

Securitization, Disclosure and Liquidity

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Abstract

We present a model of securitization where issuers of structured bonds choose coarse and opaque ratings to enhance the liquidity of their primary market, at the cost of reducing secondary market liquidity. The degree of transparency chosen by issuers is inefficiently low if the social cost of secondary market illiquidity exceeds the private one, providing a rationale for regulating the transparency of rating agencies. The model also shows that when issuers choose transparent ratings they may optimally choose to restrain the issue size, or tranche the issue so as to sell the more information-sensitive tranche to sophisticated investors only.

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1 Introduction

The securitization of mortgage loans is widely regarded as a key factor in the 2007-08 subprime lending crisis, to the point that it can be regarded as the distinctive feature of this crisis (Adrian and Shin, 2008; Brunnermeier, 2008; and Kashyap, Rajan and Stein, 2008, among others). In particular, it has become commonplace for policy makers and journalists to place a considerable part of the blame for the crisis on the lack of transparency of the ratings that accompanied the massive securitization process (see for instance the Financial Stability Forum Report, 2008, and International Monetary Fund, 2008). Not only the reliance on ratings is deemed largely responsible for massive mispricing of risk (Brennan, Hein and Poon, 2008), but the information loss in the process of securitization and rating is regarded as a source of the subsequent market illiquidity: after June 2007, the market for all structured debt securities shut down, credit default swaps spiked and all spreads widened, and even liquidity in money markets often dried up. This market illiquidity has in turn created a massive overhang of illiquid assets on banks' balance sheets, triggering or amplifying the credit crunch (Spaventa, 2008).

However, the links between securitization, ratings and market liquidity are less than obvious. How does the opaqueness of the rating process affect the secondary market liquidity of structured bonds? And if it does, why should issuers of such bonds choose opaque rather than transparent ratings? After all, if the secondary market for structured bonds is expected to be illiquid, issuers will sell them for a lower price. The pre-crisis behavior of issuers and investors alike suggests instead that both of them saw considerable benefits in a securitization process based on relatively coarse information. The fact that now this process has instead come to be seen as a key inefficiency suggests that there is a discrepancy between the private and the social benefits of transparency in the process of securitization. Which is the source of this discrepancy, and when should we expect it to be greatest? Clearly, this question is quite important in view of the current plans of tightening regulation of

rating agencies in both the United States and the European Union.

In this paper, we propose a model of securitization that addresses these issues. In our setting, issuers may wish their structured bonds to be rated with simple but coarse ratings because this allows them to expand the size and liquidity of their primary market. This is because only few potential buyers are sophisticated enough to understand the pricing implications of complex information, e.g. about the covariances of the underlying assets' payoffs.¹ So releasing such information would create a winner's curse problem for unsophisticated investors in the issue market. In other words, when some investors have limited ability to process information, releasing more public information may increase adverse selection in the market and therefore reduce its liquidity. (Incidentally, this underscores that the standard view that transparency enhances liquidity hinges on the assumption that market participants are equally skilled at information processing.)

But while uninformative ratings enhance liquidity in the primary market, they do so at the cost of damaging liquidity in the secondary market or even causing it to freeze. This is because the information undisclosed at the issue stage may still be uncovered by sophisticated investors later on, especially if it confers them the ability to earn large rents in secondary market trading. So limiting transparency at the issue stage shifts the adverse selection problem onto the secondary market. In choosing the degree of rating transparency, issuers effectively face a tradeoff between primary and secondary market liquidity.

The point that issuers will choose along this tradeoff depends on the value that investors place on secondary market liquidity, as well on the severity of the adverse selection problem in the primary market. If secondary market liquidity is valuable and/or adverse selection would not greatly affect primary market liquidity, then is-

¹Alternatively, the more complex information might concern the covariance between default losses and the marginal utility of consumption. Coval, Jurek and Stafford (2007) study the mispricing that arise if ratings only assess the probability of default but fail to indicate whether default is likely to occur in high-marginal utility states. Brennan, Hein and Poon (2008) show that some mispricing arises even if ratings assess the expected default loss, rather than simply its probability.

suers will concentrate on enhancing secondary market liquidity, and thus choose ratings to be transparent and informative, even though this reduces primary market liquidity somewhat. Conversely, if investors care little about secondary market liquidity and/or adverse selection would greatly impair primary market liquidity, then they will go for coarse and uninformative ratings.

