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Intermediary Capital and the Credit Market

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Abstract. We propose a tractable framework to examine the role of intermediary capital in the allocation and pricing of credit. In our model, regulated financial intermediaries compete with unregulated investors, targeting distributions of heterogeneous borrowers. We derive a sufficient statistic that characterizes intermediaries' cross-sectional lending decisions and provide a novel intermediary asset pricing equation that accounts for the endogenous segmentation of marginal investors across securities. These formulae reveal the central role of intermediaries' shadow cost of capital in both credit allocation and pricing. Our results can concurrently rationalize a broad array of empirical facts documented in the context of credit markets.

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Keywords: composition of credit • intermediary asset pricing • credit rationing • public market substitution • capital regulation

1. Introduction

Financial institutions' capital constraints and a variety of non-cash-flow-related asset characteristics appear to play an important role in shaping security prices and allocations in financial markets (Khwaja and Mian 2008; Kojien and Yogo 2015, 2019). In this paper, we propose a tractable equilibrium model of intermediated financial markets to analyze these relations in the context of credit markets. Our framework yields transparent formulae for two central objects of the credit market equilibrium: (1) a sufficient statistic characterizing financial intermediaries' cross-sectional lending decisions and (2) a cross-sectional intermediary asset pricing equation that accounts for the endogenous segmentation of marginal investors across different classes of securities. We show that the shadow cost of intermediaries' equity capital and non-cash-flow-related security characteristics play a central role in both these objects. Our framework can simultaneously rationalize a large set of empirical facts:

1. *Reaching-for-yield behavior:* Regulated intermediaries tilt their portfolios toward riskier securities within a given ratings category (Becker and Ivashina 2015, Iannotta et al. 2019).
2. *Abnormally cheap credit:* Debt securities are priced to yield negative abnormal returns during credit booms

(Greenwood and Hanson 2013, Granja et al. 2022), in particular those securities with high downside risks in a given regulatory risk category.

3. *Ratings' regulatory effect on the cost of debt:* Credit ratings affect debt prices above and beyond their informational content, because of ratings' implications for security demand by regulated intermediaries (Kisgen and Strahan 2010).

4. *Public market substitution:* Negative shocks to intermediary capital, for example, during banking crises, lead to increases in loan yields (Krishnamurthy and Muir 2017) and a reduction in bank lending that is partially compensated by increases in funding from public bond markets (Ivashina and Scharfstein 2010, Becker and Ivashina 2014).

5. *Access to bank alternatives encourages bank risk-taking:* (De)regulations and financial innovations that improve borrowers' access to nonbank alternatives such as public markets increase bank risk-taking (Hoshi and Kashyap 1999, 2001; Balloch 2018).

6. *Home bias in banks' sovereign debt holdings:* Banks overweight holdings of sovereign debt of their own country (Acharya and Steffen 2015).

7. *Convenience yields:* Securities and trading strategies offering identical cash flows can differ in their equilibrium returns (Du et al. 2018).

8. *Concentrated portfolios*: Regulated financial institutions investing in credit markets hold highly concentrated portfolios (Bretscher et al. 2022).

9. *Inelastic security demand*: A regulated financial institution generally responds inelastically to price changes induced by shocks to the assets under management of other institutions (Kojien and Yogo 2019, Bretscher et al. 2022).

Our model further contributes to policy discussions by offering insights into the effects of interventions like intermediary recapitalizations and adjustments to capital requirements. Unlike existing models that adopt a macro perspective with limited heterogeneity, our framework reveals the crucial interplay between the characteristics of an economy's borrower distribution and these regulatory changes.

We develop these results in a flexible framework that can accommodate any number of borrower types and aggregate states. Borrower types can differ in terms of real investment opportunities, access to non-bank sources of funding, and regulatory risk classifications. Intermediaries, which we also refer to as banks, differ from other sources of funding in that they can potentially fund a subset of borrowers more profitably because of monitoring advantages and access to implicit subsidies associated with taxpayer bailouts or deposit insurance.¹ As in practice, intermediaries are subject to Basel I–III capital requirements. Although debt financing is thus constrained by regulation, intermediaries can raise additional capital via costly issuances of outside equity. To account for imperfections of regulations prevailing in practice (such as, for example, the zero capital charges on (risky) sovereign debt that applied prior to the European debt crisis), our model can accommodate any statistical relation between securities' actual riskiness and regulatory capital charges.

To transparently characterize credit market equilibria in such an economy with multidimensional borrower heterogeneity, we depart from the conventional focus on demand and supply curves for credit which is typically expressed in terms of loan amounts and interest rates. Instead, we show that the market for intermediary capital is central to determining lending activity in the economy. Whenever internal capital is scarce, intermediaries compare its shadow cost (liability side) to the marginal *value* that capital generates with a given loan (asset side).² A key contribution of our paper is to provide a closed-form expression for this marginal value as a function of borrower characteristics, and conditional on specialized intermediaries' optimal portfolios. This characterization is essential to achieving tractable aggregation. In equilibrium, the regulated intermediary sector lends to all borrowers that generate a higher return on intermediary capital than its shadow cost. The remaining borrowers either

are rationed or secure financing from other credit market investors such as those in public markets, provided they have access to them.

We define the private surplus that a loan generates per unit of intermediary capital as the *total return on equity capital*, denoted by r_E^{total} . In equilibrium, this surplus is distributed between a borrower and its intermediary lender. In analogy to traditional price theory, r_E^{total} is akin to a borrower's reservation price for intermediary capital. If an intermediary were able to attract a borrower by charging the interest rate offered by unregulated investors, r_E^{total} would be fully internalized by the intermediary and thus represent its return on equity (*ROE*). However, because of competition, interest rate offers adjust downward to the point where, in equilibrium, intermediaries obtain a scarcity rent that compensates them for the shadow cost of the capital needed to extend a loan. This scarcity rent adds to standard return factors such as risk compensation and the time value of money. Any surplus remaining after covering these intermediary rents accrues to the borrowers. This equilibrium condition also features centrally in our intermediary asset pricing equation, which characterizes the expected returns on securities where intermediaries are the marginal investors.

The total return on intermediary capital reflects the incremental private surplus emerging from regulated intermediaries' comparative advantages relative to other lenders. In our model, these advantages can stem from monitoring capabilities and access to debt financing that is implicitly guaranteed by the government. The friction resulting is referred to as the "government put" and plays a central role in Merton (1977) and Kareken and Wallace (1978) as well as Bahaj and Malherbe (2020). Because of this friction, a wedge emerges between the ranking of borrowers based on private surplus as measured by r_E^{total} and the ranking that would maximize allocative efficiency. The severity of this distortion depends on securities' downside risk relative to the regulatory capital charges that are determined by risk weights in practice. This channel is key for generating *reaching-for-yield* behavior (Fact 1). Moreover, the more borrowers have access to public markets and do not require intermediary monitoring, the greater becomes the *relative* importance of the government put in shaping various lending activities' total return on intermediary capital. As a result, increased access to public markets strengthens intermediaries' risk-taking incentives (Fact 5). Further, negative shocks to intermediary capital, as realized for example during crises, increase capital scarcity as reflected by a higher shadow cost. As a result, relative to this increased shadow cost, more lending activities generate an insufficient return to intermediary capital, causing borrowers to substitute to other lenders, provided they have access to them (Fact 4).

Our model yields a closed-form intermediary asset pricing equation for the cost of debt of intermediary-funded borrowers. Relative to a standard asset pricing model, it introduces two additional factors: a security's expected return reflects (1) a premium providing compensation for the scarce intermediary capital used to fund the investment and (2) a discount associated with the security's subsidization via government insurance of regulated intermediaries' tail risk. These factors give rise to the possibility of *abnormally "cheap credit"* (Fact 2), the *regulatory certification effect of credit ratings* under rating-contingent regulation (Fact 3), and the presence of convenience yields (Fact 7). We obtain this intermediary asset pricing relationship in closed form despite the fact that in our model, marginal investors generally differ across securities. Intuitively, access to public backstops makes it optimal for each individual intermediary to choose concentrated portfolios with correlated downside risks. In equilibrium, assets with different downside risks are therefore optimally held by distinct intermediaries. Although the nature of specialization in our model is particularly stark, it has the benefit of allowing for a tractable aggregation across intermediaries, which is typically very challenging in the presence of levered intermediaries with heterogeneous portfolios. Moreover, the basic feature of endogenous specialization is consistent with the empirical fact that regulated credit market intermediaries hold highly concentrated portfolios and respond inelastically to price changes (Facts 8 and 9). Further, it is in line with the moral hazard view of the European debt crisis, Fact 6 (Acharya and Steffen 2015), whereby for example Italian banks with exposure to Italian small and medium-sized enterprises (SME) lending found it optimal to also have an increased exposure to Italian (rather than German) sovereign debt, thereby aligning negative tail risk realizations across their portfolio assets.

Our tractable framework can be used as a laboratory to provide insight on the compositional effects of regulatory policy changes, such as changes to capital requirements (see, e.g., Admati et al. 2011; Allen et al. 2011, 2015; Begenau 2020). Increases in capital ratio requirements operate via two distinct channels: First, they raise the quantity of intermediary capital effectively required to fund any given loan investment. Second, they decrease the r_E^{total} of various loans in the economy. For marginal changes in capital requirements, only the first effect is relevant (scarcity effect). Marginal increases in capital ratio requirements do not substantively alter the ranking of borrowers according to r_E^{total} . Yet loans to inframarginal borrowers do consume more intermediary capital as a result of capital requirement increases, thereby leaving less equity for the funding of the marginal borrowers. Policy interventions targeting one borrower type can thus crowd out bank lending to other borrowers, specifically marginal borrower types.

For larger policy interventions, the just-described scarcity effect associated with capital requirements operates in conjunction with a skin-in-the-game effect: The total returns on intermediary capital from funding risky borrowers are more sensitive to changes in capital requirements, and hence, fall more than those of safe borrowers do when capital requirements are increased. This skin-in-the-game effect implies that relatively safe borrower types will improve their ranking in terms of r_E^{total} , leading to a better alignment of credit provision with the ranking based on social surplus. If the skin-in-the-game effect dominates the scarcity effect, the ranking improvement causes safe borrowers to move from being marginal (or rationed) to becoming fully funded, explaining how relatively safe borrowers can be strictly better off under higher capital requirements. If instead the scarcity effect dominates, intermediaries are able to obtain a higher return on equity capital, as they can now extract the entire surplus from borrowers that were previously inframarginal.

Finally, as a technical contribution, we provide a framework that permits tractable aggregation in an economy with heterogeneous borrowers and levered intermediaries that differ in their portfolio holdings. In general, analyzing such environments is complicated by the fact that the total returns on equity have to be determined conditional on an intermediary holding an optimal portfolio: Portfolios matter because a levered intermediary's objective is nonlinear and a loan's contribution to its ROE depends on the comovement among all securities held. In our environment, we can provide a direct solution to intermediaries' optimal specialized portfolios, conditional on which we can characterize each lending activity's total return on intermediary capital in closed form. Rather than choosing an exposure to a common diversified portfolio, intermediaries endogenously specialize by becoming marginal investors in distinct types of securities. That is, our framework features endogenously segmented markets, yet remains tractable.

1.1. Relation to the Literature

To our knowledge, we are the first to derive the above-described explicit formulae for the allocation and pricing of credit in an economy with multidimensional borrower heterogeneity, general state-contingent cash flow distributions, intermediary capital scarcity, and government guarantees.

These results distinguish our paper from important existing contributions analyzing bank intermediation in general equilibrium such as Holmstrom and Tirole (1997), Carletti et al. (2020), and Gale and Gottardi (2020), as well as partial equilibrium analyses such as Rochet (1992) and Repullo and Suarez (2004). We further contribute to the growing literature on intermediary asset

pricing (see, e.g., Garleanu and Pedersen 2011, He and Krishnamurthy 2013, Kojien and Yogo 2019) by revealing the cross-sectional pricing implications of securities' differential use of scarce intermediary capital and their contribution to levered marginal investors' default risk.

As in Holmstrom and Tirole (1997), intermediaries in our model can create social value by lending to borrowers that would otherwise be credit rationed by other lenders. In Diamond (1984), this advantage emanates from banks' ability to monitor borrowers and thereby reduce moral hazard. Relative to Holmstrom and Tirole (1997), our framework features not only general distributions of borrowers that differ along multiple dimensions (state-contingent cash flows, bank dependence, and regulatory risk classifications), but also nonlinearities in intermediaries' objectives as caused by implicit government subsidies for debt and capital regulations. The ensuing risk-taking incentives make it possible for our model to rationalize the substitution effect documented in Becker and Ivashina (2014); that is, banks may crowd out public markets for borrowers that are not bank dependent.

In our equilibrium analysis with a cross-section of borrowers, risk-taking not only is associated with heterogeneous portfolio strategies across intermediaries,³ but also causes distortions in the cross-section of asset prices.⁴ Such pricing effects do not emerge in partial equilibrium settings such as for example the one considered in Rochet (1992), who shows that banks typically choose specialized, risky portfolios when their deposits are insured (see also Repullo and Suarez 2004).

