The paradox of safe asset creation

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Abstract

We build a competitive equilibrium model of safe asset creation through securitization. Securitization vehicles create safe assets by pooling idiosyncratic risks from loan originators. Equity investors allocate their wealth between originators, who need skin-in-the-game, and vehicles, who need loss-absorption capacity against aggregate risk. When debt investors accept risk, all equity is invested in originators, while when they demand safe assets, some equity is reallocated towards vehicles. Safe asset creation may, paradoxically, increase the risk of originated loans and reduce expected output. Our model is consistent with a broad set of facts in the run-up to the global financial crisis.

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1 Introduction

A persistent increase in demand for safe assets is perceived as one of the main structural changes in the global economy over the last two decades (Caballero and Krishnamurthy [2009], Bernanke et al. [2011]). The implications of safe asset shortages have recently attracted attention in the macroeconomics literature (Caballero, Farhi, and Gourinchas [2017]). The surge in safe asset demand is also considered an important driver in the transformation of the financial sector that led to a securitization boom in the run-up to the Global Financial Crisis (GFC). While recent evidence shows that the senior tranches of securitized loans, including subprime loans, issued ahead of the GFC were effectively safe (Ospina and Uhlig [2018]), a substantial body of research has also found evidence of a weakening of lending standards during that period (Loutskina and Strahan [2011], Ashcraft, Gooriah, and Kermani [2019]). This suggests a close link between demand for safety, the structure and risk in the financial sector, and real output, raising some questions: Are credit expansions driven by investors demanding safety *different* from traditional credit expansions in which investors are willing to bear risk? How can an increase in demand for *safety* be met with the securitization of *riskier* loans?

We provide an answer to these questions based on a novel competitive equilibrium model of securitization and the capital structure of the modern intermediation chain. The model features absolute demand for safety by debt investors, loan originators exposed to idiosyncratic and aggregate risks, and securitization vehicles that manufacture safe assets by pooling risky securities from different originators. The wealth of expert investors is limited and allocated between the equity of originators, which need skin-in-the-game due to moral hazard problems when they raise external financing, and the equity tranches of securitization vehicles, which need loss-absorption capacity against aggregate risk due to market incompleteness. Increases in the wealth of the investors demanding safety lead to lending booms fueled by securitization expansions, reallocation of equity towards securitization, and issuance of riskier loans. The reallocation of experts' wealth from the equity of originators to that of securitization vehicles necessary to manufacture safe assets exacerbates originators' moral hazard problems and may lead to a paradox of safe asset creation: the economy in which debt investors demand safety may lead to riskier loan issuance than an economy in which those investors were willing to buy risky assets. Thus, credit booms fueled by demand for safety can lead to higher risk than traditional credit booms. In those cases, expected output is subdued due to the negative effect of demand for safety on loan quality.

We model a two date competitive economy with two types of investors: experts and savers.

Experts' overall endowment is normalized to one. Experts are skilled agents that can set-up and invest their wealth in the equity of one out of two competitive financial firms: originators and securitization vehicles. Savers only invest in safe securities (they are assumed to be infinitely risk-averse), and their overall endowment determines the demand for safety in the economy.

Originators can issue loans under a constant return to scale technology. The loans are exposed to aggregate and institution-specific idiosyncratic risks, and have to be monitored to increase the likelihood that their payoff is high. Monitoring is not observable and involves a convex disutility cost for the expert managing each originator. Originators can expand lending by issuing safe and risky securities in competitive markets that are purchased by savers and vehicles, respectively. The issuance of safe securities can only be backed by the lowest return of the loans. The issuance of risky securities leads, as in Holmstrom and Tirole [1997], to a moral hazard problem because of the non-observability of loan monitoring.

Vehicles engage in securitization. They purchase the risky securities issued by many originators, diversify away their idiosyncratic risks and "manufacture" additional safe assets that can be sold to savers. Vehicles' size under this carry trade strategy is bounded because of aggregate risk: their equity tranche must be sufficient to absorb their assets' losses in the worst aggregate shock to ensure the safety of the securitized assets distributed to savers. Vehicles' need of equity results from the assumption, consistent with real practice, that the payoffs of the risky securities that are securitized are contingent on the idiosyncratic risk of the underlying loans but not on aggregate risk. This incomplete contract set-up gives a central role to the equity allocation across financial firms that drives the main results of the paper.

The financing structure of the financial firms in the intermediation chain, the risk of the originated loans, the returns of safe and risky securities and of financial firms' equity, aggregate loan issuance and expected output, and the size of the securitization sector are all determined in equilibrium. In particular, the frictionless allocation of experts' endowment between the equity of originators and vehicles induces their equity returns to be equal in equilibrium. The equilibrium equity allocation trades off the gains from reducing moral hazard at origination (*skin-in-the-game*) and those from providing loss-absorption capacity against aggregate risk to support safe asset creation by vehicles (*credit enhancement*). The existence of competitive markets for safe and risky securities and financial firms' equity, ensure that constrained versions of the Welfare Theorems hold in this economy.[1]

[1]We assume that the two financial activities along the intermediation chain, loan origination and pooling of risky securities from different originators, are conducted by different financial firms. We could equivalently assume that a single institution, a bank holding company, conducts both activities and an internal capital market

The demand for safety in the economy determines the size of the securitization sector and the risk of originated loans. When the demand for safety is low, it is directly satisfied by originators. Safe assets are abundant, the return of safe securities equals that of equity, and there is no securitization. The equilibrium coincides with that of the traditional originate-to-hold economy. The risky part of the loans is entirely funded with originators' equity, there are no moral hazard problems and loan risk is minimum (and coincides with its first-best level).

When the demand for safety is higher, safe securities become scarce, the safe rate falls and a positive equity spread arises. Experts set-up vehicles to exploit the equity spread by creating safe assets through securitization, and a fraction of the originated loans is indirectly funded through securitization. The distribution of risk from originators to vehicles creates moral hazard and increases loan risk, and this is exacerbated by the reallocation of equity from originators to vehicles. As the demand for safety keeps on increasing, the widening equity spread allows securitization vehicles to increase leverage and to offer more attractive risky funding to originators, giving the later incentives to further increase leverage through the issuance of risky securities. A securitization boom fuels the aggregate lending expansion, the intermediation chain becomes "longer" as a larger fraction of aggregate lending is channeled through vehicles, and loan risk increases.

The demand for safe securities by savers leads to the emergence of securitization and the issuance of riskier loans. Would loan risk be higher or lower if, instead, savers were willing to invest in risky securities? Two opposite forces are at play. On the one hand, demand for safety constrains the amount of risky loan payoffs that originators can (indirectly) pledge to raise funds from savers. When savers are willing to buy risky securities, the pledgeability of originators' loans increases and their financing constraints get relaxed. This leads to an increase in originators' demand for external risky funding and in the risky part of their loans that is promised to savers, which worsens the moral hazard problem and increases loan risk relative to an economy with demand for safety. On the other hand, when savers are willing to buy risky securities there is no need of securitization, and a fortiori no equity investment in vehicles. Experts' endowment is thus entirely invested in originators' equity, where it plays a skin-in-the-game role that reduces loan risk relative to an economy with demand for safety. In some cases, this equity reallocation effect dominates and the following *paradox of safe asset creation* emerges: originated loans are riskier when savers only invest in safe assets than when they are willing to invest in risky securities. While several papers have emphasized how demand for

allocates equity across them. As long as the incomplete contract setup remains, the role of equity allocation is preserved.

safety may increase financial sector fragility due to its impact on refinancing risk (e.g., Caballero and Krishnamurthy [2009], Stein [2012], Moreira and Savov [2017]), our paper highlights credit risk as an additional source of fragility implied by safety demand. Also, the increase in loan risk resulting from investors' demand for safety reduces output relative to that in a traditional credit expansion. This output reduction channel associated with safety demand complements that arising from safety traps when the safe rate hits its zero lower bound emphasized in Caballero and Farhi [2018].

The model predictions regarding the financial sector response to a credit expansion driven by demand for safety are consistent with a broad set of empirical evidence in the run-up to the GFC. In particular, the model implies that the spread between the expected return of risky loans and safe assets may fall while that between equity and safe assets increases. To the best of our knowledge, our model is the first in explaining this "puzzling" differential movement in the risk premia of fixed-income securities versus equity (Bernanke et al. [2011], Caballero et al. [2017]). This is generated by our model because, as safety demand increases, the securitization expansion allows an increase in originators' leverage that more than offsets the reduction on expected loan returns.

The paper is organized as follows. Section 2 describes the related literature. Section 3 presents the model. Section 4 describes as a benchmark the equilibrium of the traditional originate-to-hold economy. Section 5 characterizes the equilibrium of the originate-to-distribute economy and discusses the empirical predictions of the model. Section 6 focuses on the paradox of safe asset creation and its output implications, which constitute the main contributions of the paper. Section 7 concludes. All the proofs of formal results in the paper are in the Appendix.

2 Related literature

There is a growing literature on the macroeconomic implications of safe asset demand. In a model with no financial sector, Caballero and Farhi [2018] highlight that safe asset shortages depress the safe rate and reduce aggregate demand and output at the zero lower bound. Some macro-finance papers focus on how the issuance of short-term liabilities allows the financial sector to satisfy the demand for safe securities (Caballero and Krishnamurthy [2009]) or for low-risk quasi money-like securities (Gorton and Ordoñez [2013, 2014], Moreira and Savov [2017]), and highlight how this may give rise to boom-bust episodes in risky asset markets and economic activity. Our paper contributes to this literature by highlighting how the reallocation of equity in the intermediation chain towards the junior tranches of securitized assets affects originated loan risk and expected output in the economy.[2] Our static framework is rich enough to generate the opposing behavior of equity and loan risk premia observed in the run-up to the GFC.[3]

The analysis of how the financial sector satisfies demand for safety has been the focus of a strand of the banking literature. We share with Gennaioli, Shleifer, and Vishny [2013] and Diamond [2019] the focus on the manufacturing of safe assets through diversification. These papers take the risk and payoffs of the productive assets of the economy as given, while we analyze the interplay between safe asset creation through securitization and moral hazard problems at origination. Another strand of the banking literature analyzes how the financial sector satisfies the demand for safety through the issuance of short-term liabilities (Stein [2012], Ahnert and Perotti [2017]). These papers emphasize the fragility created by the presence of roll-over risk, which is complementary to our focus on the implications of safety demand on credit risk.

In practice, the securitization process involves the pooling, tranching and distribution of cash-flows generated by loans along an intermediation chain that exhibits different entities (Ashcraft et al. [2008], and Pozsar et al. [2013]). Our paper provides a tractable equilibrium framework of the financial architecture of the securitization process. A related paper is DeMarzo [2004], in which a long intermediation chain with several rounds of pooling and tranching emerges as the solution to a security design problem in presence of asymmetric information. The paper exhibits endogenous risk retention along the chain but the risk of the originated loans is exogenous.

Our paper is also related to other strands of the theoretical securitization literature. Moral hazard and adverse selection problems in the originate-to-distribute intermediation chain and how to address them with endogenous risk retentions have been extensively studied in the literature (Parlour and Plantin [2008], Daley, Green, and Vanasco [2020], Vanasco [2017], Caramp [2017], Neuhann [2019]). These papers, though, abstract from the diversification benefits associated with securitization. The interplay between origination incentives and diversification

[2] In the dynamic quantitative macroeconomic model of Begenau and Landvoigt [2018], the equity allocation between regulated banks with access to deposit insurance and shadow banks is also endogenous and affects their capability to create the liquid liabilities demanded by households. The authors focus on the calibration of optimal capital requirements, while we focus on an environment without government distortions.

[3] Our paper also differs from Moreira and Savov [2017] in that, in their model, an increase in investors' demand for absolute safety, which happens when uncertainty is high, leads to a contraction of shadow banking and an expansion of traditional intermediaries that invest in safer assets.

benefits when there is no aggregate risk is studied in Malherbe [2012], who focuses on the trade-off between ex ante and ex interim risk-sharing contracts that are issued under symmetric and asymmetric information, respectively. We only consider ex ante contracts in an environment in which aggregate risk and market incompleteness imply the need of equity tranches to support the issuance of safe tranches in securitization.[4]

The implications of general saving gluts or low interest rate environments for origination incentives are analyzed in Dell Ariccia, Laeven, and Marquez [2014], Martinez-Miera and Repullo [2017] and Bolton, Santos, and Scheinkman [2018]. Our paper emphasizes how saving gluts driven by demand for safety may differ from gluts driven by investors willing to bear risk.

Some recent papers analyze the endogenous capital structure of non-financial firms and banks (Allen, Carletti, and Marquez [2015], Gornall and Strebulaev [2018], Diamond [2019], Gale and Gottardi [2020]). We share with these papers the interest on how market forces shape the equity allocation in the economy.[5]

3 The model

Consider an economy with two dates $t = 0, 1$ and two types of investors endowed at $t = 0$ with one unit of funds: experts and savers. The measure (and aggregate wealth) of savers and experts is w and 1, respectively. Both types of agents have zero discount rate. Experts are risk neutral. Savers derive linear utility from consumption at their worst-case scenario. At $t = 0$, each expert can set-up one out of two types of competitive financial firms, called *originators* and securitization *vehicles*. Both types of firm have access to some constant return to scale investment possibilities that are funded as described below. Each expert decides at $t = 0$ whether to set-up and invest its unit endowment as equity in his own firm, or consume. Savers are special investors that *only* purchase risk-free assets as they derive zero marginal utility from risky exposures. Each saver decides at $t = 0$ whether to invest its unit endowment in *safe securities* issued by financial firms or consume.

We describe each of the financial firms that experts can create next.

[4]Some related papers stress the role of regulatory arbitrage for the the emergence of securitization and shadow banks (Plantin [2015], Ordoñez [2018]). These aspects are absent in our model.

[5]Rampini and Viswanathan [2018] and Villacorta [2019] study dynamic settings in which the equity of banks and non-financial firms are separate state variables that affect spreads and the macroeconomy.

Originators Originators have access at $t = 0$ to a constant returns to scale loan issuance technology. The per unit return of loans at $t = 1$, that we denote A_z, can be either high $(z = H)$ or low $(z = L)$, where $A_H > A_L \geq 0$. For each originator, the realization of z depends on an institution-specific shock and an aggregate shock that are described next when we introduce securitization vehicles. We refer to A_L as the safe return of the loan and to $\Delta \equiv A_H - A_L$ as its risky return. The probability that the high return is realized coincides with the unobservable monitoring intensity $p \in [0, p_{\max}]$ exerted by the expert that sets up the originator, where $p_{\max} < 1$. We henceforth refer to p as the loans' risk, under the interpretation that high risk corresponds to a low value of p.[6] The issuance of loans with risk p entails the expert a disutility cost per loan unit given by a function $c(p) \geq 0$ satisfying:

Assumption 1 $c(0) = 0,\ c'(0) = 0, c'(p_{\max}) \geq \Delta, c''(p) > 0,$ *and* $c'''(p) \geq 0$.

We denote with $\overline{p}$ the first-best loan risk, which is given by:

$$\overline{p} = \arg\max_{p} \left\{ E[A_z|p] - c(p) \right\}. \tag{1}$$

Assumption 1 implies that $\overline{p} \in (0, p_{\max}]$ and is determined by the first order condition:

$$c'(\overline{p}) = \Delta. \tag{2}$$

We assume that:

Assumption 2 $E[A_z|\overline{p}] - c(\overline{p}) > 1$.

Assumption 3 $A_L < 1$.

Assumption 2 states that loan issuance creates a surplus if first-best risk is chosen. Assumption 3 implies that loans cannot be funded exclusively with safe securities.

At $t = 0$, the originator issues x units of loans that are financed with the unit of wealth of its expert (*equity)*, and with the issuance of *safe securities* and *risky securities* in competitive markets in which the required expected market returns are R_S and R_V, respectively.[7] The

[6] This terminology is consistent with the interpretation of A_L as the loan recovery value in case of default, so that $1 - p$ amounts to the default probability. Notice that higher loan risk (lower p) implies lower quality, while the variance of the loan pay-off is $p(1 - p)$, so that provided $p > 1/2$, higher risk implies higher payoff variance.

[7] We refer with subindex V to risky securities because they are purchased by vehicles.

amount of funds raised with safe (risky) securities is denoted with x_S (x_V), and the overall notional promise on safe (risky) securities at $t = 1$ with $d_S x$ ($d_V x$). Notice that d_S and d_V are promises per unit of loan, to which we will refer as the safe and risky promise, respectively. We assume that the repayment of safe securities is senior to that of risky securities and that the funding tuple (x, x_S, x_V, d_S, d_V) is observable.