In general, however, the degree of ratings transparency chosen by issuers falls short of the socially optimal one whenever secondary market illiquidity or freeze has a social cost in excess of its private one. This may be the case if, for instance, a secondary market freeze were to trigger a cumulative process of defaults and premature liquidation of assets in the economy, for instance because banks' interlocking debt and credit positions create a gridlock effect. Then the degree of ratings transparency that is optimal for society exceeds that chosen by issuers of structured bonds, which creates a rationale for regulation. Mandatory rating transparency is more likely to be socially desirable when secondary market liquidity is valuable and/or adverse selection in the primary market is not too severe. Nevertheless, such regulation does have a cost in terms of reduced liquidity at the issue stage.

Our analysis also shows that in some cases if issuers accept a degree of "restraint" in the issue size or issue it in tranches, the area in which ratings transparency is privately optimal becomes larger. To see why, consider that a transparent rating no longer causes adverse selection in the primary market if the issue size is capped at the maximal amount that the sophisticated investors alone can buy, and priced it so as to appeal only to these investors. The gain to the issuer is a lower discount at issue, while the cost is that he will sell a smaller issue. Tranching is an even better way to address the problem, if the tranches are designed and priced so that sophisticated investors purchase the risky, information-sensitive tranche, while unsophisticated ones buy the safe and information-insensitive one. This allows the issuer to place a larger issue than he could by restraining the overall size of an untranching issue. This type of tranching is feasible only when sophisticated investors have enough wealth as to absorb the information-sensitive tranche entirely. If so, issuers will choose transparent

ratings whenever it is socially optimal, which shows that tranching also has a bright side, rather than being solely a marketing tool to gain from mispricing as argued by Brennan et al. (2008).

This argument is akin to that by Gorton and Pennacchi (1990), who show that the trading losses associated with information asymmetry can be mitigated by designing securities which split the cash flows of underlying assets so as to make them insensitive to private information, and therefore can be safely bought by uninformed investors who seek them only for their liquidity needs. An even closer argument is offered by Plantin (2004), who shows that when asset-backed securities are sold to heterogenous institutions, it is optimal for the sophisticated ones to concentrate on the most junior tranches and leave more senior tranches to unsophisticated ones, as this reduces adverse selection on senior tranches and spurs information collection on junior tranches.²

It is important to notice that our model does not rely on any form of agency problem between the issuer and the rating agency. We assume rating agencies to collect and disclose exactly the amount of information that the issuer wants them to. In other words, when transparency is poor, it is so in the interest of the issuer. An alternative (or possibly complementary) approach is to assume that the rating agencies are not doing their job properly.

A recent report by the Securities Exchange Commission (SEC, 2008) finds support for both approaches. Upon a 10-month scrutiny of three major credit rating agencies – Fitch, Moody’s and Standard & Poor’s – in the recent turmoil in the subprime mortgage-related securities markets, the study finds that some of the rating agencies appear to have suffered from conflicts of interest and did not have proper internal auditing processes. However, the report also indicates that low transparency was a critical aspect of their business: significant aspects of the ratings process were not

²The latter idea – that tranching is beneficial because it elicits information collection by sophisticated investors – is already present in Boot and Thakor (1993).

always disclosed and policies and procedures for rating CDOs were not documented enough. These findings are not necessarily a symptom of agency problems but could be in the interest of the issuer, as suggested in this paper.

The paper is organized as follows. Section 2 lays out the structure of the model. In Section 3 we solve for the equilibrium, and identify the circumstances in which securitization is privately efficient. In Section 4 we analyze in which cases the socially efficient level of transparency may exceed the privately optimal one. The impact of the choice of size of the issue and of tranching are studied in Section 5. Section 6 concludes.

