1\} = \arg\max u(c_{1s}) + \beta E u(c_{2s'}), \quad s = h, l \tag{17}$$

[1] In contrast, default is a socially useful institution in environments with private information (Dubey et al. [8], Araujo et al. [3]).

given the vector (p_h, p_l, π) of prices, and subject to (6), to (8) and the IRC's:

$$u(c_{2s'}) \geq u(m), \quad s' = h, l. \tag{18}$$

The IRC (18) simply puts a lower bound on old-age consumption, which is given by the amount of home-production the defaulting agent can engage in.

It is easy to see that, like in the commitment equilibrium, consumption in middle-age is no-stochastic so that $c_{1h} = c_{1l} = c_1$. Hence, there is only one IRC for the young agent – the two IRCs in (16) reduce to one. To find the equilibrium in the non-commitment environment, we write and solve the lagrangeans for the two problems above; the equilibrium consists of three market clearing equations (9)-(11), nine first-order conditions and three complementary slackness conditions that can be solved for the fifteen unknowns $(\pi, p_h, p_l, x_{0h}, x_{0l}, x_{1h}, x_{1l}, k_0, k_1, l_1, l_{2h}, l_{2l}, c_1, c_{2h}, c_{2l})$, where l_1 is the lagrange multiplier for the IRC (16), l_{2h} is the lagrange multiplier for the IRC (18) with $s' = h$ and l_{2l} is the lagrange multiplier for the IRC (18) with $s' = l$.

If no IRC constraint is binding, the equilibrium of the no-commitment economy is the same as in the commitment economy.

If the IRC for the young individual, namely (16), is binding, then middle-age individuals' portfolio decisions are affected by limited enforcement. More precisely, the transactions young agents entered in the committed economy would be defaulted here; hence their contracts must lower the amount of payments in middle-age to the point that default is avoided. This reduces young agents' ability to finance youth consumption and purchase assets. In other words, c_0 is lower than in the economy with commitment because young agents cannot borrow as much.

When the IRC for young individuals is binding, the rate of return on the safe asset R_f falls, the expected rate of return on the risky asset ER_s also falls, but the equity premium rises. If young agents are constrained, the aggregate demand for next period contingent consumption claims increases, thereby driving the prices (p_h, p_l) up and the rate of return on the safe asset R_f down. If young agents were selling next period contingent claims in the economy with commitment ($x_{0s} < 0$), they will now less fewer such claims ($x_{0s} \uparrow$); since supply is lower, prices rise. As young individuals borrow less, they also have lower repayment in middle-age, which in turn raises the demand for tree by middle-age individuals ($k_1 > 0$and $\uparrow$), thereby increasing the price of the tree π. As a result, the expected return on the tree falls.

Even though both rates of return are lower, the equity premium rises. The intuition for this result is simple. Young agents can borrow less and therefore can hold less of the tree; hence, middle-age individuals must hold more of the tree. Since the tree gives a i.i.d dividend and old individuals cannot insure the dividend risk away, middle-age individuals who purchase larger fraction of the tree must be compensated for such risk; hence, an equity premium arises. Section 5 gives a numerical example.

As for the IRCs for middle-age agents, notice that only one of the two constraints can be binding in equilibrium, otherwise $c_{2h} = c_{2l}$ and consumption would be deterministic over the entire life-cycle. This would violate the fact that our economy has aggregate uncertainty. To satisfy the binding IRC, middle-age individuals sell more contingent claims on future consumption ($x_1 > 0$and $\uparrow$), thereby lowering the prices (p_h, p_l) and raising the risk-free rate of return. As for tree holding, we believe that middle-age agents must raise k_1 or, in other words, must increase their holding of the tree. This is because going short on the tree requires large payments if the high state is realized, which is inconsistent with the IRC for c_{2h}. A higher tree holding by middle-age individuals will raise the price π, thereby reducing the expected rate of return on the risky asset, ER_s. As a result, we believe that the equity premium falls when the IRC for middle-age agents is binding.

5 A numerical example

This section presents a simulation of our economy with and without commitment. Let $u(c) = \log c, \beta = 1$, $y^t = (0, 1, n)$ with $n = 1$ if the individual is in the market, $y^t = (0, 1, m)$ with $m = 1.3$ if the individual has defaulted in middle-age and is autarkic. Moreover, let $d_l = 0, d_h = .1$ and $\alpha = .5$. In words, the tree is equally likely to deliver zero or 0.1 profit.

Consider first the economy with commitment. Table 1 presents the results of the simulation. Young individuals have zero private endowment and their consumption must therefore be financed via borrowing. In fact, they sell contingent claims on next period consumption, $x_{0s} < 0$; with the proceeds, they consume and purchase risky assets $k_0 > 0$. Young agents sell more claims contingent on the high than the low state, $x_{0h} < x_{0l}$, because the tree will deliver a profit in the high state, thereby raising their disposable resources. Middle-age individuals, on the other hand, buy contingent claims on future consumption $x_{1s} > 0$ and go short on the tree $k_1 < 0$. Both agents therefore sign contracts of opposite sign for the risky and safe assets: the young borrow with the safe asset and invest in the risky one, middle-age borrow with the risky asset and invest in the safe one.

The rates of return on the safe and risky asset are equalized in equilibrium and there is no equity premium. The last two rows of Table 1 report the values of the IRCs for the young and middle-age individuals, respectively: negative values indicate that the IRC is violated. Hence, young individuals would be constrained in an economy without commitment.