For given required expected returns R_S, R_V, the expert chooses at $t = 0$ a balance sheet tuple $(x, x_S, x_V, d_S, d_V, p)$ in order to solve the maximization problem

$$\max_{(x,x_S,x_V,d_S,d_V,p)} R_{E,O} \equiv \big(E\left[\max\{A_z - d_S - d_V, 0\}|p\right] - c(p)\big)x, \tag{3}$$

subject to the *budget constraint*

$$x = 1 + x_S + x_V, \tag{4}$$

the *securities repayment constraints*

$$\begin{aligned} d_S &\leq A_L, & (5) \\ d_S + d_V &\leq A_H, & (6) \end{aligned}$$

the *securities' pricing constraints*

$$\begin{aligned} R_S x_S &= d_S x, & (7) \\ R_V x_V &= E\left[\min\{d_V, A_z - d_S\}|p\right] x, & (8) \end{aligned}$$

and the *optimal risk choice constraint (moral hazard)*

$$p = \arg\max_{p'} \left\{E\left[\max\{A_z - d_S - d_V|p'\right] - c(p')\right\}. \tag{9}$$

The objective function $R_{E,O}$ in (3) is the expected utility the expert obtains from investing its wealth in the originator, which amounts to the value of the residual equity claim net of the monitoring costs. We refer to $R_{E,O}$ as the originator's equity return. The maximization of the equity return is subject to the following constraints. Constraint (4) states how the x units of loans are financed. Constraint (5) ensures that safe securities are always repaid and constraint (6) ensures that risky securities are repaid in full in state $z = H$. Constraints (7) and (8) are the pricing equations that ensure that safe and risky securities yield the required expected market returns R_S and R_V, respectively. In particular, constraint (8) takes into account that risky securities might not be repaid in full in state $z = L$, which happens with probability $1 - p$. Finally, constraint (9) captures the moral hazard problem that arises from the unobservability of the risk choice. The loan risk does not necessarily coincide with $\bar{p}$ but instead maximizes the residual payoff of the expert taking into account the promises on safe and risky securities. Notice from (8) and (9) that, given a funding structure (x, x_S, x_V, d_S, d_V), investors form rational expectations on the unobservable risk-choice p and price risky securities accordingly.

Vehicles Vehicles engage at $t = 0$ in securitization: they pool risky securities purchased from multiple originators, diversify their idiosyncratic risks and manufacture new safe assets. Vehicles need to finance a fraction of their assets with their experts own funds (*equity*) due to the presence of aggregate risk in the economy, which is described next.

At $t = 1$ an aggregate shock θ that affects the return of the originators' loans is realized. Conditional on the realization of θ, the probability of the high payoff of a loan with risk p is θp. Hence, when $\theta > 1$ ($\theta < 1$) the conditional probability of a high payoff is larger (lower) than its unconditional value. In addition, conditional on θ, the loan returns are independent across originators. The support of the shock is $[1 - \lambda, 1/p_{\max}]$, with $\lambda \in (0, 1)$, and its distribution $F(\theta)$ has positive density in a neighborhood of $\theta = 1 - \lambda$ and satisfies $E[\theta] = 1$.[8] The *aggregate risk* parameter λ hence determines the fraction of the expected return of a pool of originators' loans in the economy that is destroyed under the worst aggregate shock.

We next describe the vehicles formally. For given market returns R_S, R_V, a vehicle invests y units of funds at $t = 0$ into a pool of risky securities issued by many originators. The vehicle finances the asset purchases with the unit of equity provided by its expert and with y_S units of funds obtained from the issuance of safe securities. Given the required rate R_S on safe securities, the vehicle must issue safe securities with an overall notional promise of $R_S y_S$.

The return of the vehicle's pool of risky securities depends on the return of each of the risky securities conditional on the realization $z \in \{H, L\}$ of their issuers' loans and on the realization of the aggregate shock. For the sake of expositional simplicity, we assume that all originators

[8]Notice that the assumption $\theta \leq 1/p_{\max}$ ensures that the conditional probability of the high return is upper bounded by 1. In addition, using that $E[\theta] = 1$, for an originator with risk choice p we have:

$$\Pr[A_z = A_H] = \int_{1-\lambda}^{1/p_{\max}} \Pr[A_z = A_H | \theta] dF(\theta) = \int_{1-\lambda}^{1/p_{\max}} \theta p dF(\theta) = pE[\theta] = p,$$

as expected.

choose the same tuple $(x, x_S, x_V, d_S, d_V, p)$.[9] The return of a risky security contingent on the realization $z \in \{H, L\}$ of its issuer's loans, that we denote with $R_{V,z}$, is thus given by:

$$R_{V,z} = \frac{\min\{d_V, A_z - d_S\}x}{x_V}, \tag{10}$$

so that we can compactly describe the risky securities in the market by a tuple $(R_{V,H}, R_{V,L}, p)$. By definition of the expected return R_V, we have:

$$R_V = E\left[R_{V,z}|p\right]. \tag{11}$$

For given returns R_S, R_V and risky securities described by the tuple $(R_{V,H}, R_{V,L}, p)$ satisfying (11), the expert chooses at $t = 0$ a balance sheet pair (y, y_S) solving the maximization problem

$$\max_{(y,y_S)} R_{E,V} \equiv \int_{1-\lambda}^{1/p_{\max}} \left(E\left[R_{V,z}|p,\theta\right]\right) dF(\theta) y - R_S y_S = R_V y - R_S y_S, \tag{12}$$

subject to the *budget constraint*

$$y = 1 + y_S, \tag{13}$$

and the *repayment constraint*

$$R_S y_S \le \min_\theta E\left[R_{V,z}|p,\theta\right] y = \min_\theta \left[\theta p R_{V,H} + (1 - \theta p) R_{V,L}\right] y. \tag{14}$$

The objective function $R_{E,V}$ in (12) is the utility of the expert that sets-up a vehicle, which equals the expected residual payoff of the firm. We refer to $R_{E,V}$ as the vehicle's equity return.[10] The maximization of the equity return is subject to the following constraints. Constraint (13) states how the vehicle finances its purchase of originators' risky securities. Constraint (14) ensures that the safe securities issued by the vehicle are repaid always in full and takes into account that, by the law of large numbers, the payoff of the vehicle's pool of risky securities at $t = 1$ is a function of the risk choice of the originators, p, and the realization of the aggregate shock, θ.

[9] This is the case in equilibrium because given market expected returns R_S, R_V, the maximization problem of the originator described in (3) - (9) has a unique solution. This statement is proven in Lemma A.2 in the Appendix.

[10] Notice that the latter expression for $R_{E,V}$ in (12) immediately results from (11).

Equity allocation and aggregate lending We denote E_O, E_V the measures of experts that set-up at $t = 0$ originators and vehicles, respectively. These variables also represent the aggregate investment in the equity of each firm type. Aggregate lending in the economy, which is denoted with N, amounts to $N = E_O x$. We say that the economy features *full lending* when $N = w + 1$.

Equilibrium definition A competitive equilibrium consists of choices for originators and vehicles described by balance sheet tuples $(x^*, x_S^*, x_V^*, d_S^*, d_V^*, p^*), (y^*, y_S^*)$, respectively, overall amounts E_O^*, E_V^* of equity in originators and vehicles, respectively, and expected returns R_S^*, R_V^*, R_E^* on safe securities, risky securities, and equity, respectively, such that:

1. The choices of originators and vehicles satisfy the maximization problems in (3) - (9) and (12) - (14), respectively.
2. The return on equity obtained by an expert that sets-up any financial firm is R_E^* and the experts' decision to set-up a financial firm instead of consuming is optimal.
3. Savers' investment and consumption decisions are optimal.
4. The markets for safe and risky securities clear.

Figure 1 graphically illustrates the funding structures, the financing and securities flows, and the market clearing conditions in the economy.

3.1 Discussion of assumptions

We briefly discuss next some of our modeling assumptions.

Demand for safety Similarly to Gennaioli et al. [2013], we assume that savers are infinitely risk-averse agents, so their set of investment possibilities consists only of safe assets.[11,12] The growing importance in the economy of demand for extremely safe, money-like assets, and its price impact has been well documented in the empirical literature (Krishnamurthy and Vissing-Jorgensen [2012, 2015], Sunderam [2014]).

[11] For a given set Ω of states of nature at $t = 1$, Gennaioli et al. [2013] define the utility U derived by an infinitely risk-averse agent from a stochastic consumption distribution $(c_1(\omega))_{\omega \in \Omega}$ at $t = 1$ as $U \equiv \min_{\omega \in \Omega} c_0 + c_1(\omega)$.

[12] Savers' preference for safe assets could also be generated by introducing a money convenience yield in their utility function as in Stein [2012] and Diamond [2019], or by assuming that savers face a participation cost when they invest in risky assets as in Carletti, Marquez, and Petriconi [2019]. The results in the paper would hold under either of these alternative modeling assumptions.

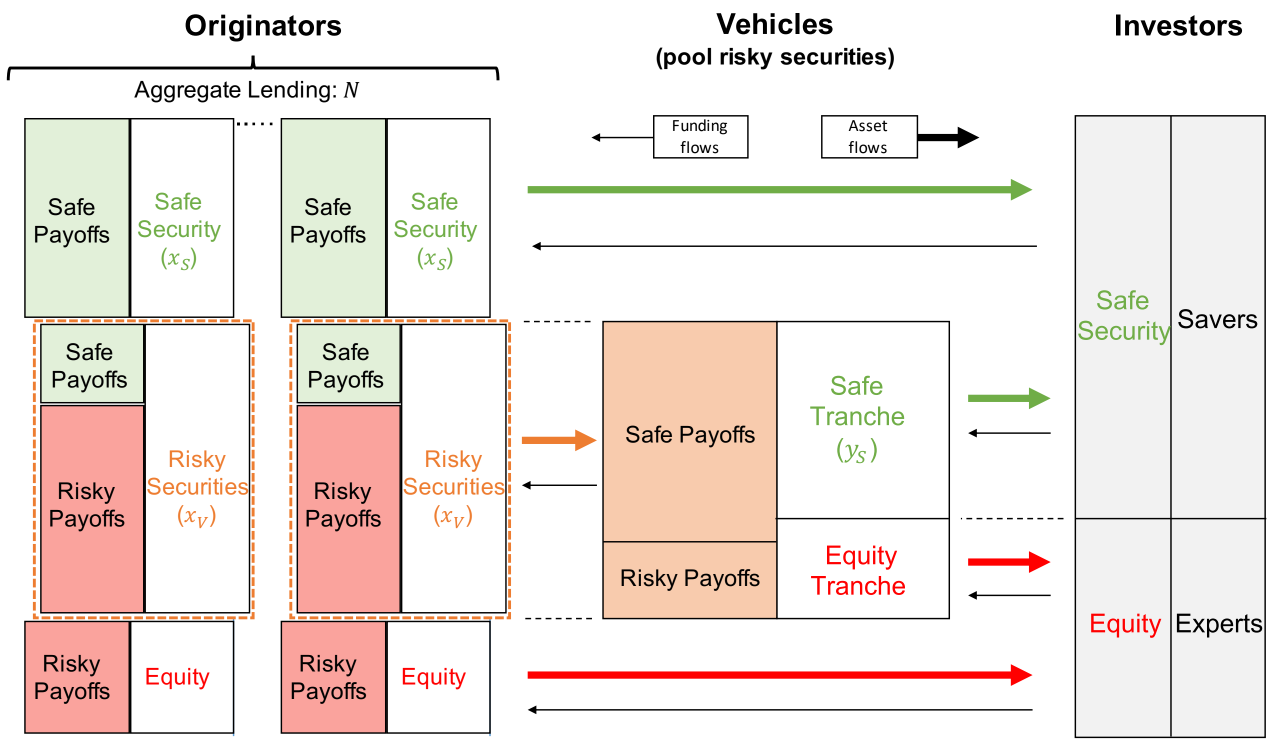

Figure 1: Asset distribution and flow of funds

Notes: Illustration of the asset distribution and funding flows along the intermediation chain.

Idiosyncratic originator risk We assume that each originator is subject to an idiosyncratic shock that affects the return of all its loans. Such institution specific risk could result from unmodeled frictions that force each originator to specialize along some geographic or industrial segment of the loan issuance market. Consistent with this assumption, the empirical literature that exploits bank-firm loan-level data finds idiosyncratic variation at the bank-level (Khwaja and Mian [2008], Amiti and Weinstein [2018]).[13]

Experts' investment choices The model assumes that experts can only invest at $t = 0$ in the equity of the financial firms they set-up. Taking into account that their utility function is linear and the investment opportunities allowed by the creation of each financial firm type are scalable, we could equivalently assume that each expert can set up a bank holding company with two divisions that: *i)* are specialized in loan origination and securitization of risky securities issued by other originators, respectively; *ii)* raise external funds separately against the returns

[13] Part of this bank-fixed factor is attributed to firm-specific shocks that are common among firms connected to the same bank, while the rest is interpreted as bank-supply shocks.

of their own assets. The expert would in this equivalent set-up choose how to allocate optimally its unit of funds between the equity of the two divisions.

Aggregate risk market incompleteness The model assumes that originators cannot issue securities with a payoff contingent on the realization of their own loans *and* the aggregate shock. This market incompleteness implies that originators cannot provide insurance to vehicles against aggregate risk, so that securitization implies a reallocation of the scarce equity in the economy towards vehicles. Such equity reallocation channel is key in generating the results on the paradox of safe asset creation in Section 6, which constitute the main novelty of our paper.[14] We think that our market incompleteness assumption is a realistic feature of the model, as the securitization process consists of the pooling and tranching of securities whose repayment depends on loan-specific cash-flows and not on economy wide variables.

4 Benchmark: equilibrium without securitization

We consider in this section a benchmark economy in which experts cannot set-up vehicles. Originators can raise external funds only with safe securities. For a given safe rate R_S, their problem is as described in (3) - (9) with the additional constraints $x_V = d_V = 0$.

Using (1) and (5), the optimal loan risk condition in (9) implies that:

$$p = \arg\max_{p'} \{E[A_z - d_S | p'] - c(p')\} = \arg\max_{p'} \{(E[A_z | p'] - c(p')) - d_S\} = \overline{p}. \tag{15}$$

Loan risk is at its first-best because safe securities are totally repaid and experts fully appropriate the marginal benefits from monitoring.

We denote with

$$R_A(p) \equiv E[A_z | p] - c(p), \tag{16}$$

the expected return of one unit of loans net of monitoring costs when risk choice is p, and refer to it as the originator's return on assets. Using equations (4), (7) and (15), the originator's equity return in (3) takes the following intuitive form:

$$R_{E,O} = R_A(\overline{p}) + (R_A(\overline{p}) - R_S)x_S, \tag{17}$$

[14] In contrast, all the positive results in Section 5 would hold under contracts contingent on aggregate risk. In fact, it can be proven that the equilibrium of such economy coincides with that in an economy with market incompleteness and aggregate risk parameter with value $\lambda' = 0$.

where recall that x_S denotes funding raised with safe securities. The expression implies that the originator issues safe securities only if $R_A(\overline{p}) - R_S \geq 0$, and since savers invest in safe securities only if $R_S \geq 1$, the next lemma results. (From here on we denote equilibrium variables in this benchmark economy with a b superscript).

Lemma 1 *The equilibrium safe rate R_S^b satisfies*

$$1 \leq R_S^b \leq R_A(\overline{p}). \tag{18}$$

Conjecture an equilibrium with $1 < R_S^b < R_A(\overline{p})$. We have from (17) that the originator finds optimal to maximize safe securities' issuance, so that constraint (5) binds and $R_{E,O}^b > R_S^b > 1$. Experts and savers' wealth is entirely invested in originators' equity and safe securities, respectively, and the economy exhibits full lending. Using (4) and (7), the market clearing of safe securities implies:

$$R_S^b = \frac{A_L(w+1)}{w}, \tag{19}$$

which states that the equilibrium safe rate equals the ratio of the overall safe loan payoffs and savers' wealth. Equation (19) implies that the safe rate is decreasing on w, and the conjectured property $1 < R_S^b < R_A(\overline{p})$ is satisfied if w lays in an intermediate region. The next formal result follows.