2 The Model

An issuer owns N financial claims over its customers (e.g., mortgage loans) and wishes to sell them because the revenue from the sale can be invested elsewhere for a net return $r > 0$. The payoff of an individual claim i can be v_B or v_G , where G and B stand for “good” (prime) and “bad” (subprime) loans, respectively. Good and bad loans yield a high payoff V_H with probabilities $p + \theta$ and p respectively, and a low payoff V_L with probability $1 - p - \theta$ and $1 - p$. Therefore the expected payoff of good claims exceeds that of bad claims by $\theta(V_H - V_L)$.

The payoffs of the two types of claims are correlated: specifically, the bad claim never pays V_H when the good one pays V_L , while it pays V_L with probability q when the good one pays V_H . Therefore, q is an inverse measure of the correlation between the two claims, or equivalently is a measure of the diversification of the loan portfolio: in the limiting case $q = 0$ the two claims are perfectly correlated – indeed they have identical payoffs; in the polar opposite case $q = 1$, they are uncorrelated – as the good one always pays V_H . Formally, the joint distribution of the payoffs of the two claims is:

Table 1. Joint Probabilities of Asset Payoffs

		v_G	
		V_L	V_H
v_B	V_L	$(1-p)(1-q)$	$(1-p)q$
	V_H	0	p

Computing the marginal probabilities of the payoffs of the two claims yields that their expected payoff differential θ equals $(1-p)q$. So a larger q implies that good claims offer a higher expected payoff, as they become less correlated with bad ones.

The quality of bad claims, as measured by the probability p , is common knowledge, while the diversification parameter q is unknown to everyone, including the issuer, although it can be discovered by a rating agency.

2.1 Securitization

We assume that the issuer must sell these claims as a portfolio because selling them individually would have prohibitive costs.³ Denoting the fraction of good claims in the portfolio by λ , the portfolio per-claim payoff is $v_P = \lambda v_G + (1-\lambda)v_B$, which takes three possible values: a high value V_H if both claim types do well (which occurs with probability p); an intermediate value $V_L + \lambda(V_H - V_L)$ if only good claims do well (which happens with probability $(1-p)q$); and a low one V_L , if both claim types do poorly (which happens with probability $(1-p)(1-q)$).⁴

Since the issuer knows the quality of his portfolio, as measured by λ , whereas investors ignore it, an adverse selection problem arises. From the viewpoint of in-

³A motivation for this prohibitive cost is that the payoff of each claim has an idiosyncratic random component that is known to the issuer and can be certified by the rating agency at a cost, while it is unknown to investors. Then, overcoming adverse selection problems would require each individual claim to be rated by the agency, which would have very large costs. Pooling the claims in a portfolio would diversify away this idiosyncratic risk and thereby eliminate the need for the rating agency to assess the idiosyncratic risk of claims.

⁴The state where good claims do poorly and bad ones do well never occurs, by the assumption made in Table 1.

vestors, λ is a random variable, distributed on $[0, 1]$. In equilibrium, investors would expect the portfolios on sale to feature a very low value of λ , which would imply a very low price for the portfolio and therefore discourage its sale – an instance of Akerlof’s lemon’s problem. A way to overcome this problem is to have a rating agency certify the value of λ .

The portfolio is sold as a collateralized debt obligation (CDO) which promises to repay a face value F comprised between the high payoff V_H and the intermediate payoff:

$$F \in (V_L + \lambda(V_H - V_L), V_H] \quad (1)$$

Below we will show that in equilibrium issuers will choose the face value of the CDO to lie in this interval (and specifically to equal V_H). Therefore, the CDO repays its face value F only if the underlying portfolio yields the high payoff V_H , and defaults otherwise. But, as shown in Table 2, the loss inflicted on the CDO holders is larger when both claim types do poorly (outcome D_1) than in the intermediate case (outcome D_2).