Finally, our paper relates to the literature that explores the role of competition for financial stability and banks' risk-taking incentives. Marcus (1984) and Keeley (1990) highlight that competition *between* banks reduces a bank's value of staying solvent and thus encourages risk taking.⁵ In our model, regulated intermediaries compete not only with each other but also with other lenders, such as bond investors in public markets. Yet, as borrowers have heterogeneous access to these markets, this channel has additional compositional implications, consistent with the above-mentioned evidence on the Japanese Big Bang (Hoshi and Kashyap 1999, 2001).

Our paper is also connected to the empirical literature that studies the effects of policy interventions and their distributional consequences in environments with regulated and unregulated intermediaries. Consistent with the substitution effects present in our framework, Buchak et al. (2018) document an increasing share of consumer lending undertaken by shadow banks and attribute this change primarily to increased regulatory costs for traditional banks following the global financial crisis, as opposed to technological changes. Buchak et al. (2024) show that substitution between shadow banks and regular banks is particularly strong among

loans that are easily sold, and that banks switch between balance sheet lending and selling loans according to the strength of their balance sheets.

2. Model Setup

We consider a discrete-state economy with two dates, 0 and 1.⁶ At date 1, the aggregate state of the world $s \in \Sigma$ is realized with probability π_s . The economy consists of three types of agents: *borrowers*, *investors*, and *bankers*. In the baseline model, all agents in the economy are risk-neutral and have a rate of time preference of zero. Investors and intermediaries run by bankers can lend to borrowers with a real investment opportunity or invest in a savings technology. To streamline the exposition, we assume that the net return of this savings technology is zero. We show in Section 5 how our results generalize to the presence of a positive risk-free rate $r_f \geq 0$ and the state-contingent pricing of aggregate risk.

2.1. Borrowers

Borrowers are cashless agents with real investment opportunities that seek financing from either public market investors or intermediaries. Each borrower owns a firm $f \in \Omega_f$ that has access to a project which requires a fixed-scale investment I at time 0 and produces cash flows at date 1. The economy consists of a continuum of borrowers of total measure one.

To allow for multidimensional firm heterogeneity, the set of borrowers denoted by Ω_f is partitioned into a finite number of firm types, where each type is characterized by the triple (q_f, β_f, ρ_f) with associated population mass $m(q_f, \beta_f, \rho_f)$. Going forward, we omit firm subscripts if doing so does not introduce ambiguity. Here, the quality $q \in \Omega_q$ governs the firm's state-contingent cash flows $C_s(q)$, which in standard, frictionless asset pricing models q is a sufficient statistic for pricing. In particular, the surplus generated by the projects is

$$NPV(q) := \mathbb{E}[C_s(q)] - I. \quad (1)$$

The parameters β and ρ capture *non-cash-flow-related* characteristics that have been shown to be empirically relevant for institutional asset demand. In particular, $\beta \in \{0, 1\}$ determines whether a firm is bank dependent ($\beta = 1$) or not ($\beta = 0$). In Appendix B, we provide a microfoundation for bank dependence in the spirit of Holmstrom and Tirole (1997). The parameter $\rho \in \Omega_\rho$ is a sufficient statistic for capital requirements associated with intermediary loans to those borrowers, such as the firm's credit rating under Basel II (see details in Section 2.3).⁷ We allow for any stochastic relation between true asset risk as determined by q and ratings ρ . Under any loan contract, borrowers are protected by limited

liability; that is, loans can only be repaid with available firm cash flows $C_s(q)$.

2.2. Investors

Competitive investors are deep pocketed and have access to the following investment opportunities: (1) securities issued by borrowers in public markets, (2) intermediary deposits and intermediary capital (equity), and (3) a savings technology. Competition, capital abundance, and access to the savings technology imply that any firm with access to direct financing from investors is able to extract the value added of its project, $NPV(q)$, provided that this value added is positive. Whether borrowers use direct financing from investors in public markets depends on whether intermediaries can offer better financing terms.

2.3. Bankers

The economy features a continuum of bankers $b \in \Omega_b$ of mass one that manage competitive financial intermediaries. To capture the notion that intermediaries are large relative to the individual borrowers they fund, we assume that borrowers are atomistic relative to intermediaries.⁸ Bank-dependent borrowers can pledge cash flows only to bankers and thus require intermediary financing.

At time 0, each banker has positive initial wealth in the form of cash, and bankers' aggregate wealth is E_I .⁹ Because the distribution of wealth is not important for our main results, we assume that aggregate wealth is uniformly distributed among bankers, implying that E_I also corresponds to bankers' initial per-capita wealth. Intermediaries may also raise external funds in the form of outside equity capital E_O and deposits D . We denote by A the total amount invested in borrowers and by M the total amount invested in the savings technology (money). Thus, we obtain the following balance sheet identity for intermediaries in terms of book values:

$$A + M = E + D, \quad (2)$$

where we define $E := E_I + E_O$ as the total book equity capital.

2.3.1. Intermediary Assets. Intermediaries can provide loans to both bank-dependent borrowers and borrowers that can also obtain direct funding from the other investors. We will use the term "loans" for any such investments going forward. To abstract from security design and to simplify the exposition, we assume that loans cannot be sold short and are fully held on the balance sheet of an intermediary. Then, given a loan yield $y(q, \beta, \rho)$, the realized return on a loan to an issuer of type (q, β, ρ) in state s is

$$r^s(q, \beta, \rho) = \min \left\{ y(q, \beta, \rho), \frac{C_s(q) - I}{I} \right\}. \quad (3)$$

Equation (3) reflects that an intermediary, after lending an amount I , receives the promised yield $y(q, \beta, \rho)$ whenever the firm survives and recovers the cash flow $C_s(q)$ in case of default. Let $x(q, \beta, \rho) \geq 0$ denote an intermediary's portfolio weight corresponding to issuers of type (q, β, ρ) and \mathbf{x} denote the corresponding vector of portfolio weights for all borrower types; then the overall rate of return on an intermediary's portfolio in state s , r_A^s , is given by

$$r_A^s(\mathbf{x}) = \sum_{\forall q, \beta, \rho} x(q, \beta, \rho) r^s(q, \beta, \rho). \quad (4)$$

2.3.2. Intermediary Liabilities and External Financing Frictions.

Intermediaries are subject to limited liability and face external financing frictions, consistent with the literature on the bank lending channel. Following Decamps et al. (2011) and Bolton et al. (2013), we model these frictions in a parsimonious and flexible way. For an intermediary to raise a net-amount E_O of new equity capital, investors need to put up $E_O + c(E_O)$ units of cash, where the *net issuance cost* $c(E_O)$ is a strictly increasing and strictly convex function for $E_O \geq 0$. In contrast, paying dividends is not subject to any frictions, $c(E_O) = 0$ for $E_O \leq 0$. Similarly, the process of issuing deposits is frictionless.¹⁰

2.3.3. Intermediary Regulation.

Given our objective to account for the positive implications of existing regulations pertaining to financial intermediaries, we take two prevalent policies as given. First, promised payments of deposit contracts are fully insured by the government. For simplicity, we assume the government finances itself via lump-sum taxes that are levied from deep-pocketed investors ex post. As common in the literature, we thus abstract from deposit insurance premia,¹¹ which are quite insensitive to intermediaries' asset risk in practice (see, e.g., Kisin and Manela 2016). This approach is also in line with our objective to capture the effects of implicit bailout guarantees, for which intermediaries do not pay insurance premia.¹²

Second, intermediaries are subject to capital regulation that is contingent on credit ratings ρ of the borrowers in which an intermediary invests. As in the regulatory frameworks of Basel I–III, capital regulation prescribes that the equity capital-to-assets ratio of every institution, $e := \frac{E_I + E_O}{A}$, be above some minimum threshold $e_{\min}(\mathbf{x})$ that is a weighted average of asset-specific capital requirements $\underline{e}(\rho)$:

$$e_{\min}(\mathbf{x}) \equiv \sum_{\forall q, \beta, \rho} x(q, \beta, \rho) \cdot \underline{e}(\rho). \quad (5)$$

2.3.4. Intermediaries' Objective. Intermediaries maximize the value of existing equity holders (bankers). With this objective, the expected return on intermediary

equity (ROE) is an essential metric guiding intermediary behavior in our model. Given the limited liability of intermediary borrowers, the ROE satisfies

$$r_E(\mathbf{x}, e) := \mathbb{E} \left[\max \left\{ \frac{r_A^s(\mathbf{x})}{e}, -1 \right\} \right], \quad (6)$$

where a positive return on equity $r_E(\mathbf{x}, e) > 0$ reflects a scarcity rent rather than a risk-premium. An intermediary's objective can now be stated as (see Appendix A.1 for a derivation)

$$\max_{E_O, e, \mathbf{x}} (E_I + E_O) \cdot r_E(\mathbf{x}, e) - c(E_O), \quad (7)$$

s.t.

$$e \geq e_{\min}(\mathbf{x}), \quad (8)$$

$$\mathbf{x} \geq \mathbf{0}. \quad (9)$$

That is, intermediaries maximize the expected return on existing and newly issued equity, net of issuance costs.

3. Analysis

We now analyze the competitive equilibrium of the economy.

Definition 1. A competitive equilibrium is a yield function $y(q, \beta, \rho)$, an investment strategy for each borrower, an outside equity, equity ratio, and portfolio strategy for each intermediary, and an investment strategy for each investor such that

a. Given its type (q, β, ρ) , each firm f decides whether to raise I units of capital at the equilibrium yield $y(q, \beta, \rho)$ to maximize its expected utility.

b. Intermediaries managed by each banker b choose outside equity E_O , the equity ratio $e \geq e_{\min}(\mathbf{x})$, and the vector of portfolio weights $\mathbf{x} \geq \mathbf{0}$ to maximize (7).

c. Investors decide on investments in the risk-free savings opportunity, firm debt, intermediary deposits, and intermediary outside equity to maximize their expected utility.

d. Markets for debt, deposits, and intermediary capital clear.

Our analysis of the equilibrium proceeds as follows. We first study the optimal behavior of an individual intermediary, taking competitive yields as given. In a second step, we determine equilibrium prices of all assets and allocations in the economy.

3.1. Individual Intermediary Problem

From intermediaries' objective (7) it is immediate that, for any value of E_O , an optimal portfolio allocation \mathbf{x} and leverage choice e maximize an intermediary's ROE.

$$\max_{\mathbf{x}, e} [r_E(\mathbf{x}, e)] \quad \text{s.t.} \quad e \geq e_{\min}(\mathbf{x}). \quad (10)$$

Lemma 1 characterizes optimal leverage and portfolios as determined by Problem (10).

Lemma 1. *It is optimal for an intermediary to choose a minimal equity capital ratio, $e^* = e_{\min}(\mathbf{x}^*)$, for any optimal portfolio \mathbf{x}^* . The optimal portfolio \mathbf{x}^* exhibits correlated downside risks across securities in that*

i. *If the intermediary fails in state s , that is, if $r_A^s(\mathbf{x}^*) < -e_{\min}(\mathbf{x}^*)$, all loans in the intermediary's portfolio feature sufficiently low returns relative to their respective capital requirements, that is,*

$$r^s(q, \beta, \rho) < -\underline{e}(\rho).$$

ii. *In intermediary survival states, that is, in states where $r_A^s(\mathbf{x}^*) \geq -e_{\min}(\mathbf{x}^*)$, all loans in the portfolio generate returns above a threshold, $r^s(q, \beta, \rho) \geq -\underline{e}(\rho)$.*

Because of the presence of implicit deposit subsidies, it is optimal for an intermediary to choose the minimal capital ratio allowed by regulation,¹³ which is broadly consistent with the empirical results of Kisin and Manela (2016) and Jiang et al. (2020).

Lemma 1 highlights that optimal portfolios exhibit correlated downside tail risks in that in every failure state, each investment exhibits losses that exceed the associated regulatory capital cushion. Choosing exposures to correlated tail risks is an optimal response to convexity in an intermediary's objective function implied by deposit guarantees.

3.1.1. Outside Equity Issuances. Given a solution e^* and \mathbf{x}^* yielding $r_E^* := r_E(\mathbf{x}^*, e_{\min}(\mathbf{x}^*))$, the incentives of an individual intermediary to issue outside equity are governed by the trade-off between the equilibrium return on equity capital r_E^* and the marginal cost of raising additional equity capital.

Lemma 2. *An intermediary gains from marginally increasing its equity capital E_O as long as $r_E^* > c'(E_O)$.*

3.2. Equilibrium Prices and Allocations

We now analyze how prices and allocations are determined in equilibrium. A key feature of our approach is to derive the total returns on intermediary equity capital that lending to various borrower types yields. This approach is instructive as intermediary capital is the key scarce resource through which equilibration occurs. As intermediaries partially fund loans to borrowers with a fraction $\underline{e}(\rho)$ of (costly) equity, a firm loan effectively consumes intermediary equity. In return, intermediaries obtain an equilibrium reward as measured by the expected return on equity capital, r_E^* . Despite competition between intermediaries, their existing equity holders earn a strictly positive rent if aggregate intermediary capital is scarce (that is, if $r_E^* > 0$).