Proposition 2 *The equilibrium of the benchmark economy without securitization is unique. Let w be savers' wealth, and define $\underline{w} \equiv \frac{A_L}{R_A(\overline{p})-A_L}$, $\overline{w} \equiv \frac{A_L}{1-A_L}$. Let R_S^b and $R_{E,O}^b$ be the equilibrium return on safe securities and equity, respectively, and N^b aggregate lending. We have:*

(i) If $w \leq \underline{w}$ then:

$$R_S^b = R_{E,O}^b = R_A(\overline{p}), \text{ and } N^b = w+1.$$

(ii) If $w \in (\underline{w}, \overline{w}]$ then:

$$R_S^b < R_A(\overline{p}) < R_{E,O}^b, \text{ and } N^b = w+1.$$

(iii) If $w > \overline{w}$ then:

$$1 = R_S^b < R_A(\overline{p}) < R_{E,O}^b, \text{ and } N^b = \frac{1}{(1-A_L)} < w+1.$$

The proposition, whose results are illustrated in Figure 2, states that, as savers' wealth increases, the equilibrium of the economy transitions from *i)* full lending and no equity spread

(a) Returns on equity and safe securities (b) Aggregate lending

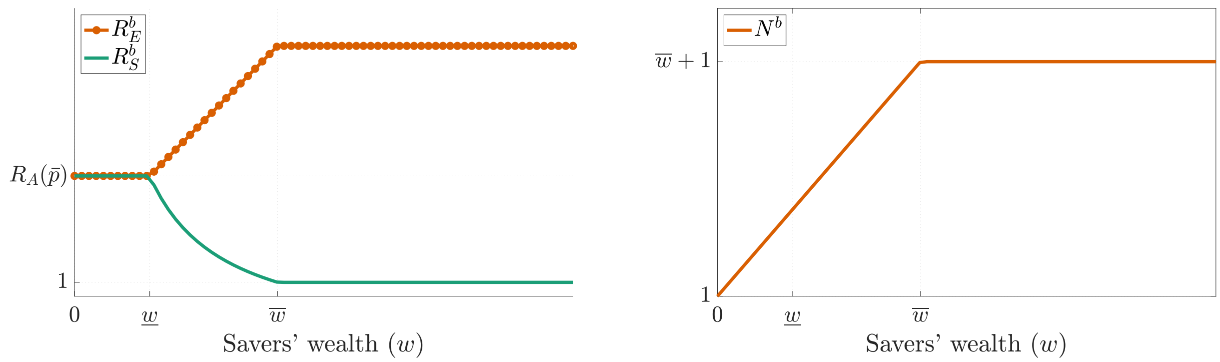

Figure 2: Equilibrium without securitization vehicles

Notes: Returns on equity R_E^b and safe securities R_S^b, and aggregate lending N^b, as a function of the savers' aggregate wealth w for the equilibrium without securitization vehicles.

(safe asset abundance), to *ii)* full lending and a positive equity spread (safe asset scarcity), to *iii)* partial lending, some consumption by savers at $t = 0$, and maximum equity spread (high safe asset scarcity).

5 Equilibrium

In this section, we analyze the equilibrium of the economy. The following lemma, which extends Lemma 1, provides intuitive equilibrium properties of the returns of the three funding sources in the economy.

Lemma 3 *The equilibrium safe rate, R_S^*, satisfies*

$$1 \leq R_S^* \leq R_A(\overline{p}).$$

Moreover, the equilibrium returns on risky securities, R_V^*, and equity, R_E^*, satisfy

$$R_S^* \leq R_V^* \leq R_E^*.$$

Finally, $R_S^* = R_V^* = R_E^*$ if and only if $R_S^* = R_A(\overline{p})$.

Notice that, in equilibrium, the expected return on risky securities lays between the returns of safe securities and equity because vehicles finance their purchases of risky securities by issuing safe securities and equity.

We next describe how the originators and vehicles' problems and the market clearing of safe and risky securities allow to determine the equilibrium of the economy. We focus our analysis on a conjectured equilibrium satisfying $1 < R_S^* < R_A(\overline{p})$, which from Lemma 3 implies that $R_S^* < R_V^* < R_E^*$.

Originators' problem Consider an originator's optimal balance sheet tuple $(x, x_S, x_V, d_S, d_V, p)$ that solves the problem (3) - (9) for given returns $R_S^* < R_A(\overline{p})$ and $R_V^* > R_S^*$. Using constraints (5) - (8), the originator's equity return in (3) can be written as:

$$R_{E,O} = R_A(p) + (R_A(p) - R_S^*)x_S + (R_A(p) - R_V^*)x_V. \tag{20}$$

This expression extends that in (17) by including a third term that captures the spread the expert obtains by issuing risky securities to expand loan size. Notice that $R_{E,O}$ depends on the originator's risk choice p, which we focus on next.

We have from the optimal risk choice condition in (9) that p is determined by the overall (per unit of loan) promise on the two types of securities issued by the originator, $d_S + d_V$. Since $R_S^* < R_A(\overline{p})$ and $R_S^* < R_V^*$, it is easy to prove from (20) that the originator finds optimal to exhaust its capability to issue safe securities, that is, constraint (5) is binding:

$$d_S^* = A_L. \tag{21}$$

Constraint (6) then implies that $d_V \leq A_H - A_L = \Delta$, and we can rewrite the pricing constraint (8) as

$$R_V^* x_V = p d_V x. \tag{22}$$

Using (21), condition (9) takes the compact form

$$p = \arg\max_{p'} \left\{ p' \left(\Delta - d_V \right) - c(p') \right\}, \tag{23}$$

and we have the following result.

Lemma 4 *For given $R_S^* < R_A(\overline{p})$ and $R_S^* < R_V^*$, the originators' optimal risk choice is a* *function* $\widehat{p}(d_V)$ *of the risky promise* $d_V \in [0, \Delta]$ *satisfying*

$$\frac{\mathrm{d}\widehat{p}(d_V)}{\mathrm{d}d_V} < 0, \widehat{p}(0) = \overline{p} \text{ and } \widehat{p}(\Delta) = 0. \tag{24}$$

The lemma states that as the risky promise d_V increases, the originator's loans become riskier (p decreases). The reason is that when d_V is larger, the expert's incentives to undertake the costly monitoring get reduced, since the value created by this action is to a larger extent appropriated by the holders of the risky securities. The non-observability of monitoring thus creates a moral hazard problem that increases loan risk when risky securities are issued.

Using (4), (7), (8), (20), (21) and Lemma 4, we can obtain the following expressions for the originator's loan issuance and equity return as functions of the single choice variable d_V:

$$x(d_V) = \frac{1}{1 - A_L/R_S^* - \widehat{p}(d_V)d_V/R_V^*}, \tag{25}$$

$$R_{E,O}(d_V) = \left[R_A(\widehat{p}(d_V)) - A_L - \widehat{p}(d_V)d_V\right] x(d_V). \tag{26}$$

Equation (25) expresses the originator's loan issuance (which can also be interpreted as its leverage) as the ratio between the expert's unit of funds and the equity downpayment contribution per unit of loan. Equation (26) in turn presents the originator's equity return as the product of the expected per loan unit residual cash-flow net of monitoring costs (term in brackets) and leverage.

The originator's problem (3) - (9) thus amounts to the following optimal risky promise choice:

$$\max_{d_V \in [0,\Delta]} R_{E,O}(d_V). \tag{27}$$

It is possible to prove using (25) and (26) that the solution d_V^* to this problem satisfies the following *optimal risky promise* first order condition:

$$\underbrace{(\chi^* - 1) \left.\frac{\mathrm{d}(\widehat{p}(d_V)d_V)}{\mathrm{d}d_V}\right|_{d_V = d_V^*}}_{\text{Leverage benefits}} + \underbrace{\left.\frac{\mathrm{d}R_A(\widehat{p}(d_V))}{\mathrm{d}d_V}\right|_{d_V = d_V^*}}_{\text{Loan quality costs}} = 0, \tag{28}$$

where we have denoted $\chi^* \equiv R_E^*/R_V^*$. The condition captures the trade-off faced by originators in their risky securities issuance decision. The first term captures the *leverage benefits* from augmenting the issuance of risky securities: a marginal increase $\mathrm{d}d_V$ in d_V allows to raise additional funds from risky securities amounting to $(1/R_V^*)\mathrm{d}(\widehat{p}(d_V)d_V)$ per unit of loan (see

(22)). The additional funds have a cost R_V^* for the originator, but free up an equal amount of equity that (levered up with external funds) allows to increase loan size and to obtain a return R_E^*. The originator thus obtains a spread $R_E^* - R_V^*$ on the additional funds raised with risky securities. The term then results from the identity $(R_E^* - R_V^*)/R_V^* = \chi^* - 1$. Notice that the leverage benefits are increasing in the variable χ^*, which is the *funding discount* offered by vehicles to originators in the funding of the risky part of their loans relative to the equity return.

The second term in (28), which from (16) and Lemma 4 is negative, accounts for the *loan quality costs* from a higher issuance of risky securities: a marginal increase $\mathrm{d}d_V$ in d_V weakens incentives to monitor, which induces an increase in loan risk and a reduction in the net return of each unit of loans of $\mathrm{d}R_A < 0$.

Vehicles' problem and the funding discount We now turn to the vehicle's problem for given returns $R_S^* < R_V^*$. Recall the definition of the realized return $R_{V,z}$ of risky securities in (10). Using (21), we have that

$$R_{V,L}^* = 0, R_{V,H}^* = R_V^*/p^*. \tag{29}$$

An expert setting up and investing its wealth in a vehicle chooses at $t = 0$ a balance sheet tuple (y, y_S) solving the maximization problem (12) - (14). Using (13), the vehicle's return on equity $R_{E,V}$ can be written as:

$$R_{E,V} = R_S^* + (R_V^* - R_S^*)y. \tag{30}$$

Since the vehicle earns a spread $R_V^* - R_S^* > 0$ on each unit of investment in risky securities, it chooses maximum leverage, which from (14) and (29) implies

$$R_S^* y_S^* = \min_{\theta} E\left[R_{V,z}^*|p^*, \theta\right] y = (1-\lambda)p^* R_{V,H}^* y^* = (1-\lambda)R_V^* y^*. \tag{31}$$

This expression shows the benefits from diversification: while from (29) the lowest return of risky securities is zero, a vehicle holding a pool of them is able to pledge a fraction $1 - \lambda$ of their expected return for the issuance of safe securities.

Using (13), (30), (31), and that in equilibrium $R_{E,V}^* = R_E^*$, we get the following equilibrium *vehicle funding discount pass-through* equation:

$$\chi^* = (1-\lambda)\frac{R_E^*}{R_S^*} + \lambda. \tag{32}$$

The equation states that the discount χ^* originators obtain from vehicles when financing the risky part of their loans with risky securities instead of equity amounts to the weighted average of the "discounts" with which the vehicles finance their pools of risky securities. In fact, in equilibrium a fraction $1-\lambda$ of the return of the vehicles' assets is financed with safe securities which have a cost advantage relative to equity of R_E^*/R_S^*, while the complementary fraction λ is funded with equity at a discount of 1 (that is, at no discount). Importantly, equation (32) implies that when in equilibrium the relative equity spread R_E^*/R_S^* is high, the vehicle offers a high funding discount to originators.

The equity allocation We next characterize the relationship between the equilibrium equity investment in originators, E_O^*, and in vehicles, E_V^*. Using the market clearing of risky securities, $E_O^* x_V^* = E_V^* y^*$, and the equality of equity returns across financial activities, $R_{E,O}^* = R_{E,V}^*$, the following equilibrium *equity allocation* equation can be derived:

$$\frac{E_V^*}{E_O^*} = \frac{\widehat{p}(d_V^*)d_V^*}{R_A(\widehat{p}(d_V^*)) - A_L - \widehat{p}(d_V^*)d_V^*}\lambda. \tag{33}$$

The equation states that the ratio of equity invested in vehicles relative to that in originators is the product of two factors. The first one captures how the expected risky payoff of the originators' loans net of monitoring costs, $R_A(\widehat{p}(d_V^*)) - A_L$, is tranched into risky securities sold to vehicles, $\widehat{p}(d_V^*)d_V^*$, and equity held by experts, $R_A(\widehat{p}(d_V^*)) - A_L - \widehat{p}(d_V^*)d_V^*$. The second factor is the aggregate risk parameter λ, that accounts for the fraction of the tranche placed to vehicles that is funded with equity. Equation (33) implies that when the expected payoff $\widehat{p}(d_V^*)d_V^*$ of the risky securities sold to vehicles is large, the amount of experts' funds invested in the equity tranches of vehicles must also be large.

The safe rate Using the market clearing of safe securities, we obtain the following equilibrium *safe rate* equation:

$$R_S^* = \frac{\left[A_L + (1-\lambda)\widehat{p}(d_V^*)d_V^*\right](w+1)}{w}. \tag{34}$$

The equation, which extends that in (19) for the no securitization economy, states that the equilibrium safe rate equals the ratio of overall safe payoffs in the economy and savers' wealth.

Its numerator consists of the product of the sum of the per unit of loan safe payoffs pledged to savers directly by originators, A_L, and indirectly through vehicles, $(1-\lambda)\widehat{p}(d_V^*)d_V^*$, times aggregate loan issuance, $w+1$. Equation (34) shows that securitization, by increasing the supply of safe securities, increases the safe rate relative to that in the benchmark economy. In addition, (34) shows that, for a given d_V^*, the safe rate is decreasing in savers' wealth. This is because as savers' share of total wealth increases, the share of payoffs pledged to them decreases.

Based on the previous analysis, and in particular on the optimal originator's risky promise condition in (28), the vehicle's funding discount in (32), the equity allocation equation in (33), and the safe rate equation in (34), it is possible to provide the following equilibrium characterization.

Proposition 5 *The equilibrium of the economy is unique up to a Modigliani-Miller type of indifference when there is no equity spread. Let w be savers' wealth and $\underline{w} < \overline{w}$ the constants defined in Proposition 2. Let R_S^*, R_E^*, p^*, N^* be the equilibrium safe rate, return on equity, originator's risk choice, and aggregate lending, respectively. There exists a constant $\overline{\overline{w}} \in R^+ \cup \{\infty\}$ satisfying $\overline{\overline{w}} > \overline{w}$ such that:*

(i) If $w \leq \underline{w}$, then there is no securitization and:

$$R_S^* = R_E^* = R_A(\bar{p}), p^* = \overline{p} \text{ and } N^* = w+1.$$

(ii) If $w \in (\underline{w}, \overline{\overline{w}}]$, then there is securitization and:

$$R_S^* < R_A(\bar{p}) < R_E^*, p^* < \overline{p} \text{ and } N^* = w+1.$$

(iii) If $w > \overline{\overline{w}}$, then there is securitization and:

$$1 = R_S^* < R_A(\bar{p}) < R_E^*, p^* < \overline{p} \text{ and } N^* \in (N^b, w+1),$$

where N^b is the equilibrium aggregate lending in the benchmark economy.

The proposition describes how the main equilibrium variables depend on the demand for safety in the economy. Figure 3 illustrates the results in the proposition and also exhibits some other equilibrium variables not discussed in the proposition.[15] When the demand for safety is low ($w \leq \underline{w}$), the originators' safe payoffs are enough to deliver a high return on safe securities. There is no equity spread and thus no securitization.

When demand for safety is medium ($w \in (\underline{w}, \overline{\overline{w}}]$), the safe securities supplied by originators become scarce, which gives rise to a positive equity spread (panel 3a), but the economy still achieves full lending (panel 3b). Securitization vehicles emerge to create safe assets and exploit the equity spread. As originators pledge to vehicles a fraction of their risky payoffs, the supply of safe securities increases but monitoring incentives at origination deteriorate, which leads to more loan risk ($p^* < \bar{p}$, panel 3c). When w increases, the economy has a larger endowment and aggregate loan issuance increases (panel 3b). The safe rate falls in order for the market for safe securities to clear (see (34), illustrated in panel 3a). The fall in originators' funding cost leads to an increase in the equity return (panel 3a). As a result, the relative equity spread widens, so that vehicles are able to offer a larger funding discount to originators (see (32)). This in turn leads originators to choose a higher risky promise that makes their loans riskier (see (28), illustrated in panel 3c). The fall in the safe rate and the increase in the relative equity spread also lead to an expansion in leverage by originators and vehicles (panel 3d). In addition, since a larger fraction of the risky part of the originators' loans is distributed to vehicles, experts must in equilibrium reallocate some of their wealth to the equity of vehicles (see (33), illustrated in full line of panel 3e). The equity reallocation exacerbates the increase in loan risk and makes the securitization sector grow faster than aggregate lending in the economy (dotted line of panel 3e). The lending expansion is thus fueled by a securitization boom. In addition, the increase in demand for safety directly reduces the safe rate, and indirectly reduces the expected return of originators' loans, $E[A_z|p^*]$, due to the lower monitoring by originators. Interestingly, the indirect effect may be stronger than the direct one and, following an increase in demand for safety, the spread $E[A_z|p^*] - R_S^*$ between the expected returns of originators' loans and safe securities may fall (panel 3f). Finally, when demand for safety becomes very large ($w > \overline{\overline{w}}$), the safe rate falls to one and some savers opt to consume their endowment at the initial date.[16]

[15]Figure 3 exhibits the equilibrium of the economy as a function of savers' wealth w, holding experts' wealth equal to one. Since investment technologies are linear, all equilibrium variables in the figure except from aggregate lending N^* are determined by the share of savers' wealth over total wealth, $w/(w+1)$.