Table 2. CDO Payoffs and Probabilities

Asset Payoff (v_P)	CDO Payoff (x)	CDO Outcomes	Probability
V_H	F	no default (ND)	p
$V_L + \lambda(V_H - V_L)$	$V_L + \lambda(V_H - V_L)$	default, small loss (D_1)	$(1 - p)q$
V_L	V_L	default, large loss (D_2)	$(1 - p)(1 - q)$

We assume that the parameters q and λ are unknown to investors but can be ascertained and certified by the rating agency, which can perform its activity at two different levels of transparency: a low transparency level, whereby it simply certifies the fraction λ of good loans, so as to overcome the issuer’s adverse selection problem; or a high transparency level, whereby it reveals the entire distribution of the CDO’s payoffs – or, equivalently, both the fraction λ of good loans and the diversification

parameter q . In the low transparency scenario, each of the ratings published by the agency (Aa1, Aa2, Aa3, A1, A2, A3, Baa1, Baa2, Baa3, etc.) corresponds to one of the possible values of λ or equivalently to the corresponding value of the expected CDO outcome. For instance, if λ can take 15 possible values, there are 15 possible ratings. In the high disclosure scenario, the number of possible ratings gets compounded by the number of possible realizations of q . If, for instance, q can take one of two values (as we shall assume later), the number of possible ratings escalates to 30. Or alternatively, the rating agency will issue a bi-dimensional rating, the two dimensions being the CDO quality λ and the diversification of the underlying portfolio q . In either case, with high transparency the rating is defined on a more finely partitioned information set than with low transparency.

Table 2 shows that in the low transparency scenario investors cannot assess the true probability weights to be assigned to the CDO payoffs in the two default states D_1 and D_2 . Therefore, they must base themselves on the unconditional mean of these weights. Assuming that q equals $(1 + \sigma)/2$ with probability $1/2$ and $(1 - \sigma)/2$ otherwise, so that $\sigma \in [0, 1]$ is an indicator of the extent of uncertainty on q and its unconditional mean is $1/2$. Therefore, in the low transparency scenario investors will consider the probability of both the two default outcomes D_1 and D_2 as being equal to $(1 - p)/2$. In contrast, in the high transparency scenario, that would correctly assess these two probabilities as being $(1 - p)q$ and $(1 - p)(1 - q)$.

The purpose of this paper is precisely to assess the private and social effects of the disclosure policy – or degree of transparency – chosen by the rating agency. In Section 3 we will assume that the issuer decides which type of information the rating agency can disclose to investors, whereas in Section 4 we shall explore the implications of constraining this choice via regulation.

2.2 Time Line

The time line of the model is illustrated in Figure 1. At the initial stage 0, Nature chooses the fraction of good claims λ and the diversification parameter q , and the issuer learns the former but not the latter.

At stage 1, the issuer chooses between the low and high transparency regime, the rating agency reveals the corresponding information, and the primary market opens. The CDO is sold at price P_1 to M investors, each endowed with capital w . A fraction μ of these are sophisticated: they can distinguish between the three states ND , D_1 and D_2 and therefore can use the information on q (if disclosed) to price the CDO correctly. The remaining $1 - \mu$ investors are unsophisticated: they cannot distinguish between the two default states D_1 and D_2 , so that they cannot interpret the information on q if disclosed.⁵ Otherwise said, the two group of investors differ in their ability to process a more finely partitioned information set.

We also assume that sophisticated investors are not numerous enough to buy the entire CDO issue, which amounts to the condition $\mu Mw < E(x | q)$, since the price at which sophisticated investors are willing to buy the entire issue is the expected CDO payoff conditional on the realized q . Instead, unsophisticated investors are sufficiently numerous as to absorb the entire issue: $(1 - \mu)Mw > E(x)$, where the price at which they are willing to buy the entire CDO issue is the unconditional expectation of its payoff. As in Rock (1986), these assumptions imply that the price P_1 must induce participation by the unsophisticated investors for the CDO sale to succeed.