Our analysis proceeds in two steps. We first determine the equilibrium supply of aggregate intermediary capital E^* and the equilibrium return r_{E^*} , which is also the shadow cost of intermediary capital. Second, given E^* and r_{E^*} , we obtain the equilibrium composition and pricing of credit.

3.2.1. The Market for Intermediary Capital

3.2.1.1. Supply of Intermediary Capital. Lemma 2 implies that the aggregate inverse supply function is given by the marginal cost function (see Appendix A.5 for details):

$$S^{-1}(E) = c'(E - E_I). \quad (11)$$

3.2.1.2. Demand for Intermediary Capital. In price theory, demand functions are based on reservation prices, which measure the total value a good provides to a consumer. Similarly, in our setting, each borrower type generates a specific total return on intermediary capital, which we denote by $r_E^{\text{total}}(q, \beta, \rho)$. This return reflects the total private surplus that is generated by extending intermediary credit to a borrower of type (q, β, ρ) , provided that funding is extended by an intermediary that is itself optimally financed and has a loan portfolio that provides the best match for this borrower. The scarcity of intermediary capital determines in equilibrium how this surplus is split between the borrower and an intermediary. In cases where an intermediary can extract all surplus, the return $r_E^{\text{total}}(q, \beta, \rho)$ is fully internalized by the intermediary. This occurs when an intermediary can charge the borrower the interest rate that would be offered by investors in public markets (in case the borrower has access to such direct funding) or an interest rate that extracts all cash flows from the firm (in case the borrower is bank dependent).

The following proposition provides closed-form solutions for the total returns on intermediary capital for each borrower type, conditional on the borrower being funded by an intermediary with a portfolio and leverage strategy that offer the optimal match for this borrower.

Proposition 1. *An issuer of type (q, β, ρ) generates the following total return on intermediary capital:*

$$r_E^{\text{total}}(q, \beta, \rho) = \frac{NPV(q) \mathbb{1}_{\beta=1} + PUT(q, \rho)}{I\ell(\rho)}, \quad (12)$$

where we define the date-0 put value:

$$PUT(q, \rho) := \mathbb{E}[\max\{I(1 - e(\rho)) - C_s(q), 0\}] \geq 0. \quad (13)$$

In general, deriving these total returns on intermediary capital is a complex task, as they depend on the characteristics of those intermediaries that are marginal investors in the given security in equilibrium. In a setting

like ours, where intermediaries have access to government bailout subsidies, specialization emerges endogenously, implying that ex ante identical intermediaries choose different portfolios ex post (see Corollary 1 below). The returns on intermediary capital generated by a given security are then a function of the equity capitalization and the other equilibrium portfolio holdings of specifically those intermediaries that are marginal investors in the security. A key reason why our flexible setting yields closed-form solutions for the total returns on intermediary capital is that it admits exact solutions for these optimal intermediary decisions (see Lemma 1): intermediaries choose minimal equity capital ratios and portfolios with correlated downside risk. Minimal capital implies that a loan effectively demands $I\ell(\rho)$ of equity, and correlated downside risk implies that the value of the put option associated with intermediaries' limited liability is equal to the sum of the value of the put options associated with each individual loan in its portfolio (as these options are in the money in the same states of the world).

The expression for the total return on intermediary capital in (12) encodes all dimensions of borrower heterogeneity (q, β, ρ) . It is the ratio of the incremental surplus obtained from intermediary financing to the effective equity capital consumed by a borrower, $I\ell(\rho)$. The incremental surplus, the numerator of (12), has two sources.¹⁴ First, for bank-dependent firm types ($\beta=1$), intermediary financing is necessary for project implementation, which generates the value added $NPV(q)$. Second, the term $PUT(q, \rho)$ captures incremental private surplus due to government deposit guarantees. Whenever there is a positive probability that the government will cover a shortfall, that is,

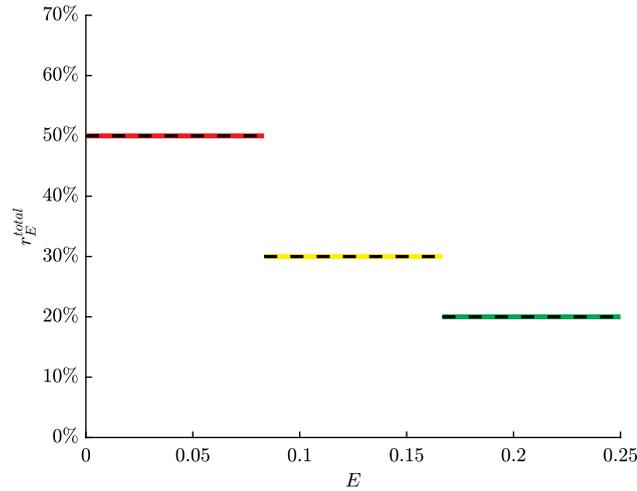
$$I(1 - e(\rho)) - C_s(q) > 0 \quad (14)$$

for some state s , the government effectively subsidizes a loan. The expected shortfall is decreasing in the required capital cushion associated with a security, $\ell(\rho)$, and increasing in the security's downside risk (see Equation (13)).

Lemma 1 allows us to construct the *aggregate* demand for intermediary capital by sorting issuer types according to $r_E^{\text{total}}(q, \beta, \rho)$. The total quantity potentially demanded by borrowers of a given borrower type (q, β, ρ) , which have mass $m(q, \beta, \rho)$, is given by $I \cdot \ell(\rho) \cdot m(q, \beta, \rho)$. Summing up across issuer types yields the aggregate demand in closed form and the corresponding (inverse) aggregate demand of all borrowers $D^{-1}(E)$ (see Appendix A.5 for details).

Figure 1 illustrates an example of the aggregate inverse demand function $D^{-1}(E)$; that is, we plot the aggregate quantity of intermediary capital on the horizontal axis, and the total return on intermediary capital on the vertical axis. The figure considers an example

Figure 1. (Color online) Aggregate Demand for Intermediary Capital



Notes. The graph illustrates the aggregate demand for intermediary capital in an economy with three issuer types with equal population mass of $m = \frac{1}{3}$, two equiprobable aggregate states, investment $I = 1$, and a uniform capital requirement of $\underline{e} = 25\%$. The green type is a good (positive NPV), safe, bank-dependent borrower with project cash flows $C = (1.05, 1.05)$. The yellow type is a good, risky borrower that has access to direct funding from regular investors and generates project cash flows $C = (1.8, 0.6)$. The red type is a bad (negative NPV), risky borrower with project cash flows $C = (1.5, 0.4)$. The three issuer types' total returns on intermediary capital are indicated by the green, yellow, and red lines. Because we assume equal mass and a uniform capital requirement, each type demands the same amount of equity at the respective total return on intermediary capital; that is, the horizontal length of each line is $0.25/3$.

economy with three issuer types which we will revisit at various points of our analysis. Following a traffic light analogy, the color assignments for the three borrower types (red, yellow, green) reflect the social surplus generated when banks finance each type. The red issuer type represents high-risk, negative-NPV borrowers, the yellow type high-risk, positive-NPV borrowers with access to direct funding from investors (e.g., public bond market access), and the green type bank-dependent, low-risk, positive-NPV borrowers (see the figure caption for parameter values).

The figure illustrates the potential misalignment of the equilibrium demand for intermediary capital with the social surplus created by intermediary funding. In fact, in this example, the ranking based on the total returns on intermediary capital is inversely related to the ranking based on social surplus—the red type's total return on intermediary capital is the highest even though the social surplus its projects create is the lowest (and negative); the green type's r_E^{total} is the lowest but its bank-dependent social surplus is the highest. This misalignment originates from the fact that total returns on intermediary capital are a function of both social surplus and deposit insurance subsidies, so that the most profitable borrowers for intermediaries are

not necessarily those that create the greatest social value. We will explore the implications of this misalignment and its dependence on various features of the economy in our comparative statics analyses below.

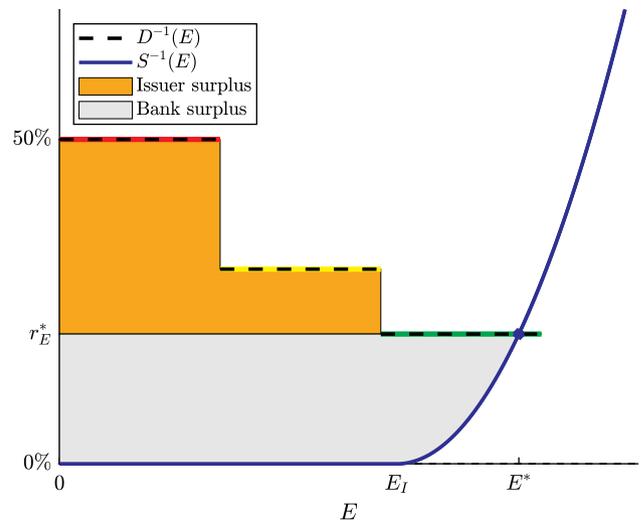
3.2.2. Equilibrium Rents and Allocations. It is important to note that expected equity returns exceeding the savings rate of zero, $r_E(x, e) > 0$, are not a reward for risk but rather constitute a rent originating from the scarcity of intermediary capital in the presence of equity issuance frictions.

The aggregate equilibrium capital in the economy E^* is obtained by the intersection of demand $D^{-1}(E)$ and supply $S^{-1}(E)$ (see Figure 2),¹⁵ which pins down aggregate equity issuances (or dividend payments), $E_O^* = E^* - E_I$. In equilibrium, the expected return on intermediary capital, and thus its shadow value, is given by

$$r_E^* = S^{-1}(E^*). \quad (15)$$

The distribution of surplus between intermediaries and borrowers follows immediately. Competitive behavior among intermediaries implies that all loan yields in the economy are set such that each intermediary earns an expected ROE of r_E^* . Note that this equalization of expected returns across loans typically requires different loan yields for borrower types with differing credit risk or risk weights.

Figure 2. (Color online) Equilibrium Price and Quantity of Capital



Notes. The graph extends Figure 1 by adding an inverse supply function. The supply of intermediary capital is given by $S^{-1}(E) = c'(E) = 50(\max\{E - E_I, 0\})^2$. The equilibrium quantity E^* and price r_E^* are indicated by the blue circle. The marginally funded borrower type is the green type. The incremental surplus that borrowers obtain above and beyond the surplus attainable from public market finance is illustrated by the orange-shaded area. The gray-shaded area measures the surplus accruing to intermediaries' initial equity holders.

If $r_E^* > 0$, the entire intermediary sector earns a total scarcity rent of

$$E^* r_E^* - c(E^* - E_I), \quad (16)$$

as illustrated by the gray-shaded region in Figure 2, which revisits the example underlying Figure 1. Only for the marginal (green) borrower type, all surplus is internalized by intermediaries; that is, intermediaries' equilibrium return on capital is exactly equal to the total return on capital of this marginal borrower type. In contrast, all inframarginal borrowers earn strictly positive surplus, which, per unit of intermediary capital used, is given by the difference between a borrower's total return on intermediary capital and intermediaries' equilibrium return:

$$r_E^{total}(q, \beta, \rho) - r_E^*. \quad (17)$$

Figure 2 illustrates three relevant types of equilibrium outcomes that we will highlight throughout our analysis: (1) overinvestment in surplus-destroying (red) issuer types, (2) underinvestment in bank-dependent (green) issuer types, and (3) crowding-out of public market financing in the sense that (yellow) issuer types that have access to public markets obtain intermediary finance in equilibrium.

We can now proceed to characterizing the composition and pricing of credit.

Proposition 2 (Composition and Pricing of Credit). *All issuer types with*

$$r_E^{total}(q, \beta, \rho) > r_E^*$$

and a fraction $\xi \in [0, 1]$ of marginal borrower types with $r_E^{total}(q, \beta, \rho) = r_E^*$ are financed by intermediaries.¹⁶ The associated loan yields, $y(q, \beta, \rho)$, are set such that the expected return on debt satisfies

$$\mathbb{E}[r^s(q, \beta, \rho)] = \underline{e}(\rho)r_E^* - PUT(q, \rho)/I. \quad (18)$$

Of the remaining borrowers in the economy, only issuer types with positive NPV and access to direct finance from public markets obtain funding. Their expected return on debt is zero.

The proposition highlights that the difference between a borrower's total return on intermediary capital and the shadow cost of intermediary capital,

$$r_E^{total}(q, \beta, \rho) - r_E^*, \quad (19)$$

is a *sufficient statistic* for intermediary funding. A borrower obtains intermediary funding if this statistic is weakly positive.

The novel intermediary asset pricing relation (18) captures the key frictions in our setting. In Section 5, we further generalize this pricing relation to the case where the economy features a positive risk-free rate and state-contingent pricing of aggregate risk. In either

case, deviations from frictionless pricing originate from two intuitive components. First, a security's expected return increases with its regulatory risk weight, $\underline{e}(\rho)$, which is interacted with the expected (excess) return on intermediary capital, r_E^* . This component of the expected return does not represent a risk premium, but rather compensation for a security's use of intermediaries' scarce capital, which could be used profitably to extend loans to other (marginal) borrowers.