Consider now the economy without commitment. Table 2 presents the results of the simulation. Young individuals are constrained in this economy and their ability to borrow to finance consumption is therefore limited. In equilibrium, youth consumption is financed by selling claims on future consumption contingent on the low state $x_{0l} < 0$ and by borrowing on the tree $k_0 < 0$. Since repayment on the tree in the high state

Young		*Middle-age*		*Old*	
Variable	*Value*	*Variable*	*Value*	*Variable*	*Value*
x_{0h}	-0.66	x_{1h}	0.66	c_{2h}	1.54
x_{0l}	-0.47	x_{1l}	0.47	c_{2l}	1.45
k_0	2	k_1	-1		
c_0	0.13	c_1	0.43		
$p_h = 0.14$					
$p_l = 0.14$					
$\pi = 0.02$					
$EV = -2.54$					
$R_f = 3.5, ER_s = 3.5, q = 0$					
$\log c_1 + \beta E \log c_{2s} - \log m = -0.66$					
$\log c_2 h - \log m = 0.17, \log c_2 l - \log m = 0.11$					

Table 1: Economy with commitment

Young		*Middle-age*		*Old*	
Variable	*Value*	*Variable*	*Value*	*Variable*	*Value*
x_{0h}	0.06	x_{1h}	-0.06	c_{2h}	1.22
x_{0l}	-0.04	x_{1l}	0.04	c_{2l}	1.21
k_0	-0.09	k_1	1.09		
c_0	0.008	c_1	0.87		
$p_h = 0.39$					
$p_l = 0.39$					
$\pi = 0.0204$					
$EV = -4.82$					
$R_f = 1.28, ER_s = 3.45, q = 2.17$					

Table 2: Economy without commitment

is onerous, young agents purchase high state consumption claims for the next period. Overall, young individuals can borrow much less than they did in the economy with commitment and youth consumption falls from 0.13 to 0.008.

The increase in aggregate demand for contingent claims doubles the prices (p_h, p_l); the reduction in k_0, on the other hand, has a relatively small impact on the price π. More importantly, young agents are unable to purchase the tree, which must now be held by the middle-age individuals. The risk connected with holding the tree is now remunerated with a very large equity premium.

6 Related literature

To our knowledge, this paper is the first to study the equity premium in an environment with finitely-lived agents and endogenous debt limits.

Debt limits resulting from participation constraints in an economy with infinitely lived households are examined in Kehoe and Levine [10]. In their setting, default triggers *perpetual* exclusion from intertemporal trades while same-date exchanges are still permitted. The size of this penalty implies, under certain technical assumptions, the existence of a second-best (constrained efficient) competitive equilibrium with linear prices. Kocherlakota [12] analyzes efficient allocations in a setting with two infinitely-lived agents, participation constraints and complete information. Efficient allocations may result in full risk sharing (as the discount factor tends to one), in limited risk sharing or no risk sharing at all, namely in autarky. Alvarez and Jermann [1] show how to model participation constraints as portfolio constraints and generate limited risk sharing in a setting with otherwise complete markets. They also characterize the conditions (high discount rates, low risk aversion, low variance and high persistence of the idiosyncratic shocks) under which autarky is the only feasible allocation.

Our model is closest in form to Azariadis and Lambertini [5], who characterize competitive equilibria with perfect foresight in a deterministic, three-period pure-exchange overlapping generations economy with perfect information and no commitment to loan contracts. They find that the combination of finite life and lack of commitment can lead to multiple steady states, persistent indeterminacy, regime switching or to the non-existence of competitive equilibria.

Alvarez and Jermann [2] are the closest in spirit to our work. They study the asset pricing implications of an economy with infinitely lived individuals and where solvency constraints are determined to efficiently deter agents from defaulting. Their model produces large equity premia and risk premia for long term bonds with low risk aversion and a plausibly calibrated income process. However, such large premia require implausibly low discount parameters.

Recently there has been a fair amount of applied work using models with limited enforceability. In a life-cycle model, Lambertini [16] shows that pay-as-you-go social security may actually reduce welfare because, by raising income in old age, it lowers the amount of borrowing that can be sustained in equilibrium. In infinite-horizon representative agent models, Attanasio and Rios-Rull [4] consider an environment with aggregate and idiosyncratic risk and no storage technology, mapping preference and income parameters into the amount of sharing for idiosyncratic risks that can be sustained in equilibrium. Their computations show a considerable amount of risk sharing, with transfers among agents varying from 30% to almost 100% of the transfers that would take place in a first-best allocation. They also find that a program providing insurance against aggregate shocks may reduce welfare, as it makes autarky less painful, and therefore reduces the amount of idiosyncratic risk sharing that is substainable in equilibrium. Ligon et al. [17] study risk sharing in a similar environment with a storage technology and find that the introduction of storage has ambiguous welfare effects as it makes autarky less onerous. Kehoe and Levine [11] compare models with exogenous liquidity and endogenous debt constraints; both models generate partial risk-sharing but have different dynamic properties. Krueger [13] also compares endogenous debt limits in a complete market model with exogenous debt limits in a bond-only model. Krueger and Perri [14] interpret evidence on U.S. consumption and income inequality to be consistent with limited enforceability models. Finally, Krueger and Fernandez-Villaverde [15] study life-cycle consumption in a setting with consumer durables.

7 Conclusions and Extensions

to be written

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