At stage 2, everyone learns whether the CDO is in default or not. At this point, if the issuer opted for low transparency in the previous stage, sophisticated investors may still try to acquire information about q at a private cost. Their probability ϕ of learning q is increasing in the resources they spend on information acquisition: specifically, by paying a cost $C\phi$ they learn with probability ϕ .

⁵In a future extension, we plan to show that this is the outcome of a rational decision under information capacity constraint

At stage 3, investors can trade the CDO on a secondary market, where risk-neutral and competitive market makers set bid and ask quotes so as to make zero profits. A fraction π of investors are hit by a liquidity shock and must choose whether to sell their stake in the secondary market at the price P_3 or rather give up investment opportunities at a private cost Δ . If they opt for the latter, the economy incurs an additional social cost $\gamma\Delta$, where $\gamma \geq 0$ is a measure of the negative externality due to poor secondary market liquidity. To simplify the analysis we will concentrate on the case where the private liquidation cost is large, and specifically we will assume that $\Delta > C$.

At stage 4, the payoffs of the underlying portfolios and of the CDOs are realized.

3 Equilibrium prices and transparency

The model is solved by backwards induction starting with stage 3, when the secondary market for CDOs opens. We will then proceed to stage 2 to the sophisticated investors' decision to invest in gathering information, and finally to stage 1 where issuers choose which information the rating company will disclose to the market.

3.1 Secondary Market Price

If the CDO is known to repay its face value F (outcome ND), its secondary market price is simply:

$$P_3^{ND} = E(x \mid ND) = F.$$

The market is perfectly liquid: if hit by liquidity shocks, investors can sell the CDO at price P_3^{ND} .

If the CDO is expected to be in default (outcomes D_1 or D_2), to determine the corresponding level of the CDO price P_3^D we must consider three cases, depending on the information made available to investors at stage 1.

First, in the high-transparency regime, investors and the market makers will learn

the realization of q . Assuming that market makers are sophisticated and therefore can interpret the rating, the realized q will be impounded in secondary market quotes. The CDO's price at stage 3 is simply the expected value of the underlying portfolio conditional on default, which we can be computed as the sum of the payoffs in D_1 and D_2 shown in Table 2, weighted by their respective probabilities q and $1 - q$:

$$P_3^D = E(x \mid D_1 \cup D_2, q) = V_L + \lambda q(V_H - V_L).$$

In this case, the secondary market is perfectly liquid since prices are fully revealing: liquidity traders face no transaction costs.

In the low-transparency regime, we need to distinguish between the subgame where sophisticated investors decide to collect information about it or not. In the subgame where they do not collect such information, all investors will estimate q at its expected value $1/2$, so that CDO price at stage 3 is:

$$P_3^D = E(X \mid D_1 \cup D_2) = V_L + \frac{\lambda}{2}(V_H - V_L) \equiv \bar{V}_\lambda,$$

where \bar{V}_λ is the unconditional expectation of the CDO recovery value in the default states. Also in this case, the secondary market is perfectly liquid, since there are no informational asymmetries between investors. So also in this case liquidity traders will face no transaction costs.

In the subgame where a fraction $\phi > 0$ of the sophisticated investors become informed, instead, the secondary CDO market features asymmetric information. In the default states, the market maker will set the bid price P_3^D so as to gain from the uninformed investors what he loses from informed investors, as in Glosten and Milgrom (1985). Suppose that uninformed investors sell whenever hit by a liquidity shock, which happens with probability π – an assumption that we shall verify below. Informed investors (who are a fraction $\phi\mu$ of the investors' pool) will only sell if the bid price is above their estimate of the CDO value, that is, if $q = (1 - \sigma)/2$, which occurs with probability $1/2$. Hence, the frequency of investors submitting a sell order is $\pi + \phi\mu/2$. The market maker gains $\bar{V}_\lambda - P_3^D$ every time he trades with an

uninformed investor, and loses $P_3^D - V_L - (1 - \sigma)\lambda(V_H - V_L)/2$ every time he trades with an informed one. Hence, the zero-profit condition for the market maker is