[16]The interested reader can find in Appendix A.1 the analysis of the welfare properties of the competitive equilibrium of the economy and the proof that constrained versions of the First and Second Welfare Theorems hold. This is because experts can freely set-up and invest in the equity of originators and vehicles, which issue safe and risky securities in competitive markets. As a result, in equilibrium the returns of the three funding sources (equity, and safe and risky securities) lead experts internalize the same trade-off between increasing safe payoffs and worsening loan quality as the as a Social Planner does.

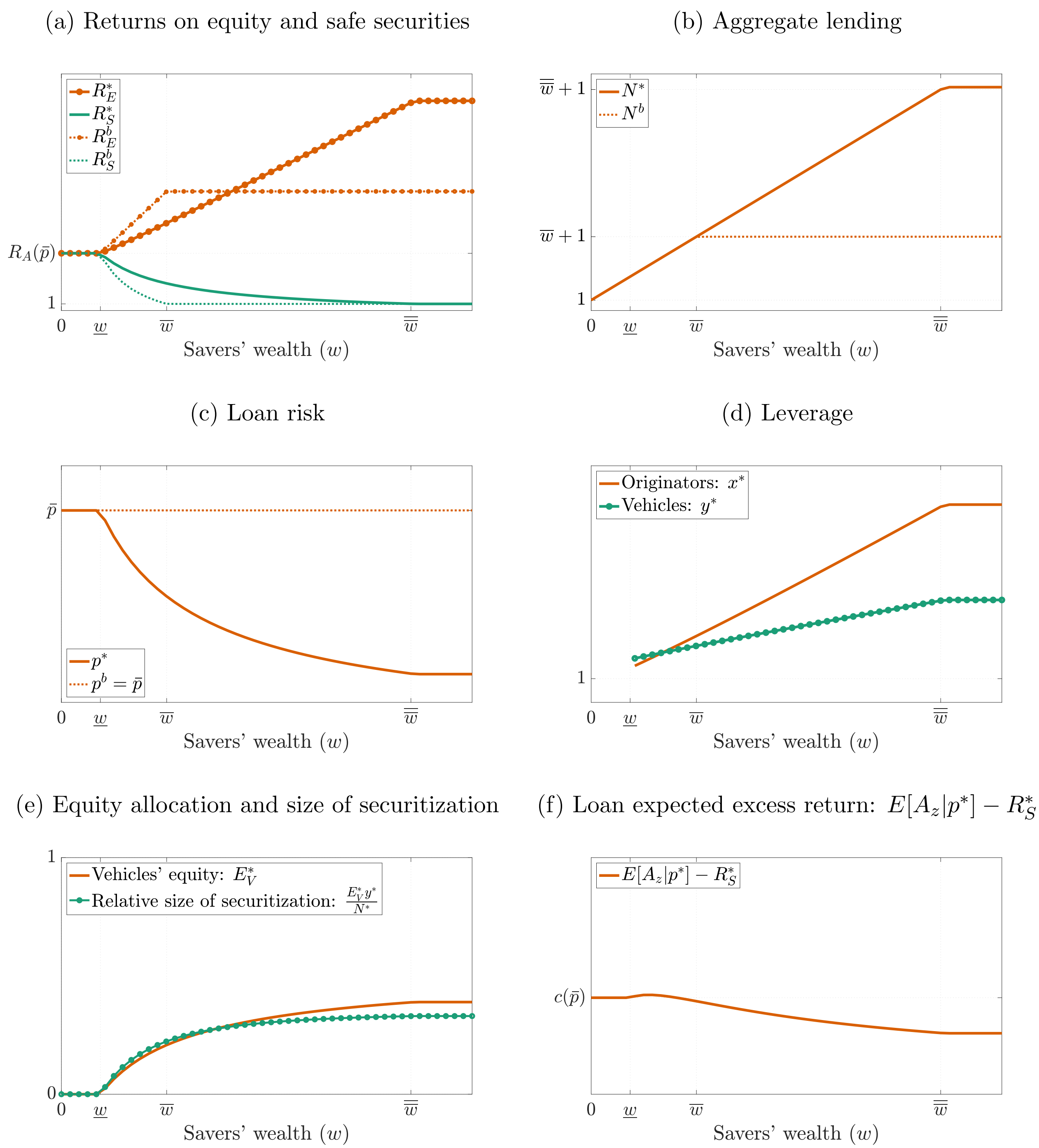

Figure 3: Equilibrium with securitization vehicles

Notes: Expected returns on equity R_E^* (solid with dots) and safe securities R_S^* (solid), aggregate lending N^* (solid), risk choice p^* (solid), leverage of originators x^* (solid) and vehicles y^* (solid with dots), equity in vehicles E_V^* (solid) and size of securitization relative to aggregate lending $E_V^* y^*/N^*$ (solid with dots), and expected loan return spread $E[A_z|p^*] - R_S^*$, as a function of the savers' aggregate wealth w for the equilibrium with vehicles. In panels a), b) and c) dotted lines correspond to equilibrium variables in the benchmark economy without vehicles.

Safety demand and the run-up to the GFC The equilibrium results described above provide, to the best of our knowledge, the richest set of implications consistent with the narrative that the run-up to the GFC was driven by an increase in the demand for safe assets (Bernanke et al. [2011], Caballero and Krishnamurthy [2009], Caballero et al. [2017]). According to this view, an increase in the demand for safe assets in the global economy exerted downward pressure on safe interest rates, and led to a boom in credit fueled by the manufacturing of AAA securitized assets and to the deterioration of lending standards, thereby sowing the seeds for the financial crisis.[17] Notice that this "safe asset demand" narrative differs from the initial view emphasized in Bernanke [2005] and Caballero [2006] that the transformation of the financial sector in the early 2000s was driven by a "global saving glut", that is, a general increase in demand for (safe and risky) assets. Evidence in favor of the "safe asset demand" view as opposed to the "global saving glut" view is provided by Ospina and Uhlig [2018] which show that there were minimal losses in AAA tranches of Residential Mortgage Backed Securities (RMBS), including from the securitization of subprime loans. Also, the findings in that paper put into question the fact that improper ratings or investors' misperceptions of the risk of RMBS tranches were a major factor in the run-up to the GFC.

The following list of empirical findings for the period 2002-2007 are consistent with the implications of an increase in demand for absolute safety in our model:

i) Expansion of financial institutions balance sheets and leverage (Adrian and Shin [2009], Adrian and Shin [2010]).

ii) Securitization sector expansion at a higher rate than the overall economy (Adrian and Shin [2010], Merrill, Nadauld, and Strahan [2017]).

iii) Worsening of lending standards (Rajan [2006], Loutskina and Strahan [2011], Bhattacharyya and Purnanandam [2011], Ashcraft et al. [2019], Keys et al. [2012]).

iv) Low real interest rate in safe assets (Bernanke et al. [2011], Caballero et al. [2017]).

[17] The following excerpt from Bernanke et al. [2011] provides a more complete description of the increase in safety demand hypotheses: "The strong demand for apparently safe assets by both domestic and foreign investors not only served to reduce yields on these assets but also provided additional incentives for the U.S. financial services industry to develop structured investment products that "transformed" risky loans into highly-rated securities. Finally, the demand for safe assets by investors, both domestic and foreign, appears to have engendered a strong supply response from U.S. financial firms. In particular, even though a large share of new U.S. mortgages during this period were of lower credit quality, such as subprime loans, agency guarantees and financial engineering in the private financial services industry resulted in the overwhelming share of mortgage-related securities being rated AAA."

v) Rise in equity expected excess returns (Loeys et al. [2005], Duarte and Rosa [2015], Caballero et al. [2017], Caballero and Farhi [2018]).

vi) Compression of risky loans expected excess returns (Loeys et al. [2005], Caballero and Krishnamurthy [2009], Bernanke et al. [2011], Bolton et al. [2018]).

To the best of our knowledge, our model is the first one able to rationalize the differential evolution of equity expected excess returns (*v)*) and expected excess returns of risky loans (*vi)*). Bernanke et al. [2011] refer to the compression of the risky loan spread as a puzzle since it implies that demand for safe assets generates a stronger indirect effect on loan rates than its direct effect on the safe rate. In our model, the fall in the safe rate leads to a securitization boom: a larger fraction of the pay-off of loans is distributed out of the balance sheets of their originators, which reduces monitoring and loan expected return. The compression of the spread between expected loan returns and the safe rate means that the originators' expected net interest margin gets reduced. Yet, since securitization allows originators to expand leverage, a fall in the net interest margin is compatible with an increase in their expected equity return, and a fortiori, on the equity spread. Alternative explanations to the compression of expected loan return spreads during this period rely on a drop in the overall risk premium (Caballero and Krishnamurthy [2009], or Shin [2012]). But, a reduction in the price of risk would imply a reduction on the spreads in all risky assets, including equity, so these papers cannot reconcile the differential behavior of risky loan and equity expected excess returns.

6 The paradox of safe asset creation

In this section, we further study the relationship between demand for safety, originated loan risk and aggregate output by comparing the equilibrium of our baseline economy, in which savers demand safety, with that of another economy in which savers are willing to buy risky securities. We refer to these economies as demand for safety economy and risky funding economy. The analysis shows that a *paradox of safe asset creation* may emerge: equilibrium loan risk in the demand for safety economy in some cases is higher than in the risky funding economy. In other words, when savers demand safety the economy may originate riskier loans than when savers are willing to bear risk. When that is the case, demand for safety reduces aggregate output net of monitoring costs.

Formally, we consider an alternative version of the model in which savers are willing to purchase risky securities and derive linear utility from their returns. The rest of the model is left invariant. In particular, originators are exposed to the same moral hazard problem when they issue risky securities, which in this economy can be directly placed to savers. There is thus no need for the manufacturing of safe assets through securitization and vehicles do not emerge.

We are interested on how the equilibrium loan risk in this economy compares to that in the demand for safety economy. In order to get intuitions of the forces driving this comparison, it is convenient to do the following conceptual exercise. Consider the equilibrium of the demand for safety economy for some savers' wealth $w \in (\underline{w}, \overline{\overline{w}})$ such that safe securities are scarce, securitization emerges and the economy features full lending (Proposition 5), and let $E_V^* > 0$ be the amount of the experts' endowment invested in vehicles' equity. Starting from this equilibrium, suppose that savers suddenly become willing to purchase risky securities. We split the transition to the equilibrium of the risky funding economy into two steps: *i)* holding fixed the experts' investments in the equity of the financial firms, and *ii)* allowing afterwards experts to reallocate their equity investments among financial firms.

Consider thus a first step in which, starting from the equilibrium of the demand for safety economy, savers become willing to purchase risky securities but experts' equity investments are held fixed. In this step, the total supply of external funds to originators amounts to $w + E_V^*$ raised from savers and the experts "locked" in the equity tranches issued by securitization vehicles. In the demand for safety economy, originators' inability to directly pledge risky payoffs to savers constrains their demand for external funds. As a result, the overall promise made by originators in return for the $w + E_V^*$ units of funds they raise from outside investors is not very large, and loan risk is not very large either. When savers become willing to invest in risky securities, the pledgeability of originators' loans increases and financing constraints get relaxed. Originators' demand for external funding expands and its cost increases. In the new equilibrium, originators make a higher overall promise in return for the $w + E_V^*$ units of external funds. A higher overall promise on external funding implies higher loan risk due to moral hazard in loan monitoring. Summing up, when savers become willing to bear risk, an *increase in loan pledgeability* effect leads to an increase in loan risk holding equity investments fixed.

Consider next a second step in which experts are allowed to freely allocate their equity investments in financial firms. Since savers are willing to purchase risky securities, vehicles do not create any value in the economy. As a result, the return obtained by the experts that were "locked" in vehicles' equity in the first step equals that of risky securities, which is below the equity return of originators. These experts thus reallocate their wealth towards originators, which have more skin-in-the-game incentives to monitor. In sum, when savers become willing to bear risk, there is an *equity reallocation effect* that reduces loan risk.

The following proposition provides conditions that ensure that the latter effect dominates.

Proposition 6 *There exist thresholds $\tilde{\lambda} > 0, \tilde{w} > \underline{w}$, where $\underline{w}$ is defined in Proposition 2, such that for aggregate risk λ and savers' wealth w satisfying $\lambda < \tilde{\lambda}, w \in (\underline{w}, \tilde{w})$, the paradox of safe asset creation emerges, that is, equilibrium loan risk in the demand for safety economy is higher than in an economy in which savers are willing to invest in risky securities. In those cases, aggregate output net of monitoring costs is lower in the demand for safety economy than in the risky funding economy.*

The proposition states that, provided the aggregate risk parameter λ and demand for safety w are not too large, the paradox of safety asset creation emerges. In those cases, as λ is not too large, there are important diversification benefits and the risky loan payoffs that can be converted in safe assets and pledged to savers through securitization are large relative to the wealth of savers w. The loan pledgeability effect that increases loan risk when savers become willing to bear risk is hence weak, and is dominated by the equity reallocation effect, that reduces such loan risk. As a result, the demand for safety economy leads to higher loan risk than the risky funding economy.

Figure 4 illustrates a case for which the paradox of safe asset creation emerges. Panel 4a in the figure exhibits how loan risk in the safety demand and risky funding economies, denoted with p^* and p^r, respectively, depend on savers' wealth w. Panel 4b instead exhibits aggregate output net of monitoring costs in the two economies (notice that for illustration purposes these variables are shown as a ratio of the initial date overall endowment $w + 1$ of the economy). When savers' wealth exceeds the level $\underline{w}$ above which safe assets become scarce, a positive spread between equity and both safe and risky securities arises in the two economies. As a result, originators find optimal to issue risky securities and loan risk increases in the two economies ($p^* < \overline{p}, p^r < \overline{p}$). Due to the reallocation of equity from originators to vehicles required to absorb aggregate risk, the increase in loan risk is initially higher in the demand for safety economy, and the paradox of safe asset creation emerges ($p^* < p^r$). The reduction in per loan output implied by the worsening of loan quality implies that aggregate net output in the demand for safety economy is lower than in the risky funding economy ($y^* < y^r$) even though the two economies achieve full lending (for $w < \overline{\overline{w}}$). Only for very high values of savers' wealth, the risky funding economy induces higher loan risk than the baseline economy. For those values, the safety demand economy has hit the lower bound on the safe rate and is not able to induce full lending. The risky funding economy is thus able to achieve higher output despite the origination of riskier loans because it is able to induce higher aggregate lending.

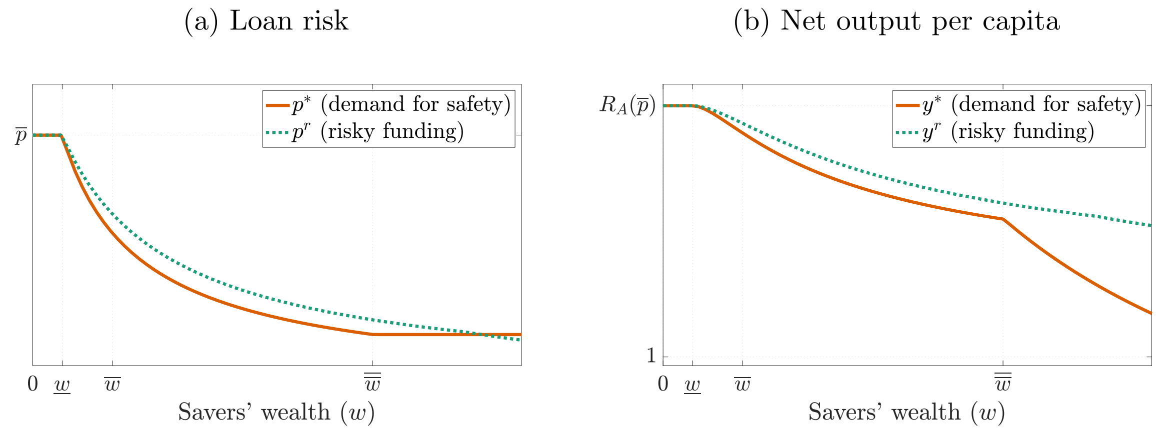

Figure 4: Equilibrium in the safety demand and risky funding economies

Notes: Pannel (a) exhibits loan risk in the demand for safety economy, p^* (solid), and in the risky funding economy, p^r (dotted), as a function of the savers' wealth w. Pannel (b) exhibits expected net output per unit of wealth in the demand for safety economy, y^* (solid), and in the the risky funding economy, y^r (dotted), as a function of the savers' wealth w. The variable y^* is defined as $y^* = ((w + 1 - N^*) + N^* R_A(p^*)) / (w + 1)$ where N^* is aggregate lending, and y^r is defined analogously.