Second, the expected return is reduced by a security-specific term, $\frac{PUT}{I}$, that reflects the implicit pass-through of deposit subsidies per unit of investment. Risky securities that contribute to an intermediary's tail risk and that have low regulatory risk weights tend to have larger *PUT* values. As a result, the pricing relation (18) predicts that these types of securities, if held by regulated levered institutions, may command *negative* expected excess returns.

In sum, our intermediary asset pricing relation (18) captures channels causing credit to be either excessively "expensive" or "cheap" relative to a frictionless benchmark. Importantly, in line with our focus on the composition of credit, pricing distortions vary in the cross-section and are directly responsible for the (mis)-allocation of credit.

These results characterize how the intermediary sector as a whole provides and prices credit to heterogeneous borrowers. A key underlying force for the intermediary sector's credit provision is that individual intermediaries, despite ex ante homogeneity, are generally exposed to heterogeneous risks.

Corollary 1 (Heterogeneous Intermediary Portfolios). *Suppose two issuer types that do not exhibit correlated tail risks (see Lemma 1) are funded in equilibrium; then the two issuer types are financed by different intermediaries.*

If the intermediary sector as a whole finances borrower types with different downside risk profiles (as determined by Proposition 2), then optimal portfolios require that intermediaries follow specialized lending strategies and are thus marginal investors in distinct sets of securities.

To illustrate this idea more concretely, consider an example with two aggregate states of the world and two borrower types that are funded by intermediaries, a safe borrower type that pays off in both states of the world and a risky borrower type with low cash flows in the bad state of the world. In this example, one set of intermediaries will choose to have no default risk by exclusively investing in safe borrowers and, as a result, never obtains government support. The remaining intermediaries will finance risky borrowers, so that government support is triggered in the bad state of the world. Because both borrower types are funded in equilibrium, loans to both borrower types must be priced such that they offer the same ROE to intermediaries.

Now suppose one of the “risky” intermediaries started to marginally tilt the portfolio to safe borrowers. This portfolio perturbation would yield the intermediary a *strictly* lower ROE because such a marginal portfolio tilt would not affect the survival states of the intermediary, and because equilibrium pricing ensures that the expected return on safe assets must be strictly lower than that for risky bonds. Conversely, starting from a portfolio with 100% safe borrowers, an intermediary also strictly lowers its ROE when marginally increasing the portfolio weight of risky borrowers. After such a marginal deviation, the intermediary still does not default, and thus, lacks the benefit of a bailout put. Therefore, it cannot assign the same marginal value to a risky bond as an intermediary that exclusively invested in risky bonds. In short, comparative financing advantages emerge in our setting endogenously, shedding light on recent evidence of bank specialization (see Paravisini et al. 2023) and the fact that regulated intermediaries hold bond portfolios that are highly concentrated in subsets of securities (see Bretscher et al. 2022).¹⁷

4. Positive and Normative Implications

Building on the equilibrium characterization detailed in the previous section, we now examine the predictions of our model.

4.1. Portfolio Allocation

We initially explore our model’s predictions for intermediaries’ portfolio choices and asset prices.

Prediction 1 (Reaching for Yield). *If two borrowers with distinct cash flow distributions have the same capital ratio requirements, the same NPV, and the same bank dependence, the one with higher downside risk is more likely to be financed by intermediaries.*

This prediction results from the fact that the put value is higher for borrowers with greater downside risk, as shown in Equation (13), implying that r_E^{total} is elevated as well. Prediction 1 is consistent with evidence from the 2007/2008 financial crisis. The structuring process of mortgage-backed securities (MBS) implied that the highly rated tranches were exposed to high tail risk, akin to “economic catastrophe bonds” (see Coval et al. 2009a, b), while simultaneously being subject to minimal capital requirements. As a result, our model predicts that these securities had a higher put value component than many other investment opportunities banks had, leading to higher total returns on intermediary capital. The prediction is also consistent with evidence from Becker and Ivashina (2015) and Iannotta et al. (2019), who have documented insurance companies’ and banks’ “reaching-for-yield” behavior within given regulatory risk classifications (see also Bretscher

et al. 2022). As a result of this behavior, our framework further predicts that under rating-contingent capital regulation, ratings will matter for equilibrium prices, above and beyond the information they convey about cash flows.

Prediction 2 (Price Effects of Ratings). *Holding a firm’s cash flow distribution fixed, an increase in the firm’s rating reduces its yields on loans funded by regulated intermediaries.*

Prediction 2 holds because, in the context of rating-contingent capital regulation, a higher credit rating results in lower capital requirements. Consequently, this elevates r_E^{total} because of both a decrease in the put value and a diminished use of scarce intermediary capital. Kisgen and Strahan (2010) document evidence in support of Prediction 2.

Prediction 3 (Concentrated Portfolios and Correlated Downside Risks). *Efficient intermediary portfolios are concentrated in a subset of securities and can exhibit a home bias for sovereign debt holdings.*

The stylized predictions of Lemma 1 that regulated financial institutions invest in highly concentrated portfolios and take correlated downside risks are consistent with empirical evidence from the fixed-income market and from the European sovereign debt crisis. In particular, Bretscher et al. (2022) document that regulated financial institutions (like life insurers) investing in the fixed-income market hold very concentrated portfolios even just within corporate bonds and are particularly responsive to the investment grade ratings classification threshold.

Moreover, Acharya and Steffen (2015) document a “home bias” in sovereign debt holdings in that, for example, Greek banks primarily hold Greek sovereign debt. For example, a removal of concentration limits for sovereign debt exposures by Eurozone regulators allowed the portfolio share that Italian banks allocated to Italian government bonds to increase from 5% in 2008 to over 10% in 2012 (see SEB 2018). A higher ranking of a country’s own sovereign debt in terms of the total return on intermediary capital is consistent with the view that the private sector lacked profitable investment opportunities, whereas the *PUT* value associated with the country’s own sovereign debt increased substantially.¹⁸

4.2. The Implications of Shocks to Intermediary Capital

In this section, we investigate our model’s predictions for the effects of shocks to regulated intermediaries’ capital or assets under management (AUM). In our model, the scarcity of intermediary capital influences not only the credit provision to bank-dependent borrowers but also nondependent borrowers’ substitution to nonbank financing. In practice, various economic

shocks can lead to declines or increases in intermediary capital. For example, a macroeconomic downturn is typically associated with higher loan default rates, and correspondingly, declines in intermediary net worth. On the other hand, equity capital injections by governments during crises can increase aggregate intermediary capital (see, e.g., Giannetti and Simonov 2013).

The following predictions, which are based on Proposition 2, summarize how changes to aggregate intermediary capital affect prices and allocations in the economy.

Prediction 4. *A decline in the aggregate amount of intermediary capital*

- increases the expected return on intermediary capital r_E^* and loan yields $y(q, \beta, \rho)$,
- decreases aggregate investment, and
- increases direct funding from public markets.

Figure 3 illustrates these predictions by extending our earlier example with three issuer types (as considered in Figures 1 and 2). The considered shocks affect only the equity supply curve, shifting it outwards (or inwards), from the solid blue line to the dashed blue line (or dotted black line). First, consider a decrease in equity capital (as stated in Prediction 4). This decrease to the dotted black line causes the equilibrium return on intermediary capital to rise to the yellow issuer type's total return on capital. Correspondingly, loan yields for all funded types (red and yellow borrowers) rise. Intermediary-financed yellow borrowers now pay the reservation interest rate offered by investors in public markets. Aggregate investment decreases because all bank-dependent green borrower types are now credit rationed. This prediction is consistent with empirical

evidence from Acharya et al. (2018), who show that bank risk-taking causes negative real effects by crowding out lending to small and medium-sized firms (as possibly represented by green borrower types in our example). In contrast, the reduction in intermediary lending to yellow borrower types (to the right of the supply curve) is fully compensated by increased funding from nonbank lenders, as these firms are not bank dependent (like large firms in practice are). Becker and Ivashina (2014) find support for this predicted substitution effect, which is an important distinguishing feature of our model relative to the setting of Holmstrom and Tirole (1997).¹⁹

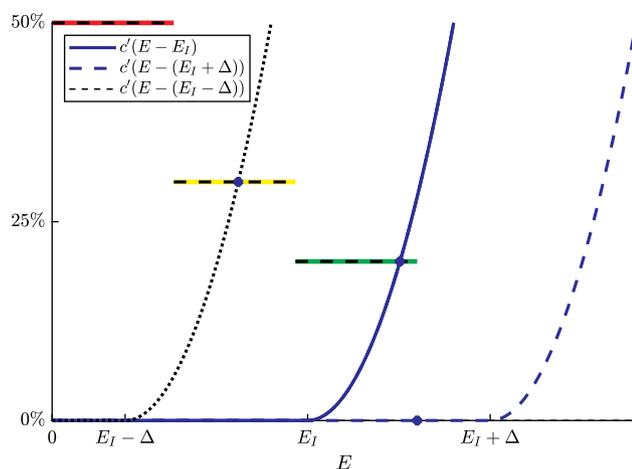
Next, we consider an increase in equity capital (to the dashed blue line). In this case, the equilibrium return on intermediary capital r_E^* drops from the green issuer type's total return on intermediary capital to zero. All borrower types are fully funded. As intermediary equity capital is no longer scarce, that is, $r_E^* = 0$, Equation (18) implies that intermediaries pass on implicit subsidies to risky borrowers. In the example, this is the case for yellow and red borrower types. Our model thus provides a rational explanation for abnormally low yields in the precrisis periods and possibly even negative expected excess returns (Greenwood and Hanson 2013, Muir 2017, Granja et al. 2022).

Comparative statics with respect to capital also speak to recent findings of the demand systems literature regarding the inelastic nature of financial institutions' security demand. In particular, Bretscher et al. (2022) document low elasticities for the fixed-income market, where regulated levered financial institutions like insurance companies are major players. In this literature, elasticities are estimated using shocks to capital or AUM, which affect institutions' demand for securities. In particular, studies examine empirically how price changes induced by such shocks to institutions with concentrated holdings affect the holdings of other institutions.

In the context of our model, consider a corresponding comparative statics analysis of an increase in the assets held by a subset of financial institutions as induced by a positive change to their capital. Our model predicts a change in security prices as induced by a change in the aggregate amount of capital E , following the discussions above. However, these price changes do not imply that individual intermediaries would hold different optimal portfolios. Rather, only a subset of institutions would necessarily need to hold different portfolios to accommodate the increased security demand of intermediaries with more capital. However, all other intermediaries could optimally still hold the same concentrated portfolios.

Take as a specific example a shock to the capital of insurance companies that invest in a particular set of highly rated debt securities. When these insurers obtain

Figure 3. (Color online) Intermediary Capital Supply



Notes. The graph illustrates how equilibrium outcomes are affected by an increase or decrease in inside capital E_I relative to the baseline level considered in Figure 2. We consider changes of magnitude $\Delta = 0.125$.

a positive shock to their capital and experience an expansion of their balance sheets, they buy more of these types of securities. According to our framework, such a shock will generally lead to a decline in the return on equity capital for levered institutions and associated heterogeneous price responses (increases) in the cross-section of securities held by levered institutions. A key variable determining the varying magnitudes is the regulatory classifications of securities. Price effects are amplified for securities with lower ratings and higher capital surcharges $\underline{e}(\rho)$. Thus, whereas assets deemed safe by regulators exhibit small price changes, those that are deemed risky exhibit larger price responses. Despite these cross-sectional price changes, institutions that did not experience a shock to their capital generally do not need to adjust their concentrated holdings. That is, these institutions appear to respond very inelastically to price changes induced by shocks to the assets under management of other institutions in the market. These predictions are consistent with the findings of Bretscher et al. (2022), who document that regulated levered institutions have significantly lower price elasticities than other players such as mutual funds.

Prediction 5 (Abnormal Expected Returns). *A security held by intermediaries is more likely to offer negative expected excess returns when (1) intermediary capital is less scarce, (2) the security's risk weight is low, and (3) the security has higher downside risk.*

Next, we investigate the allocative implications of reductions in intermediary capital. In contrast to Holmstrom and Tirole (1997), the effect of changes to intermediary capital on total surplus can be either positive or negative in our setting, depending on the value added and bank dependence of the marginal borrowers.

Prediction 6. *A marginal increase in intermediary capital increases total surplus created by all funded projects if and only if the marginal borrowers both are bank dependent, $\beta = 1$, and generate positive social surplus, $NPV(q) > 0$.*

In our example, the green type is the marginal borrower type in the benchmark specification. Because this borrower type generates positive social surplus and is bank dependent, a marginal increase in intermediary capital strictly increases total surplus. However, if intermediary capital were sufficiently scarce so that the red borrower type would become the marginal type, then a local increase in capital would strictly increase risk-taking (consistent with evidence from Giannetti and Simonov (2013) on zombie lending following small injections of capital). More generally, shocks to a financial system's intermediary capital affect lending to borrowers in the order in which they are ranked in the demand curve for intermediary capital (based on our explicit characterization in Proposition 1).

4.3. Capital Ratio Requirements

In this subsection, we investigate the compositional effects of changes to capital *ratio* requirements, the primary policy tool used by regulators in practice. We decompose capital ratio requirements of a borrower type, $\underline{e}(\rho)$, into the overall capital ratio, \underline{e} , and a security-specific risk weight $w(\rho)$, that is,

$$\underline{e}(\rho) := \underline{e} \cdot w(\rho). \quad (20)$$

All predictions of this section build on the following corollary to Proposition 1.