$$\pi(\bar{V}_\lambda - P_3^D) = \frac{\phi\mu}{2} [P_3^D - V_L - (1 - \sigma)\lambda(V_H - V_L)/2],$$

implying that the equilibrium price is

$$P_3^D = \bar{V}_\lambda - \frac{\phi\mu}{2\pi + \phi\mu} \frac{\sigma}{2} \lambda(V_H - V_L) = \bar{V}_\lambda - \frac{\phi\mu}{2\pi + \phi\mu} R, \quad (2)$$

where $R \equiv \sigma\lambda(V_H - V_L)/2$ is the rent that an informed trader extracts from an uninformed one conditional on both of them trading. As one would expect, the rent is increasing in the variance σ of the signal gathered by informed traders and in the signal's value $\lambda(V_H - V_L)$. The informed traders' rent R is weighted by the probability of a sell order being placed by an informed trader, $\phi\mu/(2\pi + \phi\mu)$. This expected rent translates into a discount that liquidity traders must bear when trading in the secondary market: if hit by a liquidity shock, they have to sell the CDO at a discount relative to the unconditional expectation of its final payoff.

Note that expression (2) is predicated on the assumption that uninformed traders sell whenever hit by a liquidity shock. But they will actually want to do so only if the discount at which they sell does not exceed the reservation value Δ that they place on liquidity. Formally, they will sell if

$$\Delta \geq \frac{\phi\mu}{2\pi + \phi\mu} R. \quad (3)$$

When this constraint is satisfied, unsophisticated investors will participate to the secondary market even when it is illiquid. However, for this regime to exist, one must also check whether a positive fraction ϕ of sophisticated investors have the incentive to acquire information about q , an issue to be analyzed in the subsequent section. If instead the constraint (3) is violated, unsophisticated investors will not participate, so that market makers cannot recover the losses incurred by trading with informed investors, and the secondary market will freeze.

3.2 Decision to Acquire Information

In the low transparency regime, sophisticated investors may have the incentive to learn the realization of q . The cost of learning q with probability ϕ is $C\phi$. The gain from learning q equals the market makers' expected trading loss found above:

$$P_3^D - V_L - (1 - \sigma)\lambda(V_H - V_L)/2 = \frac{2\pi}{2\pi + \phi\mu}R,$$

where in the second step the gain is evaluated at the equilibrium price P_3^D in (2). This gain accrues to informed investors only if condition (3) holds, which ensures that unsophisticated investors trade in the secondary market, and it is obtained with probability $1/2$, since only when $q = (1 - \sigma)/2$ the informed investor sell the CDO at a profit.⁶ Hence, the expected profit from gathering information is:

$$\frac{\phi}{2} \frac{2\pi}{2\pi + \phi\mu} R - C\phi.$$

Assuming that in the aggregate sophisticated investors choose to gather information up to the point where these expected profits are zero, ϕ will be set at the level:

$$\phi^* = \max \left\{ \frac{\pi}{\mu} \left(\frac{R}{C} - 2 \right), 0 \right\}.$$

Therefore, sophisticated investors will acquire information – that is, choose $\phi^* > 0$ – only if $C < R/2$.⁷

Replacing ϕ^* into equation (2), we obtain the equilibrium stage-3 price when the secondary market is illiquid, while replacing ϕ^* in the uninformed investors' participation constraint (3), we find that these investors participate if $\Delta \geq R - 2C$. Summarizing, when default is expected at stage 3, the secondary market price will

⁶With complementary probability, sophisticated investors instead learn that $q = (1 + \sigma)/2$, which cannot be exploited by selling the CDO, since by assumption there are no liquidity buyers.