This section highlights that credit expansions driven by demand for safety may lead to higher risk in the assets originated by the financial sector than traditional credit expansions. This source of financial fragility associated with demand for safety is new in the literature, which has focused on how demand for safety may lead to an increase in refinancing risk (e.g., Caballero and Krishnamurthy [2009], Stein [2012], Moreira and Savov [2017]). Also, the results show that safe asset shortages can depress expected output even above the lower bound on the safe rate, complementing the mechanism in Caballero and Farhi [2018] that highlights that safe asset shortages reduce aggregate demand and output at the zero lower bound.

7 Conclusion

We present a general equilibrium model that focuses on how the modern financial intermediation chain satisfies the demand for safety by debt investors. Securitization vehicles manufacture safe assets by pooling the idiosyncratic risks of the securities issued from different originators. The model exhibits an endogenous equity allocation that in equilibrium trades off the gains from reducing moral hazard at origination (skin-in-the-game) and those from providing loss-absorption capacity against aggregate risk to support safe asset creation at securitization vehicles (credit enhancement).

Our results hinge on two assumptions that are consistent with practice in the financial industry. First, due to geographic or industry specialization at the loan origination level, there exist diversification possibilities in the economy that cannot be realized “under one roof” (Pozsar et al. [2013]). As a result, vehicles that pool loan returns from different originators can create additional riskless assets and place them to the investors demanding safety, but this reduces originators’ skin-in-the-game and increases loan risk. Second, the payments of the securities that are pooled and then tranched in the securitization process depend on the returns of the underlying loans and not on economy wide variables. As a result, securitization vehicles need an equity tranche that provides sufficient loss absorption against aggregate risk to ensure the absolute safety of the senior tranche.

The paper highlights that the reallocation of equity required to create safe assets through securitization exacerbates moral hazard problems at origination and may give rise to the following risk paradox of safe asset creation: loan risk when debt investors demand safety may be higher than when they are willing to bear risk. The results shed new light on the implications of safe asset shortages for economic activity and on the differences between credit booms fueled by demand for safe assets and traditional credit booms.

Consistent with the safety demand narrative of the run-up to the GFC, following an increase in the wealth of the investors that demand safe assets, the model predicts a securitization boom and the issuance of riskier loans. In addition, the expansion of lending and distribution of loan pay-offs out of the balance sheets of their originators can induce a compression of the spread between loan expected returns and the safe rate. Even when originators’ net expected interest margin gets reduced, the equity excess return increases due to the leverage expansion allowed by securitization. The model thus can explain the differential response of expected excess returns on equity and fixed-income securities observed during the run-up to the crisis.

The paper provides a stylized static model of the modern intermediation chain that could be embedded into a richer dynamic macroeconomic model. This could allow to perform the quantitative analysis of the analytical results found in the paper. It could also allow to better understand the cyclical properties of the spreads between safe assets, loans and financial firms’ equity. In addition, a dynamic extension could also uncover new mechanisms, in which securitization and endogenous risk-taking interact with a financial accelerator, giving rise to dynamic inefficiencies and the need for regulation. We leave these important issues for future work.

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A Appendix

A.1 Constrained Social Planner problem

In this Appendix, we describe the problem of a constrained Social Planner (SP) and show that constrained versions of the Welfare Theorems hold in this economy. We consider a SP that at $t = 0$: *i)* allocates agents' funds into originators' loans and initial date consumption, *ii)* decides which experts set up, manage and hold the equity claim of originators, which experts hold equity tranches of vehicles, and which experts remain passive, *iii)* decides the safe securities that originators and vehicles issue and distributes them between savers and passive experts, and *iv)* decides the risky securities that originators issue and distributes diversified pools of them to vehicles. Notice that *a)* the residual claims held by the experts managing originators and the ones holding vehicles' equity tranches, and *b)* the distribution of safe securities between savers and passive experts, totally describe how the originators' loan payoffs at $t = 1$ are allocated for consumption across agents. The SP is constrained insofar as she cannot choose the originators' loan risk and can only distribute riskless securities to savers.[18]

An SP allocation, which we denote with γ, is defined by: the aggregate loan issuance by originators $N \in [0, w+1]$, their loan risk choice p, the per unit of loan promises d_S, d_V made by originators on safe and risky securities, respectively, the per unit of loan promise b_S made by vehicles on safe securities, the aggregate consumption at $t = 0$ of savers, passive experts, experts managing originators, and experts holding vehicles' equity tranches, $(C_{S,0}, C_{P,0}, C_{O,0}, C_{V,0})$, the aggregate consumption at $t = 1$ of savers, $C_{S,1}$, and passive experts, $C_{P,1}$, and, for each aggregate shock θ, the aggregate consumption at $t = 1$ net of monitoring costs of experts managing originators, $C_{O,1}(\theta)$, and of experts holding vehicles' equity tranches, $C_{V,1}(\theta)$.

An allocation $\gamma = (N, p, d_S, d_V, b_S, C_{S,0}, C_{P,0}, C_{O,0}, C_{V,0}, C_{S,1}, C_{P,1}, (C_{O,1}(\theta))_\theta, (C_{V,1}(\theta))_\theta)$ is *constrained feasible* if it satisfies the following properties:

- Originators totally repay safe promises and risky promises if their loans' return is high:

$$\begin{aligned} d_S &\leq A_L, && (35) \\ d_S + d_V &\leq A_H. && (36) \end{aligned}$$

- The originators' risk choice p coincides with that maximizing their residual claim:

$$p = \arg\max_{p'} \left\{ E\left[\max\{A_z - d_S - d_V, 0\} | p'\right] - c(p') \right\}. \quad (37)$$

[18] The SP is also subject to the market incompleteness discussed in Section 3.1, that is, the payoff of the risky securities that originators distribute to vehicles cannot be contingent on the realization of the aggregate shock θ.

- Vehicles always repay safe promises:

$$b_S \leq \min_{\theta} \left(\theta p d_V + (1-\theta p) \min\{d_V, A_L - d_S\}\right). \tag{38}$$

- Aggregate consumption at $t = 0$ equals the amount of funds that are not invested in originators' loans:

$$C_{S,0} + C_{P,0} + C_{O,0} + C_{V,0} = w + 1 - N. \tag{39}$$

- Aggregate consumption at $t = 1$ of savers and passive experts equals the overall payoff of safe securities:

$$C_{S,1} + C_{P,1} = (d_S + b_S)\, N. \tag{40}$$

- For each θ, aggregate net consumption of originators' managers at $t = 1$ equals their residual claim net of monitoring costs:

$$C_{O,1}(\theta) = \left[\theta p\,(A_H - d_V - d_S) + (1-\theta p)\,(\max\{A_L - d_V - d_S, 0\}) - c(p)\right] N. \tag{41}$$

- For each θ, aggregate consumption of vehicles' equity holders at $t = 1$ equals their residual claim:

$$C_{V,1}(\theta) = \left[\theta p d_V + (1-\theta p) \min\{d_V, A_L - d_S\} - b_S\right] N. \tag{42}$$

We next define the constrained Pareto frontier of the economy. In order to do so, we compactly denote with Γ the set of constrained feasible allocations. For given weights $\omega_S \geq 0$ assigned by the SP to the utility of savers and $\omega_E \geq 0$ to that of experts, with $\omega_S + \omega_E > 0$, we define the weighted welfare induced by an allocation $\gamma \in \Gamma$ as:

$$W_{\omega_S,\omega_E}(\gamma) \equiv \omega_S (C_{S,0} + C_{S,1}) + \omega_E \left(C_{P,0} + C_{O,0} + C_{V,0} + C_{P,1} + E[C_{O,1}(\theta) + C_{V,1}(\theta)|p]\right). \tag{43}$$

We say that $\gamma \in \Gamma$ is *constrained efficient* if it solves the problem

$$\max_{\gamma \in \Gamma} W_{\omega_S,\omega_E}(\gamma). \tag{44}$$

Finally, the constrained Pareto frontier of the economy is defined as the set of allocations that are constrained efficient for some weights $\omega_S, \omega_E \geq 0$, with $\omega_S + \omega_E > 0$.

For given weights ω_S, ω_E, it can be easily proven from the definition of constrained feasibility of an allocation in (35) - (42) and of the weighted welfare function in (43), that for any $\gamma \in \Gamma$ there exists $\gamma' \in \Gamma$ such that $W_{\omega_S,\omega_E}(\gamma') = W_{\omega_S,\omega_E}(\gamma)$ and the safe promise constraints (35) and (38) are binding.[19] We can hence, with no loss of generality, focus the characterization of the

[19] The intuition is that the SP has flexibility on how to allocate safe consumption at $t = 1$ to experts. Allocations

constrained Pareto frontier to constrained feasible allocations in which the safe promise constraints are binding. Notice that for those allocations, we have from (37) that the incentive compatible risk of originators' loans is given by the function $\widehat{p}(\cdot)$ defined in Lemma 4.

Finally, using the aggregate consumption constraints (39) - (42), the definition of the weighted welfare in (43) and the definition of $R_A(p)$ in (16), a constrained efficient allocation for given weights ω_S, ω_E can be simply described by a choice of aggregate loan issuance, N, risky promise by originators, d_V, and aggregate consumption of savers at each of the dates, $C_{S,0}, C_{S,1}$, that solves the following problem:

$$\max_{(N,d_V,C_{S,0},C_{S,1})} \omega_E(w+1-N+R_A(\widehat{p}(d_V))N) + (\omega_S - \omega_E)(C_{S,0}+C_{S,1}), \tag{45}$$

subject to

$$\begin{aligned} N &\leq w+1, & (46)\\ d_V &\leq \Delta, & (47)\\ C_{S,0} &\leq w+1-N, & (48)\\ C_{S,1} &\leq [A_L + (1-\lambda)\widehat{p}(d_V)d_V]N. & (49) \end{aligned}$$

The objective function of the SP in (45) is weighted welfare rewritten as the sum of aggregate net consumption of the two agent types, loaded with weight ω_E, and the aggregate consumption of savers, loaded with (positive or negative) weight $\omega_S - \omega_E$. The first two constraints in the SP problem simply capture the upper bounds on N and d_V. The last two constraints state that savers' consumption at each date is bounded by the availability of safe payoffs. In addition, it is easy to prove that constraint (48) is binding in any solution to the SP problem. The reason is that experts can issue positive NPV loans, so that allocating them consumption at the initial date reduces (weighted) welfare.

We next describe how the Pareto efficient allocations depend on the SP weights ω_S, ω_E. Figure 5 graphically illustrates our discussion. When the SP gives a lower weight to savers than experts ($\omega_S \leq \omega_E$), the second term in (45) is (weakly) negative and we trivially have that constrained efficient allocations maximize (unweighted) aggregate expected net consumption and thus satisfy $N = w+1, d_V = 0$.[20] In this case, there is no securitization, full lending is achieved and loan risk is first-best. This part of the Pareto frontier is labeled as region I in Figure 5.

When the SP weights savers more than experts ($\omega_S > \omega_E$), constraint (49) must be necessarily binding in any constrained efficient allocation, and the following fist order condition for an efficent

with binding safe promise constraints (35) and (38) leave no safe part on the residual claim of originators and vehicles, so that all the safe consumption of experts at $t=1$ is allocated through the safe securities distributed to passive experts.

[20] In addition, if $\omega_S < \omega_E$ savers' consumption is zero under the constrained efficient allocation.

choice of risky promise d_V follows:

$$\underbrace{\left(\frac{\omega_S}{\omega_E}-1\right)(1-\lambda)\frac{\mathrm{d}\left(\widehat{p}(d_V)d_V\right)}{\mathrm{d}d_V}}_{\text{Quantity effect}}+\underbrace{\frac{\mathrm{d}R_A(\widehat{p}(d_V))}{\mathrm{d}d_V}}_{\text{Quality effect}}=0. \tag{50}$$

The condition states that the SP faces a *quantity versus quality* trade-off in its risky promise choice d_V. First, an increase in d_V increases the expected payoff of the risky securities distributed to vehicles. Due to diversification, a fraction $1-\lambda$ of the expected payoff of those securities becomes safe. The quantity of safe payoffs increases, which allows to increase the consumption of savers at $t=1$. Second, an increase in d_V reduces the monitoring incentives of the originators and the net expected return of their loans.

For an intermediate range of values of $\omega_S/\omega_E>1$, it is optimal to allocate all the endowment of the economy to loan issuance. As the ratio ω_S/ω_E increases, the more important the quantity effect becomes relative to the quality effect in (50), and the higher the SP risky promise choice d_V. Consumption of the two agent types moves south-east along the Pareto frontier in region II in Figure 5. The absolute value of the slope of the frontier is above one and increasing because a larger manufacturing of safe payoffs implies a worsening of loan quality. When ω_S/ω_E becomes sufficiently large, the SP finds optimal to increase savers' utility by allocating some of the economy's endowment to their consumption at $t=0$. This part of the Pareto frontier is labeled as region III in Figure 5.[21]

The trade-off in the d_V choice faced by the SP in (50) is analogous to that faced by the originator in (28). In fact, using the equilibrium funding discount pass-through equation (32), it is immediate to check that the two trade-offs coincide when the SP weights ω_S, ω_E and the equilibrium returns R_S^*, R_E^* satisfy

$$\frac{\omega_S}{\omega_E}=\frac{R_E^*}{R_S^*}. \tag{51}$$

The above property suggests that the competitive equilibrium outcome is Pareto constrained efficient. Conversely, lump-sum transfers from experts to savers at the initial date lead to equilibria with a higher relative equity spread R_E^*/R_S^*. These equilibria are Pareto constrained efficient allocations for higher SP weight ratios ω_S/ω_E (that is, rightwards along the Pareto frontier illustrated in Figure 5). The opposite happens when lump-sum transfers are directed from savers to experts. Building on these intuitions we obtain the following result.

Proposition 7 *The equilibrium of the economy belongs to the Pareto constrained efficient set.*

[21] This region, in which there is no full lending, exists if and only if

$$A_L+(1-\lambda)\max_{d_V}\widehat{p}(d_V)d_V<1,$$

that is, if and only if the maximum amount of safe payoffs that can be created per unit of loan is strictly below one.

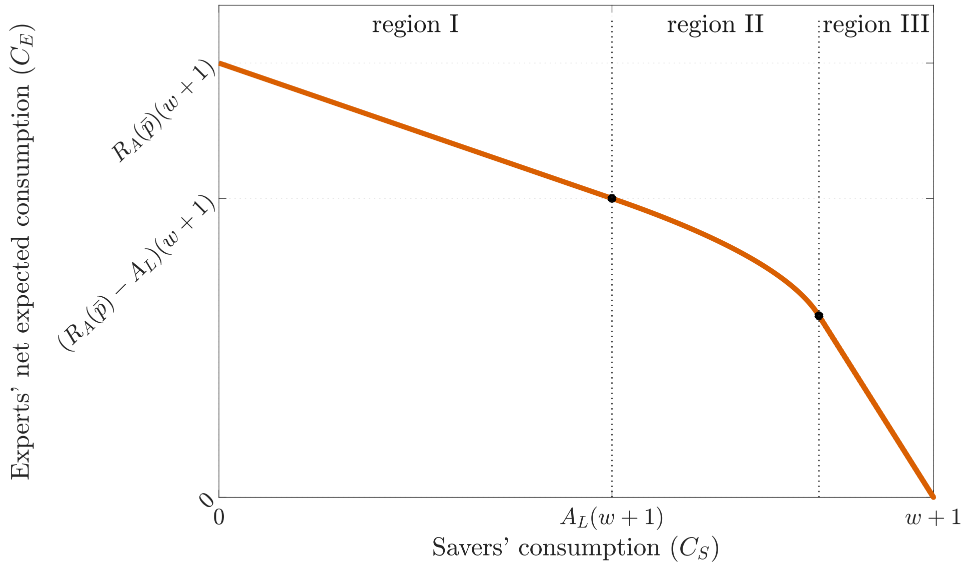

Figure 5: Constrained Pareto frontier

Notes: Constrained Pareto frontier of the economy. The x-axis displays savers' total consumption at both dates: $C_S = w + 1 - N + C_{S,1}$. The y-axis displays experts' total net expected consumption: $C_E = R_A(\widehat{p}(d_V))N - C_{S,1}$.

Any allocation in the Pareto constrained efficient set can be achieved as the equilibrium of the economy following some transfers across investors at the initial date.

The proposition states that constrained versions of the First and Second Welfare Theorems hold in this economy. The reason is that experts can freely set-up and invest in the equity of originators and vehicles, which issue safe and risky securities in competitive markets. As a result, in equilibrium the returns of the three funding sources (equity, and safe and risky securities) lead experts internalize the same trade-off between increasing safe payoffs and worsening loan quality as the as the SP does.[22]

A.2 Proofs of lemmas and propositions

This appendix contains the proofs of the formal results included in the body of the paper.