Corollary 2. *The total return on intermediary capital of a borrower of type (q, β, ρ) is strictly decreasing in both the overall capital ratio requirements \underline{e} and the risk weight $w(\rho)$. The equity demanded by a borrower type is strictly increasing in both \underline{e} and $w(\rho)$.*

The total returns on intermediary capital fall for two reasons when overall capital ratio requirements \underline{e} are increased. First, the numerator of the total return (12) weakly decreases because an increase in capital ratio requirements decreases the put value, strictly so if the security has downside risk. Second, the denominator (12) strictly decreases because a loan of size I uses more intermediary capital.

Whereas an increase in overall capital ratio requirements reduces all borrowers' total returns on intermediary capital (by Corollary 2), the magnitude of this effect differs across borrower types.

Corollary 3 (Skin-in-the-Game). *The elasticity of the total return on intermediary capital with respect to the overall capital ratio requirement \underline{e} is larger in absolute value for borrower types with a higher shortfall probability, that is,*

$$\left| \frac{d \ln r_E^{\text{total}}}{d \ln \underline{e}} \right| = 1 + \frac{\Pr((C_s(q)/I - 1) < -e(\rho))}{r_E^{\text{total}}(q, \beta, \rho)}. \quad (21)$$

The numerator of the ratio on the right-hand side of Equation (21) represents a borrower's shortfall probability. For safe borrower types this probability is zero. Thus, an increase in \underline{e} only affects the quantity of intermediary capital used, implying a baseline elasticity of one. In contrast, borrowers with a strictly positive shortfall probability exhibit an additional effect operating through a reduction in the put value (the numerator of (12)). This latter effect is larger for borrowers with a higher shortfall probability. This corollary formalizes the intuition that higher overall capital ratio requirements generate more skin in the game, and hence, make risk-taking *relatively* less attractive.

Despite this result, marginal changes in \underline{e} are generally insufficient to induce changes in the ranking of borrowers according to their total returns on intermediary capital. Thus, only the funding of marginal borrowers

is affected. In contrast, for nonmarginal changes in \underline{e} , the overall effects depend on the relative importance of two channels: (1) changes in the ranking of borrower types according to the total return on intermediary capital and (2) the crowding-out of marginal borrowers because of capital scarcity.

Prediction 7. *An increase in capital ratio requirements*

- (a) *decreases the expected return on intermediary capital r_E^* if the marginal borrower type is unchanged, but may increase it otherwise,*
- (b) *increases loan yields for at least one borrower type, but may decrease loan yields for some borrower types,*
- (c) *decreases aggregate investment, and*
- (d) *increases funding by public markets.*

We again illustrate these results by revisiting our three-type example. As an initial reference point, Figure 4(a) simply replicates the baseline parameterization of Figure 2. Figure 4, (b) to (d), in turn, shows the effects of gradual increases in the overall equity ratio requirement \underline{e} relative to this benchmark.

Part (a) of Prediction 7 highlights that the conventional wisdom that intermediary profits suffer from increases in capital ratio requirements holds only unambiguously when the marginal borrower type is unchanged. In this case, r_E^* is pinned down by this marginal type's total return on intermediary capital, which declines in \underline{e} , as stated in Corollary 2. In contrast,

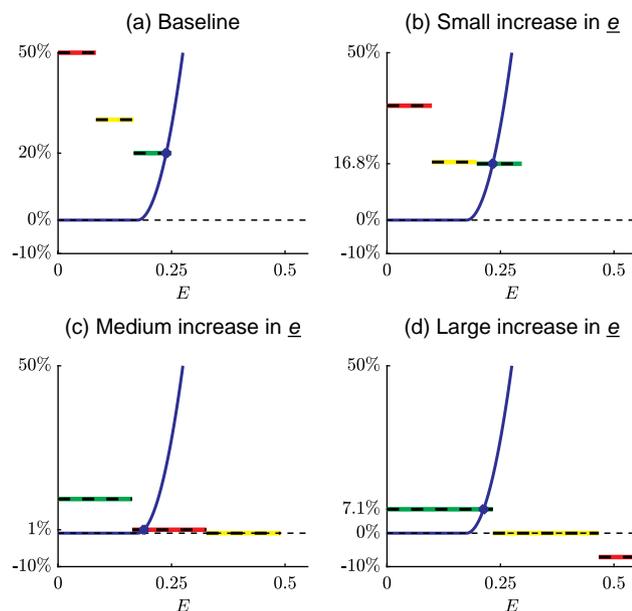
nonmonotonic effects on r_E^* can arise when the marginally funded borrower type changes. Figure 4 illustrates this result. A small increase in capital ratio requirements (from panel (a) to panel (b)) keeps the marginal borrower type unchanged so that r_E^* must decline (here from 20% to 16.8%). In contrast, a further increase in capital requirements (from panel (b) to panel (c)) implies that the marginal type switches to the red type. Yet now r_E^* declines even further because under such high capital requirements, lending to the red borrower types only yields a minimal return, even if intermediaries extract all rents from this type. Interestingly, a further increase in capital ratio requirements (from panel (c) to panel (d)) not only changes the marginal type back to the green type, but also leads to an increase in intermediaries' return on capital, r_E^* . That is, high capital requirements can amplify the scarcity and value of intermediary capital.

Conventional wisdom suggests that an increase in overall capital ratio requirements increases the cost of capital for all borrowers. However, our framework reveals that if borrowers are heterogeneous, this result generally no longer applies; see Prediction 7, part (b). Although increased capital ratio requirements mandate an increased use of equity capital funding and reduce the *PUT* value, they can also increase the return on intermediary capital. In particular, in Figure 4, (a), (b), and (d), the green borrower type is the marginal borrower type and intermediaries fully extract that borrower type's total return on intermediary capital by charging the interest rate that nonbank lenders would offer. In contrast, for a medium increase in overall capital ratio requirements (see Figure 4(c)), this borrower type pays strictly less than the interest rates offered by nonbank lenders. The intuition for this nonconventional case is that safe borrowers effectively face less competition from risky borrower types under such capital requirements.

These implications for borrowers' funding costs are also reflected in allocations. Higher capital requirements lead to lower aggregate investment (see part (c) of Prediction 7), but may strictly increase lending to safe borrower types. Indeed, in the example underlying Figure 2, a medium increase in overall capital ratio requirements ensures that all safe (green) borrower types are funded, whereas risky borrowers are rationed. Part of this reduction in intermediary funding is compensated by an increase in funding from nonbank lenders (see part (d) of Prediction 7): Yellow borrower types will now access nonbank funding rather than seeking financing from intermediaries at subsidized rates (a substitution effect as documented empirically by Becker and Ivashina 2014).

Overall, our analysis reveals that in the presence of borrower heterogeneity, changes to overall capital ratio requirements are a fairly blunt tool. On the one hand,

Figure 4. (Color online) Capital Ratio Requirements



Notes. Panels (a) through (d) illustrate the effects of increases in capital ratio requirements. Panel (a) replicates the economy illustrated in Figure 2, where all borrower types are subject to a ratio requirement of $\underline{e} = 0.25$. Panels (b) through (d) consider gradual increases in capital ratio requirements, up to a level of $\underline{e} = 0.55$ in panel (d).

increases can have the desirable effect of aligning the private ranking of borrower types with the ranking based on social surplus—the “medium increase” in $\underline{\ell}$ considered in Figure 4(c) achieves this result. A better alignment obtains as greater skin in the game reduces distortions introduced by the *PUT* component affecting the demand for intermediary capital (see Corollary 3). On the other hand, increases in ratio requirements can also cause the rationing of surplus-generating bank-dependent borrowers—the “small increase” considered in Figure 4(b), for example, shows a case where that type of rationing is more severe than in the baseline economy with the lowest ratio requirements.

4.4. Development of Nonbank Lending

The development and accessibility of credit from sources other than regulated intermediaries vary considerably across countries (see, e.g., Rajan and Zingales 1995, 1998). Moreover, financial innovations imply that borrowers may obtain better access to alternative sources of funding over time. For example, important innovations have included the development of junk bond markets in the 1980s, securitization and shadow banking in the 2000s, and most recently, the development of FinTech funding platforms, such as those facilitating crowdfunding. Despite this variation in the cross-section and over time, the rules governing capital requirements have changed very infrequently, and following the Basel accords, a large set of countries has instituted very similar rules.

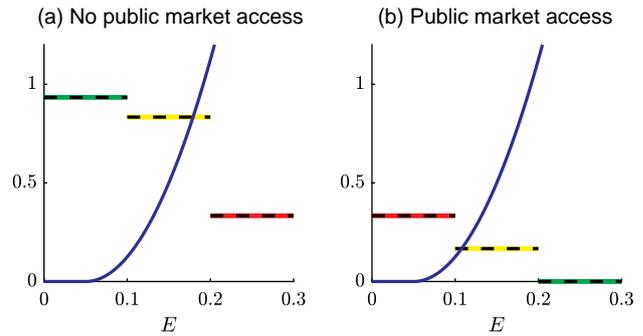
In this section, we analyze how a given set of rules for capital requirements can have starkly different allocative implications across economies that differ in their availability of nonbank lending.

Prediction 8 (Nonbank Lenders Encourage Bank Risk-Taking). *Ceteris paribus*, increased access to nonbank lenders leads to more risk-taking by banks.

Figure 5 illustrates the intuition for this result. As detailed in the figure’s caption, the graphs again build on our baseline Figure 2, subject to a few adjustments. In panel (a), both green and yellow borrower types do not have access to direct funding from investors in public markets. Lacking alternatives, these borrower types are highly profitable for intermediaries, as measured by their high total returns on intermediary capital. As a result, intermediaries use their scarce capital to extend credit to green and yellow borrower types only. Surplus-destroying red borrower types are rationed.

In contrast, in panel (b), green and yellow types have access to direct lending from investors (e.g., the public bond market). Moreover, because borrowers of the green type also have safe cash flows, these borrowers do not create any incremental private surplus with intermediary finance (as the *PUT* component is

Figure 5. (Color online) Changes in Public Market Development



Notes. The figure illustrates the effect of public market development that enables access to competitive investors for productive borrowers (yellow and green types). The panels of the figure build on our previous benchmark parameterization shown in Figure 2, subject to the following adjustments: the green type now has cash flows $C = (1.28, 1.28)$, the general capital requirement is $\underline{\ell} = 30\%$, and $E_I = 0.05$.

also zero). As a result, the green type’s total return on intermediary capital drops to zero, causing this type to move off the intermediary sector’s balance sheet. The total returns on intermediary capital of the (risky) yellow type also drop for the same reason, but not to zero, because intermediary funding is (still) effectively subsidized by the *PUT* value. In contrast, the total returns on intermediary capital of surplus-destroying risky red borrower types are unaffected by the change in the development of nonbank lenders, as they are not a feasible source of funding for these borrowers. As a result, red borrowers yield the highest total returns on intermediary capital, and therefore start to obtain intermediary finance in response to public market development.

In sum, the model reveals intermediaries’ increased incentives to focus on reaching for yield (instead of using monitoring abilities) after nonbank lenders become more efficient and a greater competitive threat. This result suggests that the optimal design of capital requirements should account for competition from nonbank lenders.

5. Discussion of Modeling Assumptions

In this section, we discuss the robustness of our results with respect to various modeling assumptions.

5.1. Risk Aversion and Positive Savings Rate

For ease of exposition, our baseline analysis considered a setting in which all agents were risk-neutral and the savings rate was zero. We now extend the setup to allow for a positive risk-free rate $r_F \geq 0$ and state-contingent risk pricing. We denote expectations under the risk-neutral probability measure by \mathbb{E}^Q .

A firm's social value added and the put value under optimal intermediary financing are then given by

$$NPV(q) := \frac{\mathbb{E}^Q[C_s(q)]}{1 + r_F} - I, \quad (22)$$

$$PUT(q, \rho) = \frac{\mathbb{E}^Q[\max\{I(1 - e(\rho))(1 + r_F) - C_s(q), 0\}]}{1 + r_F}. \quad (23)$$

Subject to these modifications, the expression for the total return on intermediary capital in (12) is unaffected. The generalized version of our intermediary asset pricing relation in (18) is thus given by

$$\mathbb{E}^Q[r^s(q, \beta, \rho)] = r_F + \underline{e}(\rho)(r_E^* - r_F) - \frac{PUT(q, \rho)(1 + r_F)}{I}. \quad (24)$$

Expression (24) highlights the robust insight that a loan's deviation from frictionless pricing, $\mathbb{E}^Q[r^s(q, \beta, \rho)] - r_F$, originates from the intensity of the use of intermediary capital, $\underline{e}(\rho)$ interacted with the equilibrium scarcity rent on intermediary capital, $(r_E^* - r_F)$ and a discount due to implicit government subsidies.