Proof of Lemma 1 Recall that $R_A(\bar{p}) > 1$ from Assumption 2. Suppose that $R^b_S < 1$. The demand for safe securities would be zero. Since $R_A(\bar{p}) > R^b_S$, we have from (17) that originators would borrow as much as possible and $R^b_{E,O} > R_A(\bar{p})$. Hence, all experts would find optimal to set-up originators and invest in them, so that the supply of safe securities would be strictly positive. The market for safe securities would not clear.

[22]In contrast, it can be proved that when experts' equity allocation is exogenously fixed the resulting equilibrium is not necessarily constrained efficient.

Suppose that $R_S^b > R_A(\bar{p})$. Since $R_A(\bar{p}) > 1$ savers would invest their entire endowment in safe securities and the demand for these assets would be strictly positive. From (17) originators would not find optimal to issue safe securities, so that their supply would be zero. The market for safe securities would not clear.■

Proof of Proposition 2 We proceed in a sequence of steps. Define $\underline{w} = \frac{A_L}{R_A(\overline{p})-A_L}$, $\overline{w} = \frac{A_L}{1-A_L}$.

a) $R_S^b \in (1, R_A(\overline{p}))$ is the safe rate of an equilibrium if and only if $R_S^b = A_L(w+1)/w$, in that case $N^b = w+1$.

Suppose $R_S^b \in (1, R_A(\overline{p}))$. If R_S^b is the safe rate in an equilibrium then the arguments in the main text preceding the proposition show that R_S^b satisfies (19), that is, $R_S^b = A_L(w+1)/w$, and that $N^b = w+1$.

If $R_S^b = A_L(w+1)/w$, then those arguments can be reverted and R_S^b is the safe rate of an equilibrium in which $N^b = w+1$.

b) If $w \in (\underline{w}, \overline{w}]$, then the equilibrium is unique and satisfies the properties in statement ii) in the Proposition.

Suppose first that $w \in (\underline{w}, \overline{w})$. Define R_S^b as $R_S^b = A_L(w+1)/w$. By the definition of $\underline{w}, \overline{w}$, we have that $R_S^b \in (1, R_A(\overline{p}))$ and *a)* shows the existence of an equilibrium.

Suppose there exists another equilibrium and denote $R_S^{b\prime}$ its safe rate. Using Lemma 1, it must be the case that $R_S^{b\prime} = 1$ or $R_S^{b\prime} = R_A(\overline{p})$.

If $R_S^{b\prime} = 1$ then reproducing the arguments in the main text preceding the proposition we have that the supply of safe securities amounts to $\frac{A_L}{R_S^{b\prime}-A_L}$, which satisfies

$$\frac{A_L}{1-A_L} = \overline{w} > w.$$

This implies that the market for safe securities does not clear because their demand is upper bounded by w.

If $R_S^{b\prime} = R_A(\overline{p})$, then we have from (17) that $R_{E,O}^b = R_A(\overline{p})$. Experts would be indifferent between investing in originators and in safe securities. This implies that the supply of safe securities is upper bounded by $\frac{A_L}{R_A(\overline{p})-A_L}$, which satisfies

$$\frac{A_L}{R_A(\overline{p})-A_L} = \underline{w} < w.$$

This implies that the market for safe assets does not clear because their demand is lower bounded by w.

Suppose that $w = \overline{w}$. It suffices to reproduce arguments done above to show that the equilibrium is unique and satisfies $R_S^b = 1$ and $N^b = 1 + w$.

c) If $w > \overline{w}$, then the equilibrium is unique and satisfies the properties in statement iii) in *the Proposition.*

It suffices to reproduce arguments done in the proof of *b)*.

d) If $w \leq \underline{w}$, *then the equilibrium is unique and satisfies the properties in statement i) in the Proposition.*

It suffices to reproduce arguments done in the proof of *b)* .■

Proof of Lemma 3 In the proof we will make use of some expressions and results that are presented in the main text of the paper after Lemma 3. Each time we do so we include a footnote in which we explain why the arguments are not subject to circularity problems. The superscript $*$ will throughout the proof denote equilibrium variables.

We have to prove three results

i) If an equilibrium exists, then $1 \leq R_S^* \leq R_A(\overline{p})$

The inequality $R_S^* \geq 1$ is proven as in Lemma 1.

Suppose that $R_S^* > R_A(\overline{p})$ and an equilibrium exists. Since $R_A(\bar{p}) > 1$ savers would invest their entire endowment in safe securities. Since experts have the option to invest in safe securities, then $R_E^* \geq R_S^*$, because otherwise there would be no investment at all in the economy to back the repayment of safe securities. Suppose that aggregate investment by originators is N^* and their risk choice is p^*. At $t = 1$ all the payoffs in the economy are distributed to the measure N^* of savers and experts that have provided funding either directly or indirectly (through vehicles) to originators. Since $R_E^* \geq R_S^*$, necessarilly have that $R_A(p^*) \geq R_S^*$ which implies $R_A(p^*) > R_A(\overline{p})$, which contradicts (1).

ii) If $1 \leq R_S^* \leq R_A(\overline{p})$, then $R_S^* \leq R_V^* \leq R_E^*$

Suppose that $R_V^* > R_E^*$. From the expression for $R_{E,V}$ in (30),[23] we have that an expert that sets up a vehicle obtains a return on equity $R_{E,V}$ satisfying $R_{E,V} \geq R_V^*$, so that in equilibrium $R_E^* \geq R_{E,V} \geq R_V^*$.

Suppose that $R_S^* > R_V^*$. From (30), we have that an expert that sets up a vehicle can obtain a return on equity $R_{E,V}$ satisfying $R_{E,V} = R_V^*$. Besides, an expert that sets-up an originator obtains a return $R_{E,O}$ satisfying $R_{E,O} \geq R_A(\overline{p}) \geq R_S^* > R_V^*$. All experts would thus find optimal to set-up originators, and the demand for risky securities (whose potential only buyers are vehicles) would be zero. The clearing of the market for risky securities then implies that originators do not issue risky securities. Yet, since $R_V^* < R_S^* \leq R_A(\overline{p})$, from (17) we have that originators would find optimal to issue safe securities in the market for risky securities.

iii) If $1 \leq R_S^* < R_A(\overline{p})$, then $R_S^* < R_V^* < R_E^*$, and if $R_S^* = R_A(\overline{p})$, then $R_S^* = R_V^* = R_E^*$

Suppose that $R_S^* < R_A(\overline{p})$. Since $R_S^* < R_A(\overline{p})$, the arguments in the main text preceding Proposition 2 imply that $R_S^* < R_E^*$ because an originator has the possibility not to issue risky

[23] Equation (30) is presented in Section 5 but is derived directly from expressions (12) and (13) in the vehicle's problem presented in Section 3.

securities. Suppose that $R_V^* = R_E^*$, which implies that $R_S^* < R_V^*$. Then, using expression (32),[24] we would have that $R_S^* = R_{E,V}^* = R_E^* = R_V^*$. Hence, we must have $R_V^* < R_E^*$. Suppose that $R_S^* = R_V^*$. From (30), we would have that $R_S^* = R_{E,V}^* = R_E^*$. Hence, we must have $R_S^* < R_V^*$.

Finally, suppose that $R_S^* = R_A(\overline{p})$. The same argument as at the end of *i)* and *ii)* implies that $R_S^* = R_V^* = R_E^*$. ■

Proof of Lemma 4 The first order condition of the problem in (23), which characterizes the optimal risk-choice p as a function of d_V, is

$$\Delta - d_V = c'(p). \tag{52}$$

The lemma is a direct implication of the optimality condition above and Assumption 1. ■

Proof of Proposition 5 The proof makes use of the equations (28), (32), (33) and (34) derived in section 5. Combining (25) and (26), and using that in equilibrium $R_E^* = R_{E,O}(d_V^*)$, we get that in equilibrium:

$$R_E^* = \frac{R_A(\widehat{p}(d_V^*)) - A_L + (\chi^* - 1)\widehat{p}(d_V^*)d_V^*}{1 - A_L/R_S^*}. \tag{53}$$

We split the proof into two steps. First, we consider the partial equilibrium of the economy in which the safe rate R_S is exogenously fixed. Second, we use the market clearing condition for safe securities to determine the endogenous safe rate R_S^*.

i) Partial equilibrium with exogenous safe rate R_S. Consider an exogenous safe rate R_S. We denote partial equilibrium variables with the superscript $*$ and make explicit their dependence on R_S. The following sequence of lemmas provides a characterization of the equilibrium with exogenous safe rate.

Lemma A.1 For a given exogenous safe rate $R_S < R_A(\overline{p})$, if a partial equilibrium exists, then the associated equilibrium returns $R_V^*(R_S)$ and $R_E^*(R_S)$ satisfy

$$R_S < R_V^*(R_S) < R_E^*(R_S).$$

Proof It suffices to reproduce the arguments done in the proof of part *iii)* of Lemma 3. ■

All the derivations in section 5 up to (33) remain valid in a partial equilibrium context in which the exogenous safe rate satisfies $R_S < R_A(\bar{p})$. As a result, a partial equilibrium exists if and only if the system of equations (28), (32), (33) and (53) in the four variables $d_V^*, R_E^*, \chi^*, E_O^*$ has a solution, and conversely, any partial equilibrium is described by a solution to that system.

[24]Equation (32) is presented in Section 5. It can be checked that it only relies on the definitions in Section 3 and on $R_S^* < R_V^*$, and thus makes no use of the equilibrium results in Lemma 3.

Notice that in the derivation in the main text of (28) we have stated that, when an equilibrium exists, the originator's problem has a unique solution given by a FOC. This unproven statement is shown in the next lemma.

Lemma A.2 For given $R_S < R_A(\overline{p})$, let $\overline{R}_V > \underline{R}_V$ be the positive constants given by

$$\overline{R}_V = \frac{R_A(\overline{p}) - A_L}{1 - A_L/R_S} \text{ and } \underline{R}_V = \frac{\max_{d_V}\left(\widehat{p}(d_V)d_V\right)}{1 - A_L/R_S}.$$

Suppose that $R_V > R_S$. Then if $R_V \in \left(\underline{R}_V, \overline{R}_V\right)$, the solution d_V^* to (27) is unique, satisfies

$$\left(\frac{R_{E,O}(d_V)}{R_V} - 1\right)\frac{\mathrm{d}(\widehat{p}(d_V)d_V)}{\mathrm{d}d_V} + \frac{\mathrm{d}R_A(\widehat{p}(d_V))}{\mathrm{d}d_V} = 0, \tag{54}$$

and leads to $R_{E,O}(d_V^*) > R_V$. Besides, if $R_V \geq \overline{R}_V$ then $d_V^* = 0$ is the unique solution to (27), while if $R_V \leq \underline{R}_V$, then $R_{E,O}(d_V)$ can grow unboundedly.

Proof We first present the following results which are an immediate consequence of (16), Lemma 4 and (52), and will be used without explicit reference throughout the proof of this lemma and the next proposition:

$$\frac{\mathrm{d}(\widehat{p}(d_V))}{\mathrm{d}d_V} = -\frac{1}{c''(\widehat{p}(d_V))}, \tag{55}$$

$$\frac{\mathrm{d}R_A(\widehat{p}(d_V))}{\mathrm{d}d_V} \leq 0 \text{ with equality iff } d_V = 0. \tag{56}$$

Consider an exogenous $R_S < R_A(\overline{p})$ and $R_V > R_S$. Let $\overline{R}_V > \underline{R}_V$ be the constants defined in the Lemma. By definition we have that $\overline{R}_V = R_{E,O}(0)$. The originator's problem is described by (27). Denote with d_V^* any of its solutions in case they exist. After some algebra, we have from (25) and (26) that:

$$\frac{\mathrm{d}R_{E,O}(d_V)}{\mathrm{d}d_V} = \frac{\left(R_{E,O}(d_V) - R_V\right)\left(\frac{1}{R_V}\frac{\mathrm{d}(\widehat{p}(d_V)d_V)}{\mathrm{d}d_V}\right) + \frac{\mathrm{d}R_A(\widehat{p}(d_V))}{\mathrm{d}d_V}}{1 - A_L/R_S - \widehat{p}(d_V)d_V/R_V}, \tag{57}$$

$$\left.\frac{\mathrm{d}R_{E,O}(d_V)}{\mathrm{d}d_V}\right|_{d_V=0} = \frac{\left(\overline{R}_V - R_V\right)\frac{\overline{p}}{R_V}}{1 - A_L/R_S}. \tag{58}$$

We proceed in a sequence of steps.

i) If $R_V \geq \overline{R}_V$ then $d_V^* = 0$ is the unique solution to (27).

If $R_V \geq \overline{R}_V$, then consider the function

$$G(a) = \frac{R_A(\overline{p}) - A_L - a}{1 - A_L/R_S - a/R_V}.$$

We have:

$$G'(a) = \frac{(R_A(\overline{p}) - A_L)/R_V - (1 - A_L/R_S)}{(1 - A_L/R_S - a/R_V)^2}.$$

Using the definition of $\overline{R}_V$ and $R_V \geq \overline{R}_V$, we have from the expression above that $G'(a) \leq 0$. The following sequence of inequalities follows immediately for $d_V > 0$:

$$R_{E,O}(d_V) = \frac{R_A(\overline{p}) - A_L - \widehat{p}(d_V)d_V}{1 - A_L/R_S - \widehat{p}(d_V)d_V/R_V} = G(\widehat{p}(d_V)d_V) \leq G(0) = R_{E,O}(0),$$

which proves the claim.

ii) If $R_V \leq \underline{R}_V$ then a solution to (27) does not exist, because $R_{E,O}(d_V)$ can grow unboundedly

We have from Assumption 1 and (52) that for any $d_V \in [0, \Delta)$:

$$R_A(\widehat{p}(d_V)) - A_L - \widehat{p}(d_V)d_V = \widehat{p}(d_V)c'(\widehat{p}(d_V)) - c(\widehat{p}(d_V)) > 0. \tag{59}$$

By definition of $\underline{R}_V$ we have that $1 = A_L/R_S + \max_{d_V}(\widehat{p}(d_V)d_V)/\underline{R}_V$. As a result, if $R_V \leq \underline{R}_V$ for d_V sufficiently close to $\arg\max_{d_V}(\widehat{p}(d_V)d_V)$ the originator could lever up unboundedly and from (59) its equity return would also do so.

iii) If $R_V \in (\underline{R}_V, \overline{R}_V)$ then any d_V^* satisfies (54).

If $R_V \in (\underline{R}_V, \overline{R}_V)$ then $R_{E,O}(d_V)$ is bounded in the compact interval $[0, \Delta]$ and some d_V^* exists. From (58) we have that $\left.\frac{\mathrm{d}R_{E,O}(d_V)}{\mathrm{d}d_V}\right|_{d_V=0} > 0$. Besides, since $\widehat{p}(\Delta) = 0$, we have that $R_{E,O}(\Delta) = 0 < R_{E,O}(0)$. Hence any d_V^* must be interior and satisfy $\left.\frac{\mathrm{d}R_{E,O}(d_V)}{\mathrm{d}d_V}\right|_{d_V=d_V^*} = 0$, which from (57) is equivalent to (54).

iv) For given $\chi \geq 1$, the following equation in d_V has a unique solution in the interval $[0, \Delta]$:

$$(\chi - 1)\frac{\mathrm{d}(\widehat{p}(d_V)d_V)}{\mathrm{d}d_V} + \frac{\mathrm{d}R_A(\widehat{p}(d_V))}{\mathrm{d}d_V} = 0. \tag{60}$$

Using (16) and (52), (60) can be rewritten as

$$d_V = \frac{(\chi - 1)}{\chi}\widehat{p}(d_V)c''(\widehat{p}(d_V)), \tag{61}$$

so that it is sufficient to prove that this equation has a unique solution. From Assumption 1, we have that

$$\frac{\mathrm{d}(\widehat{p}(d_V)c''(\widehat{p}(d_V))}{\mathrm{d}d_V} \leq -1. \tag{62}$$

If $\chi > 1$, from (62) we have that the RHS in (61) is decreasing in d_V. Besides from Assumption 1 and Lemma 4 it is strictly positive for $d_V = 0$ and is zero for $d_V = \Delta$. Hence it has a unique intersection with the line d_V in the interval $(0, \Delta)$, and (61) has a unique solution. If $\chi = 1$, we trivially have that $d_V = 0$ is the unique solution of (61).

v) If $R_V \in \left(\underline{R}_V, \overline{R}_V\right)$ then d_V^* is unique.