For the subsequent discussion of additional economic channels, we will repeatedly refer to the following broad definition of a borrower's total return on intermediary capital:

$$r_E^{total} = \frac{\text{Private surplus from intermediary lending}}{\text{Intermediary capital required to fund the loan}}.$$

5.2. Intermediary Market Power

Our environment features the standard assumption that intermediaries act competitively (as, e.g., in Holmstrom and Tirole 1997). One may wonder how our results would be affected if intermediaries instead had market power in the loan market and/or the deposit market.²⁰

Although the exact nature of intermediaries' market power would matter, borrowers' total return on intermediary capital would still be a key object governing the provision of credit—in any canonical monopoly problem, the demand curve is essential. Yet, the exercise of market power in the loan market would allow intermediaries to extract a greater fraction of the surplus, relative to the competitive setting. Furthermore, if intermediaries had market power in the deposit market, any investments yielding expected returns above the deposit rate (including safe government bonds) would generate additional private surplus. This source of surplus would imply an incremental wedge between the private ranking of borrowers

according to the total returns on intermediary capital and the ranking based on social surplus. In particular, investments in securities that are associated with lower risk weights can be financed more extensively with “cheap” deposits, making these investments more attractive, *ceteris paribus*.

5.3. Ex Ante Differences Across Intermediaries

Our model reveals that even ex ante identical intermediaries optimally choose heterogeneous portfolio strategies (see Corollary 1). If subgroups of intermediaries additionally differed ex ante in terms of characteristics such as the probability of receiving government bailouts, legacy asset holdings, or monitoring technologies, these sources of heterogeneity would naturally lead to clientele effects. These clientele effects imply multiple intermediary capital demand curves, one for each subgroup of intermediaries. For example, *ceteris paribus*, intermediaries that are more likely to receive government bailouts would generate higher total returns on intermediary capital with risky borrowers, as the *PUT* component would be higher for them. Moreover, intermediaries could have heterogeneous abilities to fund bank-dependent borrowers, for example because of underlying differences in monitoring technologies. In this case, intermediaries that have more limited capabilities in funding bank-dependent borrowers would also have greater risk-taking incentives—the *PUT* component would be relatively more important in shaping the total returns on intermediary capital for them. Similarly, if intermediaries had different types of legacy assets, they would create more private surplus with those types of new borrowers that exhibit correlated tail risks with the existing assets. For example, as Greek banks are generically more exposed to Greek risk factors, this logic predicts that these banks have a comparative advantage specifically in holding Greek sovereign debt, rather than just any risky debt.

It is useful to relate our predictions regarding the effects of legacy assets to the work of Bahaj and Malherbe (2020). The authors demonstrate that a bank with risky legacy assets may be reluctant to add a good, safe lending opportunity to its portfolio, as this could reduce the overall value the bank can derive from deposit insurance guarantees. This insight implies that raising capital ratio requirements may lead to an increase in investment by the bank, as it dampens how government guarantees distort the bank's decisions. Our environment with multiple intermediaries yields the complementary implication that institutions with distinct legacy assets will specialize in different parts of the borrower distribution (see Corollary 1). Whereas banks with risky legacy assets may resist adding safe loans, those with safe legacy assets, if present, could be predisposed to do so.

5.4. Multiperiod Settings

To focus on compositional effects, our framework considers a two-period setup. The main economic principles developed in this paper would, however, extend to dynamic environments. In particular, as in our current setting, the equilibrium return on intermediary capital can generally be defined as the derivative of an intermediary's value function with respect to the level of its current capital. In multiperiod settings, intermediaries still effectively rank potential loans according to the value that these loans provide to equity holders, per unit of scarce capital they consume, a metric we have defined as a loan's total return on intermediary capital. In a dynamic environment, these total returns would account for the continuation value ("franchise value") that intermediaries forgo when defaulting. For example, in times with high franchise values, intermediaries would effectively have more skin in the game, thus lowering the *PUT* components of loans' total returns on intermediary capital and reducing reaching-for-yield incentives for intermediaries. More generally, any time variation in economic prospects (future cash flows, bank dependence, regulations, etc.) would then make the magnitude of the *PUT* component and associated distortions time dependent. Another interesting feature of dynamic environments is the notion that intermediaries can retain profits to gradually build up equity capital, a channel that can help reduce the scarcity of intermediary capital. Although these types of dynamics are undoubtedly relevant in practice, the main economic principles highlighted in this paper still apply in their presence.

5.5. Endogenous Capital Requirements and Deposit Insurance Premia

The proposed modeling environment allows capturing many details of regulatory frameworks used in practice. It can, hence, facilitate analyses of how regulators should choose parameters of the regulatory environment to maximize social welfare.²¹ Such an analysis is particularly interesting under the plausible limitation that regulations can condition only on a given set of noisy security risk classifications so that two cash flow types, q and q' , may be pooled under the common regulatory risk classification ρ . Because of this type of pooling, setting risk weights for specific risk classifications then generically involves trade-offs. In particular, regulators typically face the dilemma that high risk weights on the one hand reduce the funding of surplus-destroying risky borrowers of a given risk classification, but on the other hand they can also cause rationing of credit to bank-dependent surplus-generating borrowers with the same risk classification (see Section 4.3). This trade-off emerging from imprecise risk classifications could also not be alleviated by additional regulatory tools used in practice, such as *deposit insurance*

premia, because these tools also have to rely on the same noisy risk classifications. However, deposit insurance premia levied on intermediaries would generally lower the incremental private surplus from intermediary lending for all borrowers of a given classification, leading to a reduction in the total returns on intermediary capital.

5.6. Endogenous Equity Supply Function

To maintain tractability in the presence of multidimensional borrower heterogeneity, our setup features the simplifying assumption that issuance costs are exogenous. In practice, these costs might be time varying and correlated with borrower types and other fundamentals. For example, a negative shock to the level of intermediary capital (see Section 4.2) is likely positively correlated with higher short-run issuance costs (a steeper issuance cost function), thereby exacerbating the effect of lower amounts of intermediary capital. More fundamentally, changes in government policies, like an increase in capital ratio requirements, may affect the costs of raising equity, for example via a reduction of the stigma and concomitant adverse selection discount. For small changes in policies, these feedback effects on the supply function are likely of second-order relevance for the composition of credit: In particular, it is the marginal borrowers that will be affected by changes in capital ratio requirements whereas inframarginal borrowers are unaffected. For larger changes in policies, such feedback effects may play a more important role. Future research could extend our analysis to incorporate such effects.

6. Conclusion

An influential literature in macroeconomics and banking highlights intermediary capital as a key state variable affecting aggregate economic outcomes. In this study, we propose a transparent and flexible framework to analyze which types of borrowers in an economy are most affected by shocks relating to intermediary capital and the regulations governing it. To do so, we develop a novel approach to characterizing the credit market equilibrium based on the total returns on intermediary capital that different borrower types generate. Despite the presence of multidimensional borrower heterogeneity, this approach yields transparent predictions for the composition and pricing of credit.

Our analysis reveals that the total return on intermediary capital that the funding of a borrower generates has an economically intuitive representation and provides sharp predictions on the behavior of intermediary funding. In particular, the difference between a borrower's total return on intermediary capital and the shadow value of intermediary capital is a sufficient statistic for the provision of intermediary credit. Moreover,

we derive a novel intermediary asset pricing equation that shows how the shadow value of intermediary capital shapes the cross-section of borrowers' funding costs, while recognizing the specialization of intermediaries as marginal investors across different securities.

Existing empirical studies analyzing microlevel bank data typically recognize that credit demand and supply are materially affected by borrower heterogeneity and factors linking credit demand and supply curves across borrower-bank pairs (Khwaja and Mian 2008). To limit confounding factors, this literature often focuses on outcome variation at the borrower level, which, however, provides limited insights on compositional effects at the aggregate level. The approach proposed in this paper—to determine loans' total returns on intermediary capital—might provide useful conceptual guidance for future studies analyzing the complex behavior of the composition of credit and its importance for macroeconomic stability and efficiency.

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Appendix A. Proofs

All proofs and derivations consider the general case where $r_F \geq 0$.

A.1. Intermediary Objective Function

After raising a net amount of outside equity E_O and deposits D , the total market value of an intermediary's equity is

$$E_M = \frac{\mathbb{E}[\max\{(1 + r_A^s(\mathbf{x}))A + (M - D)(1 + r_F), 0\}]}{1 + r_F}, \quad (\text{A.1})$$

which accounts for an intermediary's limited liability. The intermediary's return on equity before the cost of outside equity satisfies

$$r_E(\mathbf{x}, e) \equiv \mathbb{E} \left[\max \left\{ r_F + \frac{r_A^s(\mathbf{x}) - r_F}{e}, -1 \right\} \right].$$

Before raising outside finance, a banker's objective is to maximize the value of her equity stake, that is, the market value of the inside equity, which we denote by $E_{M,I}$. Competition implies that the value outside equity holders obtain must be equal to the cash they put up, $E_O + c(E_O)$. Thus, we obtain

$$E_{M,I} = \max_{E_O, M, D, \mathbf{x}} \{E_M - E_O - c(E_O)\}. \quad (\text{A.2})$$

It is useful to express this objective function in terms of the equity ratio $e = \frac{E_I + E_O}{A}$. Using this definition, the definition of $r_E(\mathbf{x}, e)$, and the balance sheet identity (2), we can eliminate the variables D and M , and write the objective function as follows:

$$E_{M,I} = E_I + \max_{E_O, e, \mathbf{x}} \left[(E_I + E_O) \frac{r_E(\mathbf{x}, e) - r_F}{1 + r_F} - c(E_O) \right], \quad (\text{A.3})$$

s.t.

$$e \geq e_{\min}(\mathbf{x}), \quad (\text{A.4})$$

$$\mathbf{x} \geq \mathbf{0}. \quad (\text{A.5})$$

Because E_I is exogenous and using $r_F = 0$ yields the objective

$$\max_{E_O, e, \mathbf{x}} [(E_I + E_O)r_E(\mathbf{x}, e) - c(E_O)]. \quad (\text{A.6})$$

A.2. Proof of Lemma 1

We analyze the individually optimal portfolio choice of an intermediary that faces a perfectly elastic supply of securities and takes as given the associated state-dependent returns $r^s(q, \beta, \rho)$. The intermediary's inner (ROE) maximization problem (10) is

$$\max_{e, \mathbf{x}} r_E(\mathbf{x}, e) - r_F \text{ s.t. } e \geq e_{\min}(\mathbf{x}), \mathbf{x} \geq \mathbf{0}, \quad (\text{A.7})$$

where

$$r_E(\mathbf{x}, e) - r_F = \frac{1}{e} \mathbb{E}[\max\{r_A^s(\mathbf{x}) - r_F, -(1 + r_F)e\}].$$

We note that $r_E(\mathbf{x}, e) - r_F \geq 0$ if the intermediary chooses a strictly positive investment in a loan portfolio, $A > 0$. Otherwise, it would prefer to invest in cash or pay out dividends $E_O = -E_I$. We thus only consider the relevant case where a weakly positive excess return is attainable.

A.2.1. Leverage. Taking the partial derivative of $r_E(\mathbf{x}, e)$ w.r.t. e yields

$$\begin{aligned} \frac{\partial r_E(\mathbf{x}, e)}{\partial e} &= -\frac{1}{e^2} \mathbb{E}[\max\{r_A^s(\mathbf{x}) - r_F, -(1 + r_F)e\}] \\ &\quad - \frac{1}{e} \Pr \left[\frac{r_A^s(\mathbf{x}) - r_F}{1 + r_F} < -e \right]. \end{aligned}$$

Note that if $r_E(e, \mathbf{x}) > r_F$ for some (e, \mathbf{x}) , then it must be the case that

$$\mathbb{E}[\max\{r_A^s(\mathbf{x}) - r_F, -(1 + r_F)e\}] > 0.$$

It follows that $\frac{\partial r_E(\mathbf{x}, e)}{\partial e} < 0$ if $r_E(\mathbf{x}, e) > r_F$. Further, if $r_E(\mathbf{x}, e) = r_F$, then $\frac{\partial r_E(\mathbf{x}, e)}{\partial e} < 0$ as long as there is one state s with positive probability, where the intermediary defaults, that is, $\Pr \left[\frac{r_A^s(\mathbf{x}) - r_F}{1 + r_F} < -e \right] > 0$.

Thus, for any choice (\mathbf{x}, e) that yields $r_E(\mathbf{x}, e) > r_F$, it is optimal to decrease e at the margin, unless the constraint $e \geq e_{\min}$ is already binding. Because decreasing e increases $r_E(\mathbf{x}, e)$, the condition $r_E(\mathbf{x}, e) > r_F$ remains satisfied after any decrease in e . Thus, for any $(\bar{\mathbf{x}}, \bar{e})$ such that $r_E(\bar{\mathbf{x}}, \bar{e}) > r_F$, it is the case that $\arg \max_e r_E(\bar{\mathbf{x}}, \bar{e}) = e_{\min}$.

Further, for any choice (\mathbf{x}, e) that yields $r_E(\mathbf{x}, e) = r_F$ and $\Pr \left[\frac{r_A^s(\mathbf{x}) - r_F}{1 + r_F} < -e \right] > 0$, marginally decreasing e also increases r_E (provided such a decrease is feasible, that is, the constraint

$e \geq e_{\min}$ is not already binding). Because marginally decreasing e increases $r_E(\mathbf{x}, e)$ (maintaining the condition that $r_E(\mathbf{x}, e) \geq r_F$) and weakly enlarges the set of default states (maintaining $\Pr\left[\frac{r_A^s(\mathbf{x}) - r_F}{1+r_F} < -e\right] > 0$), it is optimal to decrease e until the constraint $e \geq e_{\min}$ is binding. Formally, for any $(\bar{\mathbf{x}}, \bar{e})$ such that $r_E(\bar{\mathbf{x}}, \bar{e}) = r_F$, it is the case that $\arg \max_e r_E(\bar{\mathbf{x}}, e) = e_{\min}$ if $\Pr\left[\frac{r_A^s(\bar{\mathbf{x}}) - r_F}{1+r_F} < -e\right] > 0$.

This concludes the proof of the two statements about optimum leverage.

A.2.2. Portfolio Choice. The analysis in the previous paragraph implies that it is optimal for intermediaries to choose $e = e_{\min}$ as long as there exists a portfolio \mathbf{x} such that $r_E(\mathbf{x}, e) > r_F$, or $r_E(\mathbf{x}, e) = r_F$ and $\Pr\left[\frac{r_A^s(\mathbf{x}) - r_F}{1+r_F} < -e\right] > 0$. The following lemma will be useful for characterizing the intermediaries' portfolio choice.

Lemma A.1. *For all (q, β, ρ) with $x^*(q, \beta, \rho) > 0$, we obtain*

$$\frac{\mathbb{E}\left[\frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} \mid s : \frac{r_A^s(\mathbf{x}^*) - r_F}{1+r_F} > -e_{\min}(\mathbf{x}^*)\right]}{\Pr\left[s : \frac{r_A^s(\mathbf{x}^*) - r_F}{1+r_F} > -e_{\min}\right]} = k > 0. \quad (\text{A.8})$$

where v is the Lagrange multiplier on the constraint $\sum_{q, \rho} w(q, \rho) = 1$ and k is some positive constant.

Proof. Presume that such a portfolio \mathbf{x} exists and that intermediaries (optimally) choose $e = e_{\min}$. Then we can rewrite the expected excess return on an intermediary's book equity as follows:

$$\begin{aligned} & r_E(\mathbf{x}, e_{\min}) - r_F \\ &= \mathbb{E}\left[\max\left\{\frac{r_A^s(\mathbf{x}) - r_F}{e_{\min}(\mathbf{x})}, -(1+r_F)\right\}\right] \\ &= \mathbb{E}\left[\max\left\{\frac{\sum_{q, \rho} x(q, \beta, \rho)[r^s(q, \beta, \rho) - r_F]}{\sum_{q, \rho} x(q, \beta, \rho)\underline{\ell}(\rho)}, -(1+r_F)\right\}\right] \\ &= \mathbb{E}\left[\max\left\{\sum_{q, \beta, \rho} \frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} \frac{x(q, \beta, \rho)\underline{\ell}(\rho)}{\sum_{\tilde{q}, \tilde{\beta}, \tilde{\rho}} x(\tilde{q}, \tilde{\beta}, \tilde{\rho})\underline{\ell}(\tilde{\rho})}, -(1+r_F)\right\}\right]. \end{aligned} \quad (\text{A.9})$$

Defining $w(q, \beta, \rho) = \frac{x(q, \beta, \rho)\underline{\ell}(\rho)}{\sum_{\tilde{q}, \tilde{\beta}, \tilde{\rho}} x(\tilde{q}, \tilde{\beta}, \tilde{\rho})\underline{\ell}(\tilde{\rho})} \in [0, 1]$ for all (q, β, ρ) as the new choice variables, we obtain

$$r_E(\mathbf{w}) - r_F = \mathbb{E}\left[\max\left\{\sum_{q, \beta, \rho} w(q, \beta, \rho) \frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)}, -(1+r_F)\right\}\right].$$

Maximizing subject to the constraint that $\sum_{q, \beta, \rho} w(q, \beta, \rho) = 1$ and $w(q, \beta, \rho) \geq 0$ (short-sales constraint), we obtain for all (q, β, ρ) with $w^*(q, \beta, \rho) > 0$ the following condition at the optimum:

$$\frac{\partial r_E(\mathbf{w}) - r_F}{\partial w(q, \beta, \rho)} = v. \quad (\text{A.10})$$

Further, we can write

$$\begin{aligned} \frac{\partial r_E(\mathbf{w}) - r_F}{\partial w(q, \beta, \rho)} &= \mathbb{E}\left[\frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} \mid s : \frac{r_A^s - r_F}{1+r_F} > -e_{\min}\right] \\ &\cdot \Pr\left[s : \frac{r_A^s - r_F}{1+r_F} > -e_{\min}\right]. \end{aligned} \quad (\text{A.11})$$

Combining (A.10) and (A.11), we obtain (A.8) if $w^*(q, \beta, \rho) > 0$ (and, hence, $x^*(q, \beta, \rho) > 0$). \square

A.2.3. Correlated Tail Risks. First, note that we established in Lemma A.1 that for any optimal choice (\mathbf{x}^*, e^*) the expected excess asset return conditional on intermediary survival scaled by $\underline{\ell}(\rho)$ is identical across issuer types (q, β, ρ) with $x^*(q, \beta, \rho) > 0$. Suppose there is a type $(\tilde{q}, \tilde{\beta}, \tilde{\rho})$ with $x^*(\tilde{q}, \tilde{\beta}, \tilde{\rho}) > 0$ in the optimal portfolio that yields $\frac{r^s(\tilde{q}, \tilde{\beta}, \tilde{\rho}) - r_F}{1+r_F} > -\underline{\ell}(\tilde{\rho})$ in some state s where the intermediary defaults, that is, where $\sum_{q, \rho} \frac{x^*(q, \beta, \rho)r^s(q, \beta, \rho) - r_F}{1+r_F} < -e_{\min}$. Then the intermediary could obtain a higher expected return on equity $r_E > r_E(\mathbf{x}^*, e^*)$ by investing only in this asset $(\tilde{q}, \tilde{\beta}, \tilde{\rho})$, as it not only yields the same expected levered return across previous survival states (under the previous policy (\mathbf{x}^*, e^*)) but also allows the intermediary to survive in at least one additional state s .

Conversely, suppose \mathbf{x}^* is an optimal portfolio and there is an asset of type $(\tilde{q}, \tilde{\beta}, \tilde{\rho})$ in the optimal portfolio with a strictly positive weight ($x^*(\tilde{q}, \tilde{\beta}, \tilde{\rho}) > 0$) that yields $r^s(\tilde{q}, \tilde{\beta}, \tilde{\rho}) \leq -\underline{\ell}(\tilde{\rho})$ in some state \tilde{s} where the intermediary survives and has strictly positive equity value, that is, where $\sum_{q, \rho} w^*(q, \beta, \rho) \frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} > -(1+r_F)$. Then it must be the case that in this survival state \tilde{s} other assets in the portfolio yield $\frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} > -(1+r_F)$; otherwise the intermediary would default in that state. For notational simplicity define the set of states where the intermediary survives under policy $(\mathbf{x}^*, e_{\min}(\mathbf{x}^*))$ as $\Sigma_S(\mathbf{x}^*, e_{\min}(\mathbf{x}^*))$. We showed in Lemma A.1 that

$$\mathbb{E}\left[\frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} \mid \Sigma_S\right] = k,$$

for all (q, β, ρ) with $x^*(q, \beta, \rho) > 0$. However, because asset $(\tilde{q}, \tilde{\beta}, \tilde{\rho})$ performs worse than other assets in the portfolio in state \tilde{s} , that is, $\frac{r^s(\tilde{q}, \tilde{\beta}, \tilde{\rho}) - r_F}{\underline{\ell}(\tilde{\rho})} < -(1+r_F) \leq \frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)}$, it must outperform, relative to the other assets in the portfolio in expectation in the other survival states, to ensure that Equation (A.8) can hold, that is,

$$\mathbb{E}\left[\frac{r^s(\tilde{q}, \tilde{\beta}, \tilde{\rho}) - r_F}{\underline{\ell}(\tilde{\rho})} \mid \Sigma_S \setminus \tilde{s}\right] > \mathbb{E}\left[\frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} \mid \Sigma_S \setminus \tilde{s}\right] \quad \text{for all } (q, \beta, \rho) \neq (\tilde{q}, \tilde{\beta}, \tilde{\rho}) \text{ with } x^*(q, \beta, \rho) > 0. \quad (\text{A.12})$$

If we set $w(\tilde{q}, \tilde{\beta}, \tilde{\rho}) = 1$ and $w(q, \beta, \rho) = 0$ for all $(q, \beta, \rho) \neq (\tilde{q}, \tilde{\beta}, \tilde{\rho})$, we obtain the following expected excess return on equity conditional on the states Σ_S :

$$\begin{aligned} & (1 - \Pr[\tilde{s} \mid \Sigma_S]) \cdot \mathbb{E}\left[\frac{r^s(\tilde{q}, \tilde{\beta}, \tilde{\rho}) - r_F}{\underline{\ell}(\tilde{\rho})} \mid \Sigma_S \setminus \tilde{s}\right] + \Pr[\tilde{s} \mid \Sigma_S] \cdot (-1 - r_F) \\ & > (1 - \Pr[\tilde{s} \mid \Sigma_S]) \mathbb{E}\left[\frac{r^s(q, \beta, \rho) - r_F}{\underline{\ell}(\rho)} \mid \Sigma_S \setminus \tilde{s}\right] \\ & \quad + \Pr[\tilde{s} \mid \Sigma_S] \frac{r^s(\tilde{q}, \tilde{\beta}, \tilde{\rho}) - r_F}{\underline{\ell}(\tilde{\rho})} \\ & = k, \end{aligned} \quad (\text{A.13})$$

that is, we obtain a conditional expected return that is greater than the one obtained from portfolio \mathbf{x}^* . Further, in failure states Σ_F , this new portfolio cannot yield equity holders lower returns than the previous portfolio \mathbf{x}^* , because equity holders are protected by limited liability. This implies that setting $x(\tilde{q}, \tilde{\beta}, \tilde{\rho}) = 1$ and $x(q, \beta, \rho) = 0$ for all $(q, \beta, \rho) \neq (\tilde{q}, \tilde{\beta}, \tilde{\rho})$ increases r_E , contradicting the supposition that \mathbf{x}^* was an optimal portfolio.

Thus, if \mathbf{x}^* is an optimal portfolio, then any asset (q, β, ρ) in this optimal portfolio with a strictly positive weight ($x^*(q, \beta, \rho) > 0$) must yield $\frac{r^s(q, \beta, \rho) - r_F}{1 + r_F} > -\underline{e}(\rho)$ in all states s where the intermediary survives and has strictly positive equity value.

A.3. Proof of Lemma 2

Recall that the optimal intermediary inside equity value can be written as follows:

$$E_{M,I} = E_I + \max_{E_O} \left[\frac{(E_I + E_O)(\max_{\mathbf{x}} [r_E(\mathbf{x}, e)] - r_F)}{1 + r_F} - (c(E_O) - E_O) \right].$$

Let (\mathbf{x}^*, e^*) denote the optimal solution to the inner return on investment (ROI) maximization problem. It follows that if $(c'(0) - 1) \geq \frac{r_E(\mathbf{x}^*, e^*) - r_F}{1 + r_F}$, the intermediary optimally sets $E_O = 0$ (note that c is weakly convex). Further, at any E_O where $(c'(E_O) - 1) < \frac{r_E(\mathbf{x}^*, e^*) - r_F}{1 + r_F}$, the intermediary can strictly increase its objective function at the margin by increasing E_O .

A.4. Proof of Proposition 1

The total return on intermediary capital of an issuer is defined as the date-0 value added to intermediary equity holders per unit of allocated intermediary equity if the issuer is financed at her outside option. The derivation of the total return on intermediary capital builds on results in Lemmas B.1 and 1. First, if an issuer demands a loan to finance an investment of size I , optimal financing decisions by the intermediary (by Lemma 1) imply that the issuer “effectively” demands $I\underline{e}(\rho)$ units of intermediary capital. Intermediaries obtain the remaining funds of $I(1 - \underline{e}(\rho))$ via (subsidized) deposits. Because the government transfers the difference between the promised repayment to depositors $I(1 - \underline{e}(\rho))(1 + r_F)$ and the cash flows produced by intermediaries’ assets (the cash flows generated by the borrower, $C_s(q, 1)$) in intermediary default states, the present value of government transfers ultimately accruing to intermediary equity holders is

$$PUT(q, \rho) \equiv \frac{\mathbb{E}[\max\{I(1 - \underline{e}(\rho))(1 + r_F) - C_s(q, 1), 0\}]}{1 + r_F} \geq 0. \quad (\text{A.14})$$

The value of $PUT(q, \rho)$ uses the optimality of portfolios with correlated tail risk (by Lemma 1) and that intermediaries hold senior loans with promised yields of $y(q, \rho) \geq r_F$.