Suppose $R_V \in \left(\underline{R}_V, \overline{R}_V\right)$ and there exist two solutions. From *iii),* they must satisfy (54). Let $R_{E,O}^*$ the originator's equity return they lead to. Define $\chi = R_{E,O}^*/R_V$. Since $\left.\frac{\mathrm{d}R_{E,O}(d_V)}{\mathrm{d}d_V}\right|_{d_V=0} > 0$ we have $R_{E,O}^* > \overline{R}_V > R_V$ and $\chi > 1$. By definition of equation (60) and χ, any solution to (54) is also a solution to (60), and conversely. From iv) the latter equation has a unique solution, which contradicts that the former has at least two.■

The next lemma uses (28) and (33) to derive the partial equilibrium variables $d_V^*(R_S), p^*(R_S), E_O^*(R_S)$ as a function of the partial equilibrium variable $\chi^*(R_S)$.

Lemma A.3 There exists a function $\widehat{d}_V(\chi)$ defined for any $\chi \geq 1$, such that if a partial equilibrium exists for a given safe rate $R_S < R_A(\overline{p})$ then the partial equilibrium variables $d_V^*(R_S), p^*(R_S), E_O^*(R_S)$ and $\chi^*(R_S)$ satisfy

$$d_V^*(R_S) = \widehat{d}_V(\chi^*(R_S)), p^*(R_S) = \widehat{p}\left(\widehat{d}_V(\chi^*(R_S))\right), \tag{63}$$

$$E_O^*(R_S) = \frac{R_A\left(\widehat{p}\left(\widehat{d}_V(\chi^*(R_S))\right)\right) - A_L - \widehat{p}\left(\widehat{d}_V(\chi^*(R_S))\right)\widehat{d}_V(\chi^*(R_S))}{R_A\left(\widehat{p}\left(\widehat{d}_V(\chi^*(R_S))\right)\right) - A_L - (1-\lambda)\widehat{p}\left(\widehat{d}_V(\chi^*(R_S))\right)\widehat{d}_V(\chi^*(R_S))}. \tag{64}$$

In addition, the function $\widehat{d}_V(\chi)$ satisfies

$$\frac{\mathrm{d}\widehat{d}_V(\chi)}{\mathrm{d}\chi} > 0, \frac{\mathrm{d}\widehat{p}\left(\widehat{d}_V(\chi)\right)}{\mathrm{d}\chi} < 0, \frac{\mathrm{d}\left(\widehat{p}\left(\widehat{d}_V(\chi)\right)\widehat{d}_V(\chi)\right)}{\mathrm{d}\chi} > 0, \text{ and } \widehat{d}_V(1) = 0. \tag{65}$$

Proof Recall partial result *iv)* in the proof of Lemma A.2. For given $\chi \geq 1$, denote $\widehat{d}_V(\chi)$ the unique solution to (60), or equivalently to (61). We proceed in two steps:

i) The function $\widehat{d}_V(\chi)$ satisfies the properties in (65)

We have that $\frac{(\chi-1)}{\chi}$ is increasing in χ for $\chi \geq 1$. From (62) we immediately have that $\frac{\mathrm{d}\widehat{d}_V(\chi)}{\mathrm{d}\chi} > 0$, and hence from Lemma 4 that $\frac{\mathrm{d}\widehat{p}\left(\widehat{d}_V(\chi)\right)}{\mathrm{d}\chi} < 0$. Besides, from (61) we have after some immediate algebra that

$$\frac{\mathrm{d}\left(\widehat{p}\left(\widehat{d}_V(\chi)\right)\widehat{d}_V(\chi)\right)}{\mathrm{d}\chi} = \frac{\widehat{p}\left(\widehat{d}_V(\chi)\right)}{\chi}\frac{\mathrm{d}\widehat{d}_V(\chi)}{\mathrm{d}\chi}. \tag{66}$$

Moreover, from (61) and $\widehat{p}(d_V) = 0$ if and only if $d_V = \Delta$, we have that $\widehat{p}\left(\widehat{d}_V(\chi)\right) > 0$ for all $\chi \geq 1$. We hence have from (66) and $\frac{\mathrm{d}\widehat{d}_V(\chi)}{\mathrm{d}\chi} > 0$ that $\frac{\mathrm{d}\left(\widehat{p}\left(\widehat{d}_V(\chi)\right)\widehat{d}_V(\chi)\right)}{\mathrm{d}\chi} > 0$.

Finally, (61) implies that $\widehat{d}_V(1) = 0$ and a continuity argument leads to $\lim_{\chi\to 1} \widehat{d}_V(\chi) = 0$.

ii) The function $\widehat{d}_V(\chi)$ satisfies the properties in (63) and (64)

Immediate from the definition of $\widehat{d}_V(\chi)$ and (28), (33). ■

The next lemma uses (53), (32) and Lemma A.3 to derive the partial equilibrium variables $R_E^*(R_S), \chi^*(R_S)$.

Lemma A.4 There exists $\underline{R}_S \in (A_L, R_A(\overline{p}))$*, such that for a given safe rate* $R_S < R_A(\overline{p})$ *a partial equilibrium exists if and only if* $R_S > \underline{R}_S$*, in which case the equilibrium is unique. For* $R_S > \underline{R}_S$*, the functions* $R_E^*(R_S), \chi^*(R_S)$ *describing the partial equilibrium return on equity and vehicle funding discount, respectively, satisfy*

$$\begin{aligned}\frac{\mathrm{d}R_E^*(R_S)}{\mathrm{d}R_S} &< 0, \lim_{R_S \to \underline{R}_S} R_E^*(R_S) = \infty, \text{ and } \lim_{R_S \to R_A(\overline{p})} R_E^*(R_S) = R_A(\overline{p}),\\ \frac{\mathrm{d}\chi^*(R_S)}{\mathrm{d}R_S} &< 0, \lim_{R_S \to \underline{R}_S} \chi^*(R_S) = \infty, \text{ and } \lim_{R_S \to R_A(\overline{p})} \chi^* = 1.\end{aligned}$$

Proof We start defining the following function:

$$\widehat{R}_E(R_S, \chi) = \frac{R_A(\widehat{p}(\widehat{d}_V(\chi))) - A_L + (\chi - 1)\widehat{p}(\widehat{d}_V(\chi))\widehat{d}_V(\chi)}{1 - A_L/R_S}. \tag{67}$$

Suppose a partial equilibrium exists. Then from (53), (32) and the definition above we have that the equilibrium variables $R_E^*(R_S), \chi^*(R_S)$ satisfy:

$$\chi^*(R_S) = (1 - \lambda)\frac{\widehat{R}_E(R_S, \chi^*(R_S))}{R_S} + \lambda, \tag{68}$$

and $R_E^*(R_S) = \widehat{R}_E(R_S, \chi^*(R_S))$. In addition, we have from (67):

$$\frac{\partial \widehat{R}_E(R_S, \chi)}{\partial R_S} < 0 \text{ and } \frac{\partial \widehat{R}_E(R_S, \chi)}{\partial \chi} = \frac{\widehat{p}(\widehat{d}_V(\chi))\widehat{d}_V(\chi)}{1 - A_L/R_S} > 0, \tag{69}$$

where for the partial derivative with respect to χ we have used the optimality condition in (28) and that $\frac{dR_A(p)}{dp} = \Delta - c'(p)$.

Let $R_S < R_A(\overline{p})$. Any equilibrium vehicle discount χ^* satisfies $\chi^* \geq 1$ and (68), and conversely. We denote with $G(\chi^*, R_S)$ the function of χ^* and R_S in the RHS of (68). Using (69), we have that

$$\frac{\partial G(\chi^*, R_S)}{\partial \chi^*} = \frac{(1 - \lambda)\widehat{p}(\widehat{d}_V(\chi^*))\widehat{d}_V(\chi^*)}{R_S - A_L}. \tag{70}$$

We proceed in a sequence of steps:

i) For any R_S*, any solution* $\chi^* \geq 1$ *to (68) satisfies* $\frac{\partial G(\chi^*, R_S)}{\partial \chi^*} < 1$.

Suppose that there exists a solution $\chi^* \geq 1$ to (68) with $\frac{\partial G(\chi^*, R_S)}{\partial \chi^*} \geq 1$. Let R_E^* and R_V^* denote the equilibrium returns in the economy with equilibrium vehicle discount χ^*. From (70) we have

$$\frac{\widehat{p}(\widehat{d}_V(\chi^*))\widehat{d}_V(\chi^*)}{R_S - A_L} \geq \frac{1}{1 - \lambda}. \tag{71}$$

Recall from Lemma A.2 that if an equilibrium exists we must have $R_V^* > \underline{R}_V$, otherwise R_E^* would be infinity and χ^* as well. From the definition of $\underline{R}_V$ and (71), we have that

$$\underline{R}_V = \frac{\max_{d_V} \widehat{p}(d_V)d_V}{1 - A_L/R_S} \geq \frac{\widehat{p}(d_V(\chi^*))d_V(\chi^*)}{1 - A_L/R_S} \geq \frac{R_S}{1-\lambda}.$$

The equilibrium condition (32) and the inequality above imply that

$$\frac{1}{R_V^*} = (1-\lambda)\frac{1}{R_S} + \frac{1}{R_E^*} > \frac{1-\lambda}{R_S} \geq \frac{1}{\underline{R}_V},$$

which contradicts that $R_V^* < \underline{R}_V$.

ii) Equation (68) has at most one solution $\chi^* \geq 1$

Suppose that there exist two solutions $\chi_1^* < \chi_2^*$. Notice that the derivative with respect to χ^* of the LHS of (68) is equal to one. From Lemma A.3 and (70) we have that $\frac{\partial^2 G(\chi^*, R_S)}{\partial^2 \chi^*} > 0$. And then the existence of two solutions $\chi_1^* < \chi_2^*$, implies that

$$\frac{\partial G(\chi_1^*, R_S)}{\partial \chi^*} < 1 < \frac{\partial G(\chi_2^*, R_S)}{\partial \chi^*}.$$

The second inequality contradicts *i)*.

Before stating the next partial results, we denote

$$\Gamma = \{R_S : R_S < R_A(\overline{p}) \text{ st } (68) \text{ has a solution } \chi^* \geq 1\}.$$

From *ii)* we can define for any $R_S \in \Gamma$ the unique solution to (68) as $\chi^*(R_S)$. We also introduce the function $F^*(R_S) = \left.\frac{\partial G(\chi^*, R_S)}{\partial \chi^*}\right|_{\chi^* = \chi^*(R_S)}$.

iii) Γ *is non empty*

We have from (70) and Proposition 3 that $\frac{\partial G(\chi^*=1, R_S)}{\partial \chi^*} = 0$. In addition, from (53) we have

$$\lim_{R_S \to R_A(\overline{p})} R_E^*(R_S, \chi^* = 1) = R_A(\overline{p}),$$

so that as $R_S \to R_A(\overline{p})$, we have that $G(1, R_S)$ tends to 1. Then equation (68) necessarily has a solution for R_S sufficiently close to $R_A(\overline{p})$.

iv) If $R_{S,1}, R_{S,2} < R_A(\overline{p})$ *with* $R_{S,1} < R_{S,2}$ *and* $R_{S,1} \in \Gamma$, *then* $R_{S,2} \in \Gamma$

This simply results from the fact that $G(\chi^*, R_S)$ is decreasing in R_S and that for all $R_S < R_A(\overline{p})$ we have $G(\chi^* = 1, R_S) > 1$.

v) There exists $\underline{R}_S < R_A(\overline{p})$ *such that* $\Gamma = (\underline{R}_S, R_A(\overline{p}))$

Let $\underline{R}_S = \inf(\Gamma)$. It suffices to prove that $\underline{R}_S \notin \Gamma$. Suppose that $\underline{R}_S \in \Gamma$. Then *i)* implies that $F^*(\underline{R}_S) < 1$. By definition this implies that for small $\varepsilon > 0$, we have that $\chi^* \in (\chi^*(\underline{R}_S), \chi^*(\underline{R}_S) + \varepsilon)$ implies $\chi^* > G(\chi^*, \underline{R}_S)$. And thus for small $\delta > 0$, we have that $R_S' \in (\underline{R}_S - \delta, \underline{R}_S)$ implies that

$\chi^* > G(\chi^*, R'_S)$. Since we have that $1 < G(\chi^* = 1, R'_S)$, we conclude that $R'_S \in \Gamma$. But we have that $R'_S < \underline{R}_S = \inf(\Gamma) \leq R'_S$.

vi) $\chi^*(R_S)$ is strictly decreasing in R_S, with $\lim_{R_S \to R_A(\overline{p})} \chi^*(R_S) = 1$

The monotonicity of $\chi^*(R_S)$ can be obtained by derivating implicitly equation (68) and using *i),* and $\frac{\partial G(\chi_1^*, R_S)}{\partial R_S} < 0$. The other statement results from $\lim_{R_S \to R_A(\overline{p})} G(\chi^* = 1, R_S) = 1$ and *ii).*

vii) $R_E^*(R_S)$ is strictly decreasing in R_S, with $\lim_{R_S \to R_A(\overline{p})} R_E^*(R_S) = R_A(\overline{p})$

By definition we have $R_E^*(R_S) = R_E^*(R_S, \chi^*(R_S))$. The monotonicity of $R_E^*(R_S)$ is immediately obtained from (69) and *vi).* ■

Lemma A. 5 For a given safe rate $R_S \in (\underline{R}_S, R_A(\overline{p}))$, the partial equilibrium aggregate investment $N^*(R_S)$ is given by

$$N^*(R_S) = \frac{1}{1 - (A_L + (1-\lambda)p^*(R_S)d_V^*(R_S))/R_S}, \tag{72}$$

and satisfies

$$\frac{\mathrm{d}N^*(R_S)}{\mathrm{d}R_S} < 0, \lim_{R_S \to \underline{R}_S} N^*(R_S) = \infty.$$

Proof From (21), we have that the overall supply of safe securities by originators is

$$E_O^* x_S^* = \frac{A_L N^*}{R_S^*}, \tag{73}$$

and from (31) and the market clearing for risky securities $E_O^* x_V^* = E_V^* y^*$, we obtain that supply of safe securities by vehicles is:

$$E_V^* y_S^* = \frac{(1-\lambda)\widehat{p}(d_V^*)d_V^* N^*}{R_S^*}. \tag{74}$$

The expression in (72) is obtained from (73), (74) and the aggregate flow of funds constraints that implies $N^* = E_O^* + E_V^* + E_O^* x_S^* + E_V^* y_S^* = 1 + E_O^* x_S^* + E_V^* y_S^*$. The remaining results are a consequence of Lemma A.3 and Lemma A.4. ■

ii) General equilibrium with endogenous safe rate R_S^*. We have proven so far that for a given exogenous $R_S \in (\underline{R}_S, R_A(\overline{p}))$ the partial equilibrium of the economy exists, is unique and described by the previous lemmas. We use these results and the market clearing condition for safe securities, to prove existence and uniqueness of the general equilibrium with an endogenous safe rate R_S^*.

We start with the following observation. In an equilibrium with $1 < R_S^* < R_A(\bar{p})$ the market for safe securities clears if and only if (34) is satisfied. Taking into account that in such an equilibrium there is full lending, we have equivalently that the satisfaction of (34) is equivalent to

$$N^*(R_S^*) = w + 1, \tag{75}$$

where the function $N^*(R_S)$ is defined in (72).

Recall the defintion of the variable $\underline{w} \equiv \frac{A_L}{R_A(\overline{p}) - A_L}$. Using the partial equilibrium functions $p^*(R_S), d_V^*(R_S)$, define

$$\overline{\overline{w}} \equiv \begin{cases} \frac{A_L + (1-\lambda)p^*(1)d_V^*(1)}{A_L + (1-\lambda)p^*(1)d_V^*(1) - 1} & \text{if } \underline{R}_S < 1 \\ \infty & \text{otherwise} \end{cases}.$$

Existence of general equilibrium

a) If $R_S \in (\underline{R}_S, R_A(\overline{p}))$ *and* $R_S > 1$ *(*$R_S = 1$*), then* $N^*(R_S) = w + 1$ *(*$N^*(R_S) \leq w + 1$*) if and only if* R_S *is the safe rate in some general equilibrium*

Suppose a given safe rate R_S satisfying $R_S \in (\underline{R}_S, R_A(\overline{p}))$ and $R_S > 1$. We know that a unique partial equilibrium of the economy exists for such R_S. In addition, since $N^*(R_S) = w+1$, condition (75) is also satisfied, which implies that the market for safe securities clears for such value of R_S. The result then follows.

The statement for $R_S = 1$ is proven analogously after noticing that when the safte rate equals one savers are indifferent between investing in safe securities or consuming, and aggregate lending satisfies $N^* \leq w + 1$.

b) If $w \in (\underline{w}, \overline{\overline{w}}]$ *there exists an equilibrium satisfying* $R_S^* < R_A(\bar{p}) < R_E^*, p^* < \overline{p}$ *and* $N^* = w + 1$. *Moreover, the equilibrium is unique within the class of equilibria with* $R_S^* < R_A(\bar{p})$.

Suppose that $w \in (\underline{w}, \overline{\overline{w}}]$. From (72), we have that

$$\lim_{R_S \to R_A(\overline{p})} N^*(R_S) < w + 1 \Leftrightarrow w > \underline{w}. \tag{76}$$

Using Lemma A.5 and the definition of $\underline{w}$, we conclude that there exists a solution $R_S^* < R_A(\overline{p})$ such that $N^*(R_S^*) = w + 1$ iff $w > \underline{w}$, and in such a case the solution is unique. In addition, the solution R_S^* satisfies $R_S^* \geq 1$ iff $\underline{R}_S < 1$ and $N^*(1) \geq w + 1$, which from the definition of $\overline{w}$ is equivalent to $w \leq \overline{\overline{w}}$. The result is then a consequence of *a)*, Lemma A.3 and Lemma A.4.

c) If $w > \overline{\overline{w}}$ *there exists an equilibrium satisfying* $1 = R_S^* < R_A(\bar{p}) < R_E^*$, $p^* < \overline{p}$ *and* $N^* = \overline{\overline{w}} + 1 \in (N^b, w + 1)$. *Moreover, the equilibrium is unique within the class of equilibria with* $R_S^* < R_A(\bar{p})$.

Suppose that $w > \overline{\overline{w}}$. From the definition of $\overline{\overline{w}}$, this implies that $\underline{R}_S < 1$. From (72), we have also that $N^*(1) = \overline{\overline{w}} + 1 < w + 1$. Then *a)* implies that $R_S^* = 1$ is the safe rate of a general equilibrium. The results for R_E^*, p^* are then a consequence of Lemma A.3 and Lemma A.4. The inequality $N^* > N^b$ results from Proposition 2. Finally, for any $R_S \in (1, R_A(\bar{p}))$ we have from

Lemma A.5 that $N^*(R_S) < w + 1$ and *a)* implies that R_S is not the safe rate in some general equilibrium.

d) If $w \leq \underline{w}$ *there exists M-M equilibria with* $R_S^* = R_E^* = R_A(\bar{p})$, $p^* = \overline{p}$ *and* $N^* = 1$

Suppose that $w \leq \underline{w}$. The equilibria of the economy with no vehicles are in the M-M indifference region and satisfy $R_S^* = R_E^* = R_A(\bar{p})$. Consider one such equilibrium and suppose the return of the risky securities is $R_V^* = R_A(\bar{p})$. It is easy to directly prove from the originator's problem (3) - (9) that for the pair of returns $R_S^* = R_V^* = R_A(\bar{p})$ it is weakly optimal for the originator to choose $d_V = 0$. If originators do not issue risky securities, then market clearing implies that the supply of risky securities is zero which means that vehicles do not enter. This proves that the equilibrium of the no securitization benchmark economy can be sustained when experts can set up vehicles and they expect a return for risky securities $R_V^* = R_A(\bar{p})$ in that market.

e) An equilibrium exists.

Immediate from *b), c)* and *d).*

Uniqueness of equilibrium

f) If $w > \underline{w}$ *the equilibrium is unique.*

Suppose that $w > \underline{w}$. We have from *b)* and *c)* that the economy has a unique equilibrium with a safe rate $R_S^* < R_A(\bar{p})$. Suppose that $R_S^* = R_A(\bar{p})$ is the safe rate in some general equilibrium. Then, Lemma 3 implies that $R_S^* = R_V^* = R_E^* = R_A(\bar{p})$ and the arguments made in the proof of that lemma imply that originator's risk choice is $p^* = \overline{p}$. Besides, aggregate investment must be $N^* = 1 + w$. Let d_S^*, d_V^* be the equilibrium safe and risky promises per unit of loan made by originators. From (9) we have that $p^* = \overline{p}$ implies that $d_S^* + d_V^* \leq A_L$, and thus risky securities are in fact safe. This means that vehicles, in case they enter in the economy, they do not expand the supply of safe securities by diversifying idiosyncratic risks. Formally, the supply of safe securities in this economy is necessarilly upper bounded by

$$\frac{A_L N^*}{R_S^*} = \frac{A_L(w+1)}{R_A(\bar{p})} = \frac{\underline{w}}{\underline{w}+1}(w+1).$$

Besides, since $R_S^* > 1$, savers find strictly optimal to invest in safe securities and the demand for safe securities is at least w. But since $w > \underline{w}$ then this market does not clear. We conclude that $R_S^* = R_A(\bar{p})$ cannot be the safe rate in some general equilibrium.

g) If $w \leq \underline{w}$ *all the equilibria are M-M type with* $R_S^* = R_E^* = R_A(\bar{p}), p^* = \overline{p}$ *and* $N^* = w + 1$

Suppose there exists an equilibrium with $R_S^* < R_A(\bar{p})$. Then, *a)* implies that $N^*(R_S^*) \leq w + 1$. From Lemma A.5, we have that $\lim_{R_S \to R_A(\overline{p})} N^*(R_S) < w + 1$ and (76) states that $w > \underline{w}$. We conclude that any equilibrium must have $R_S^* = R_A(\bar{p})$. Reproducing arguments made in f*)* we get the result.

h) The equilibrium is unique up to M-M indifference if and only if $w \leq \underline{w}$

Immediate from *f)* and *g).* ■

Proof Proposition 6 We denote with λ_0 the exogenous aggregate risk parameter in the baseline economy and refer to an economy with generic aggregate risk parameter λ as a λ-economy. We denote equilibrium variables with the superscript * and explicitly show their dependence on λ and w.

We prove the proposition in two steps.

i) The equilibrium in the risky economy is equivalent to the one in the baseline economy with $\lambda = 0$.

Originators' problem is the same in the risky economy than in the baseline economy. However, market clearing conditions change since savers buy directly the risky securities. In the risky economy, savers are indifferent between holding safe or risky securities so their returns must be the same: $R_S = R_V$. Vehicles do not enter the market. Thus, we have that all equity is allocated to originators $E_O = 1$. The market clearing of total originators' external funding implies:

$$R_S w = R_V w = (A_L + p d_V) N.$$

It is easy to see from the system (28), (32), (33), (53), and (34) that determines the equilibrium in the baseline economy that this is the case in the baseline economy with $\lambda = 0$.

ii) There exists $\tilde{\lambda}$ *such that for* $0 < \lambda < \tilde{\lambda}$ *there exist values of savers' endowment* w *such that* $p^*(\lambda; w) < p^*(0; w)$

Recall that from (28) we have that the equilibrium $d_V^*(\lambda; w)$ and so $p^*(\lambda; w)$ are determined only by the equilibrium vehicle discount $\chi^*(\lambda; w)$. So, it suffices to prove that $\chi^*(\lambda; w) > \chi^*(0; w)$ for $\lambda < \tilde{\lambda}$ and some w.

From (32) it follows that

$$\frac{d\chi^*(\lambda; w)}{d\lambda} = -\left(\frac{R_E^*(\lambda; w)}{R_S^*(\lambda; w)} - 1\right) + \frac{d\left(\frac{R_E^*(\lambda; w)}{R_S^*(\lambda; w)}\right)}{d\lambda}. \tag{77}$$

The first term in the RHS of (77) is negative, and represents the direct effect of a change in λ in (32): for given equity spread a higher λ reduces the leverage of vehicles and the discount they can offer. The second term in the RHS of (77) represent the indirect effect in (32) through the change in the equity spread: higher λ reduces the amount of safe payoffs, thus increases the rents obtained by experts and the equity spread.

For the case of full investment ($w \in (\underline{w}, \overline{w}]$) in the baseline economy, we have from (34) and (**??**) that

$$\frac{R_E^*(\lambda; w)}{R_S^*(\lambda; w)} = \frac{R_A(p^*(\lambda; w)) - A_L - (1-\lambda)p^*(\lambda; w)d_V^*(\lambda; w)}{(A_L + (1-\lambda)p^*(\lambda; w)d_V^*(\lambda; w))\,\frac{1}{w}}. \tag{78}$$

From (77) and (78), we have that

$$\operatorname{sgn}\left(\frac{d\chi^*(\lambda;w)}{d\lambda}\right)=\operatorname{sgn}\left(H(\lambda,w)\right), \tag{79}$$

with

$$H(\lambda,w)=-\left(\frac{R_E^*(\lambda,w)}{R_S^*(\lambda,w)}-1\right)+(1-\lambda)p^*(\lambda,w)d_V^*(\lambda,w)\frac{(1+w)}{R_S^*(\lambda,w)}\left(1+\frac{R_E^*(\lambda,w)}{R_S^*(\lambda,w)}\frac{1}{w}\right). \tag{80}$$

Using (61), which is an implication of (28), we have that (after some manipulations)

$$\operatorname{sgn}\left(H(\lambda,w)\right)=\operatorname{sgn}\left(pc''(p)(1-\lambda)^2p\frac{1+w}{R_S}\left(1+\frac{R_E}{R_S}\frac{1}{w}\right)-\chi\right), \tag{81}$$

and

$$\lim_{w\to\underline{w}}\operatorname{sgn}\left(H(\lambda,w)\right)=\operatorname{sgn}\left(\bar{p}c''(\bar{p})\bar{p}\left(\frac{R_A}{R_A-A_L}\frac{1}{A_L}\right)-\frac{1}{(1-\lambda)^2}\right). \tag{82}$$

Since from Assumption 1 we have that the first term in the RHS of (82) is greater than 1, we can see that there exist $\tilde{\lambda}$ such that, for $\lambda\in(0,\tilde{\lambda})$, $\lim_{w\to\underline{w}}\operatorname{sgn}\left(H(\lambda,w)\right)>0$. Therefore, from (79) we have that $\lim_{w\to\underline{w}}\chi^*(\lambda,w)$ is increasing in $\lambda\in(0,\tilde{\lambda})$, which immediately proves the statement. ■

Proof of Proposition 7 Recall the variables $\underline{R}_S\in(A_L,R_A(\overline{p}))$ defined in Lemma A.4, and $\underline{w},\overline{w},\overline{\overline{w}}$ defined in Proposition 5. We rely extensively in this proof without explicit reference to the results in Proposition 5 and to the discussion in the main text preceding Proposition 7, in particular the equivalence between the FOC in (50) and that in (28) after plugging in (32).

We first describe the set of Pareto efficient allocations. For SP weights ω_S,ω_E with $\omega_E>0$, we define $\omega\equiv\omega_S/\omega_E$ and adopt the convention that $\omega=\infty$ when $\omega_E=0$. We have from (45) that if $\omega_E>0$ then the associated optimal allocations depend only on ω. Besides, we have from the main text that optimal allocations are described by a tuple $(N,d_V,C_{S,0},C_{S,1})$. For each value of ω, the optimal allocations are denoted with a superscript SP, can be obtained from (45), and are presented next (Details of the derivations are ommitted):

Region I. For $\omega\leq 1$: $N^{SP}=w+1,d_V^{SP}=0,C_{S,0}^{SP}=0,C_{S,1}^{SP}$ is any value satisfyng (49) (with $C_{S,1}^{SP}=0$ for $\omega<1$).

For the rest of the allocation Pareto frontier, we distinguish two cases:

Case $\underline{R}_S\geq 1$ ($\Leftrightarrow\overline{\overline{w}}=\infty$):

Region II. For $\omega>1$: $N^{SP}=w+1,d_V^{SP}\in(0,\Delta)$ is the unique solution to (50)$,C_{S,0}^{SP}=0,C_{S,1}^{SP}$ satisfies (49) with equality.

Case $\underline{R}_S<1$ ($\Leftrightarrow\overline{\overline{w}}<\infty$): Let $\chi^*(R_S=1)$ denote the vehicle funding discount in the equilibrium of the economy with an exogenous $R_S = 1$. Define $\overline{\omega} = (1-\lambda)\chi^*(R_S = 1)$.

Region II. For $\omega \in (1, \overline{\omega})$: $N^{SP} = w + 1, d_V^{SP} \in (0, \Delta)$ is the unique solution to (50), $C_{S,0}^{SP} = 0, C_{S,1}^{SP}$ satisfies (49) with equality.

Region III. For $\omega = \overline{\omega}$: N^{SP} is any value in the interval $[0, w+1], d_V^{SP} \in (0, \Delta)$ is the unique solution to (50), $C_{S,0}^{SP} = 1 - N^{SP}, C_{S,1}^{SP}$ satisfies (49) with equality.

Region IV. For $\omega > \overline{\omega}$: $N^{SP} = 0, d_V^{SP}$ is irrelevant as there is no investment, $C_{S,0}^{SP} = 1, C_{S,1}^{SP} = 0$.

We now proceed to the proof of the two constrained Welfare Theorems in the proposition. For the sake of brevity we restrict to the slightly more involved case of $\underline{R}_S < 1 \Leftrightarrow \overline{\overline{w}} < \infty$.

First Welfare Theorem:

For given w, we need to prove that the (general) equilibrium of the economy is a Pareto efficient allocation. We distinguish three cases:

i) $w \leq \underline{w}$: The equilibrium is of the M-M type and thus belongs to the efficient allocation region **I**.

ii) $w \in (\underline{w}, \overline{\overline{w}}]$: Let $\omega = (1-\lambda)\chi^*$ where χ^* denotes the general equilibrium vehicle discount for the given w. We have by construction that $\omega \leq \overline{\omega}$ and the equilibrium coincides with the efficient allocation in region **II** if $\omega < \overline{\omega}$ and the unique efficient allocation in the region **III** with $N^{SP} = w + 1$ if $\omega = \overline{\omega}$.

iii) $w > \overline{\overline{w}}$: The equilibrium coincides with the unique efficient allocation in the region **III** with $N^{SP} = \overline{\overline{w}} + 1$.

Second Welfare Theorem: We now consider initial date transfers between experts and savers. Such transfers would modify the initial wealth of each kind of investors, while maintaining the overall wealth in the economy $w + 1$. For given lump-sum transfer $\tau \in [-w, 1]$ from experts to savers. We denote the after transfers wealth of savers and experts with $w_S = w + \tau, w_E = 1 - \tau$, respectively.

It is easy to see that all equilibrium variables $d_V^*, R_S^*, R_E^*, \chi^*, E_O^*$ determined by the system 28-34 depend only on the share of savers' wealth that we denote $\mu = w/(1+w)$.[25]

Thus, we can rewrite Proposition 5 in terms of the the share of savers' wealth μ with analogous thresholds:

$$\underline{\mu} = \frac{A_L}{R_A(\bar{p})}, \overline{\overline{\mu}} = \begin{cases} A_L + (1-\lambda)p^*(1)d_V^*(1) & \text{if } \underline{R}_S < 1 \\ 1 & \text{otherwise} \end{cases}.$$

For given Pareto efficient allocation $(N^{SP}, d_V^{SP}, C_{S,0}^{SP}, C_{S,1}^{SP})$, we need to prove that there exists a savers' wealth share μ such that the allocation coincides with that induced by the equilibrium of the economy for such value of μ. We distinguish three cases:

i) $(N^{SP}, d_V^{SP}, C_{S,0}^{SP}, C_{S,1}^{SP})$ in regions **I**: Define $\mu = C_{S,1}^{SP}/R_A(\bar{p})$. Then we have by construction that $\mu \leq \underline{\mu}$ and the equilibrium of the economy for this value of μ induces the allocation.

[25]Actually, only (34) depends on w through $\mu(w) = w/(1+w)$. As shown in the first part of the proof of Proposition 5, the system of equations (28), (32), (33), and (53) depends only on R_S^*.

ii) $(N^{SP}, d_V^{SP}, C_{S,0}^{SP}, C_{S,1}^{SP})$ in regions **II** or **III** with $N^{SP} = w + 1$**:** Let $\omega \leq \overline{\omega}$ be the SP weight ratio associated with the allocation. Taking into account the properties of the partial equilibrium function $\chi^*(R_S)$ described in Lemma A.4, we have that there exists a unique $R'_S \in [1, R_A(\overline{p}))$ such that $\chi^*(R'_S) = \omega/(1-\lambda)$. Define $\mu = C_{S,1}^{SP}/R'_S$. Then we have by construction that $\mu \in (\underline{\mu}, \overline{\overline{\mu}}]$ and the equilibrium of the economy for this value of μ induces the efficient allocation.

iii) $(N^{SP}, d_V^{SP}, C_{S,0}^{SP}, C_{S,1}^{SP})$ in regions **III** with $N^{SP} < w + 1$ or **IV**: Define μ to be the unique solution to $1 - \mu = \frac{N^{SP}}{1+w}(1 - \overline{\overline{\mu}})$. Then, we have by construction that $\mu > \overline{\overline{\mu}}$ and the equilibrium of the economy for this value of μ induces the efficient allocation. ■