Conditional on financing an issuer, the total private surplus shared between the intermediary equity holders and the issuer is, thus, given by $NPV(q) + PUT(q, \rho)$. Because of the borrower’s outside option of unmonitored finance (see Lemma B.1), the maximum value added that the intermediary can reap

is given by

$$\Pi(q, \rho) = NPV(q) + PUT(q, \rho) - NPV(q) \mathbb{1}_{\{NPV(q) \geq B(q)\}}. \quad (\text{A.15})$$

Scaling (A.15) by $I\underline{e}(\rho)$ and adding one yields the effective price that an intermediary’s equity holder receives per unit of bank equity if the borrower is financed at his outside option, that is, the issuer’s total return on intermediary capital in (12).

A.5. Aggregate Demand and Supply Function

A.5.1. Supply. Lemma 2 implies that for any given ROE $\hat{r}_E > 0$, each individual intermediary run by banker b chooses to raise $E_{O,b} = [c^{-1}]'(\hat{r}_E)$, where the notation $[c^{-1}]'$ refers to the inverse of an intermediary’s marginal issuance cost function. Then, the total equity supply $S(\hat{r}_E)$ given any $\hat{r}_E > 0$ is the sum of inside equity E_I and the total issuance amount of outside equity, that is,

$$S(\hat{r}_E) = E_I + \int_{\Omega_b} E_{O,b} db = E_I + [c^{-1}]'(\hat{r}_E), \quad (\text{A.16})$$

which implies that the aggregate inverse supply function satisfies

$$S^{-1}(E) = c'(E - E_I). \quad (\text{A.17})$$

A.5.2. Demand. The total quantity potentially demanded by borrowers of a given borrower type (q, β, ρ) , which have mass $m(q, \beta, \rho)$, is given by $I \cdot \underline{e}(\rho) \cdot m(q, \beta, \rho)$. Summing up across issuer types yields the aggregate demand in closed form and the corresponding (inverse) aggregate demand of all borrowers

$$D^{-1}(E) = r_E^{\text{total}}(\hat{q}, \hat{\beta}, \hat{\rho}), \quad (\text{A.18})$$

where $(\hat{q}, \hat{\beta}, \hat{\rho})$ denotes the marginal borrower type given an aggregate amount of intermediary capital $E \in [0, \sum_{(q, \beta, \rho)} I \cdot \underline{e}(\rho) \cdot m(q, \beta, \rho)]$ where the upper bound of the domain refers to the amount of intermediary equity demanded if all borrower types were financed by intermediaries.

A.6. Proof of Proposition 2

As is standard in general equilibrium theory (see, e.g., Mas-Colell et al. 1995), all issuer types (q, ρ) with a reservation price $p^r(q, \rho)$ above the equilibrium price p^* get financed. To obtain ξ , note that after financing all borrowers with $p^r(q, \rho) > p^*$, an amount of $E^* - \sum_{(q, \beta, \rho): p^r(q, \beta, \rho) > p^*} I \cdot \underline{e}(\rho) \cdot m(q, \beta, \rho)$ is left to fund borrowers with $p^r(q, \rho) = p^*$. The total capital demanded by these borrowers is $\sum_{(q, \beta, \rho): p^r(q, \beta, \rho) = p^*} I \cdot \underline{e}(\rho) \cdot m(q, \beta, \rho)$. Hence, we obtain that

$$\xi = \frac{E^* - \sum_{(q, \beta, \rho): p^r(q, \beta, \rho) > p^*} I \cdot \underline{e}(\rho) \cdot m(q, \beta, \rho)}{\sum_{(q, \beta, \rho): p^r(q, \beta, \rho) = p^*} I \cdot \underline{e}(\rho) \cdot m(q, \beta, \rho)}. \quad (\text{A.19})$$

To obtain the expected return on debt of intermediary-financed borrowers, we use the fact that all loans must yield the same ROE for intermediaries (or equivalently, the same price) if financed in optimal portfolios. That is,

$$\mathbb{E} \left[\max \left\{ \frac{r^s(q, \beta, \rho) - r_F}{\underline{e}(\rho)}, - (1 + r_F) \right\} \right] = r_E^* - r_F, \quad (\text{A.20})$$

where $r_E^* - r_F = p^*(1 + r_F)$. Multiplying (A.20) by $\underline{e}(\rho)$ and using basic algebra gives us

$$\mathbb{E}[r^s(q, \beta, \rho)] = r_F + \underline{e}(\rho)[r_E^* - r_F] - \mathbb{E}[\max\{(1 - \underline{e}(\rho))(1 + r_F) - [1 + r^s(q, \beta, \rho)], 0\}] \quad (\text{A.21})$$

Because $y(q, \beta, \rho) \geq r_F$, we obtain that $1 + r^s(q, \beta, \rho) = \frac{C_s(q, 1)}{1}$ whenever $\frac{r^s(q, \beta, \rho) - r_F}{\underline{e}(\rho)} < -(1 + r_F)$. Thus, we get

$$\mathbb{E}[r^s(q, \beta, \rho)] = r_F + \underline{e}(\rho)[r_E^* - r_F] - \frac{1 + r_F \mathbb{E}[\max\{I(1 - \underline{e}(\rho))(1 + r_F) - C_s(q, 1), 0\}]}{1 + r_F}. \quad (\text{A.22})$$

Using the definition of (13), we thus obtain (18).

Appendix B. Microfounding Bank Dependence

Our main analysis captures bank dependence in reduced form via the parameter $\beta \in \{0, 1\}$. This section endogenizes bank dependence of a borrower building on the model of Holmstrom and Tirole (1997). In this model, financing frictions arise as firm cash flows, $C_s(q, a)$, are no longer just a function of the exogenous quality q , but also depend on unobservable effort $a \in \{0, 1\}$. Shirking, $a = 0$, allows the borrower to enjoy a private benefit of $B(q)$ when unmonitored, and zero when monitored by intermediaries.²² As is standard, we assume that no project generates positive social surplus (including the private benefit) under shirking, that is,

$$\frac{\mathbb{E}[C_s(q, 0)]}{1 + r_F} + B(q) < I \quad \forall q. \quad (\text{B.1})$$

As a result, a firm with fundamental q can obtain financing from investors in public markets if there exists a security with promised state- s cash flows, $CF_s \geq 0$, that satisfies both the borrower's IC constraint and investors' IR constraint:

$$\frac{\mathbb{E}[\max\{C_s(q, 1) - CF_s, 0\}]}{1 + r_F} \geq B(q) + \frac{\mathbb{E}[\max\{C_s(q, 0) - CF_s, 0\}]}{1 + r_F}, \quad (\text{IC})$$

$$\frac{\mathbb{E}[\min\{C_s(q, 1), CF_s\}]}{1 + r_F} \geq I. \quad (\text{IR})$$

To simplify exposition going forward, we make the following assumption.

Assumption B.1. *Under shirking the cash flow is sufficiently low in each state of the world, that is, $\frac{C_s(q, 0)}{1 + r_F} < I \quad \forall s, \forall q$.*

This assumption simplifies the borrower's incentive problem when unmonitored finance is provided and implies that debt is the optimal contract. Denoting $NPV(q) \equiv \frac{\mathbb{E}[C_s(q, 1)]}{1 + r_F} - I$ as the surplus under high effort, we then obtain the following lemma:

Lemma B.1. *A firm with fundamental q is bank dependent, $\beta = 1$, if $NPV(q) < B(q)$. Otherwise, the firm can obtain unmonitored finance from investors in public markets, $\beta = 0$. In this case, debt is an optimal contract and the value of a firm's equity is $NPV(q)$.*

Proof. First, we show that if $NPV(q) < B(q)$, the borrower cannot raise financing under any contract. As $\frac{\mathbb{E}[C_s(q, 0)]}{1 + r_F} + B(q) < I$, public financing requires high effort, that is, $a = 1$. If the borrower exerts effort, the maximum value of the borrower's stake

is given by $NPV(q)$, because the IR constraint and investor competition imply that investors' expected discounted payoff is equal to I , and $NPV(q)$ is equal to the difference between the present value of the firm's cash flows $\frac{\mathbb{E}[C_s(q, 1)]}{1 + r_F}$ and I . Second, as reflected by the IC constraint, the borrower's payoff under shirking is bounded from below by $B(q)$, because of limited liability. Hence, if $NPV(q) < B(q)$, it is impossible to jointly satisfy IC and IR.

We next show that whenever $NPV(q) \geq B(q)$, the borrower can raise financing with a debt contract that gives all surplus to the borrower, which also proves the optimality of debt. Set $CF_s = FV$ for all s , where FV is the face value of debt. Then IR requires that $\frac{FV}{1 + r_F} \geq I$. Now, using Assumption B.1, we obtain that $\mathbb{E}[\max\{C_s(q, 0) - FV, 0\}] = 0$ and the right-hand side of IC achieves the lower bound $B(q)$ under any debt contract that satisfies IR. Because investors are competitive, the face value of debt is set such that IR binds, so that the borrower's payoff is $NPV(q)$. We have thus proven that whenever $NPV(q) \geq B(q)$, there exists a debt contract that satisfies IR and allows the borrower to extract the entire NPV. \square

We note that unlike in Innes (1990) the optimality of debt is implied by Assumption B.1 rather than the joint assumption of the monotone likelihood ratio property (MLRP) and the monotonicity constraint of investors' payoff in firm cash flows. There are cash flow distributions that satisfy Assumption B.1, but not MLRP, and vice versa.

Endnotes

¹ See Atkeson et al. (2019) and Duffie (2019) for evidence on this distortion.

² Recent empirical work has estimated this shadow cost for regulated financial institutions such as banks and insurance companies (see, e.g., Koijen and Yogo 2015, Kisin and Manela 2016).

³ Kahn and Winton (2004) show that such "segmentation" may even obtain within a bank by creating subsidiaries without mutual recourse.

⁴ Becker and Ivashina (2015) provide empirical evidence of reaching-for-yield behavior by life insurers, consistent with predictions of Penacchi (2006).

⁵ Related implications of competition for regulation have also been studied in Boot et al. (1993), Hellmann et al. (2000), and Repullo (2004).

⁶ In Section 5, we discuss the robustness of our main insights to multiperiod settings.

⁷ Whereas we do not endogenize the relation between cash flow risk and the rating ρ , Opp et al. (2013) examine how credit ratings are determined in equilibrium when credit ratings are used for regulatory purposes. More broadly, the parameter ρ could capture alternative metrics for risk classification, for example, based on asset classes (see Becker et al. 2022).

⁸ Formally, one may think of the set of borrowers as a double continuum $\Omega_f = [0, 1] \times [0, 1]$ and $f = (b, i)$ so that each banker b faces a continuum of borrowers.

⁹ In Appendix A.5, we discuss the robustness of our analysis with respect to the possibility that intermediaries have market power and illiquid legacy assets.

¹⁰ A wedge between intermediaries' costs of raising debt on the one hand and equity on the other is a general property of models in which moral hazard impedes outside financing, and debt provides better incentives (Innes 1990, Tirole 2006). Such a wedge may also

arise because of adverse selection (Gorton and Pennacchi 1990), or because of equity claims' lack of monetary services (Stein 2012).

¹¹ See, for example, Hellmann et al. (2000) and Repullo and Suarez (2013). See also Pennacchi (1987, 2006) and Iannotta et al. (2019) for analyses of deposit insurance pricing and implications for bank regulation and financial system risks.

¹² See Diamond and Dybvig (1983) for a rationalization of deposit insurance and Bianchi (2016) or Chari and Kehoe (2016) for a rationalization of bailouts.

¹³ Although these transfers accrue ex post to depositors, competition among investors on the deposit rate ensures that the present value of these transfers (that is, the put (see Merton 1977)) is passed on to intermediary equity holders ex ante. Once we endogenize loan yields in equilibrium, intermediaries pass on part of the put value to borrowers.

¹⁴ In Appendix A.5, we highlight that the concept of this total return on intermediary capital naturally extends to the presence of other sources of intermediary-dependent surplus.

¹⁵ In some parameterizations, there may not be an intersection (e.g., because the aggregate demand is not continuous). Then, $E^* = \max\{E \geq 0 : D^{-1}(E) \geq S^{-1}(E)\}$.

¹⁶ Here, $\xi = \frac{E^* - \sum_{(q,\beta,\rho) \in E^*} \text{total}(q,\beta,\rho) > r_E^* I_E(q,\beta,\rho) m(q,\beta,\rho)}{\sum_{(q,\beta,\rho) \in E^*} \text{total}(q,\beta,\rho) = r_E^* I_E(q,\beta,\rho) m(q,\beta,\rho)}$.

¹⁷ Moreover, in Section 5, we discuss how these results extend to environments where intermediaries differ ex ante in terms of characteristics such as legacy asset holdings.

¹⁸ See further discussion in Section 5, where we address how our results extend to legacy assets.

¹⁹ In Holmstrom and Tirole (1997), banks only fund bank-dependent borrowers, so that a reduction in bank equity capital can never be compensated by nonbank lenders.

²⁰ See, for example, Scharfstein and Sunderam (2016), Drechsler et al. (2017), and Granja et al. (2022).

²¹ A proper welfare analysis could also account for the dead weight taxation costs arising from funding bailouts.

²² More generally, similar qualitative results obtain as long as intermediaries strictly reduce the private benefit of shirking.

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