⁷Notice that sophisticated investors may not have the incentive to acquire q at the stage when the CDO is sold on the primary market because in that case the probability of the default state is $1 - p$. Hence, the cutoff on C is much more difficult to satisfy: $C < (1 - p)R/2$. Hence, we assume that $2C \geq (1 - p)R$.

depend on the transparency regime chosen at stage 1 and on parameter values as follows:

$$P_3^D = \begin{cases} V_L + \lambda q(V_H - V_L) & \text{with high transparency;} \\ \bar{V}_\lambda & \text{with low transparency, if } R \leq 2C; \\ \bar{V}_\lambda - (R - 2C) & \text{with low transparency, if } R \in (2C, 2C + \Delta]; \\ \bar{V}_\lambda - \Delta & \text{with low transparency, if } R > 2C + \Delta. \end{cases} \quad (4)$$

Based on this result, we characterize the equilibrium secondary market outcome:

Proposition 1 *In the high transparency regime, the secondary market is perfectly liquid. In the low transparency regime, the secondary market is:*

- (i) *perfectly liquid if the rent from informed trading is low ($R \leq 2C$);*
- (ii) *illiquid if the rent from informed trading is at an intermediate level ($R \in (2C, 2C + \Delta]$);*
- (iii) *inactive if the rent from informed trading is high ($R > 2C + \Delta$).*

Therefore, the secondary market's ability to cater to liquidity sellers is inversely related to the rent that can be earned by informed investors. Since this rent is rationally anticipated when the CDO is sold on the primary market, it will translate into an illiquidity discount at the issue stage, as will be shown in the next section.

3.3 Primary Market Price

Under the assumptions of Section 2, the equilibrium price in the primary market is such that unsophisticated investors break even in expectation, conditional on their information set and on their probability of their bids being successful:

$$P_1 = \xi E\left(x \mid q = \frac{1 + \sigma}{2}\right) + (1 - \xi)E\left(x \mid q = \frac{1 - \sigma}{2}\right), \quad (5)$$

where ξ is the probability that unsophisticated investors successfully bid for a high-value CDO, conditional on sophisticated investors playing their optimal bidding strategy. Of course, this probability is a function of the disclosure policy of the issuer, as this changes the information set of the sophisticated investors.

3.3.1 Issue Price with Low Transparency

If the realization of q is not disclosed, the two types of investors are on equal ground at stage 1 in their valuation of the securities. The CDO price is determined by the unconditional expectation of its payoff net of the expected stage-3 liquidity costs:

$$P_1 = \begin{cases} pF + (1-p)\bar{V}_\lambda & \text{if } R \leq 2C; \\ pF + (1-p)[\bar{V}_\lambda - \pi(R - 2C)] & \text{if } R \in (2C, 2C + \Delta]; \\ pF + (1-p)(\bar{V}_\lambda - \pi\Delta) & \text{if } R > 2C + \Delta. \end{cases} \quad (6)$$

3.3.2 Issue Price with High Transparency

If instead q is disclosed, the secondary market is expected to be perfectly liquid, so that unsophisticated investors will require no illiquidity discount at the issue stage. But sophisticated investors will have an informational advantage in their bidding, so that the CDO will be underpriced at the issue stage. To see this, consider that for sophisticated investors the conditional expectation of the CDO payoff is

$$E(x | q) = pF + (1-p)[V_L + \lambda q(V_H - V_L)],$$

so that they are willing to bid and pay a price $P > E(x | q = (1 - \sigma)/2)$ if $q = (1 + \sigma)/2$, but they will place no bids if $q = (1 - \sigma)/2$. As a result, if $q = (1 + \sigma)/2$ both types of investors bid: the sophisticated investors get a share of the portfolio with probability μ and the unsophisticated get it with probability $1 - \mu$. If instead $q = (1 - \sigma)/2$, the unsophisticated investors buy a share of the portfolio with certainty.

So the probability that an unsophisticated gets a share of the CDO if $q = (1 + \sigma)/2$ is $\xi = \mu/(2 - \mu)$ and, using equation (5), the issue price is:

$$P_1 = pF + (1 - p) [\bar{V}_\lambda - \xi R], \quad (7)$$

where $(1 - p)\xi R$ is the discount required by unsophisticated traders to compensate their winner's curse. This is increasing in the fraction of sophisticated investors μ (as ξ is increasing in μ) and in their informational rent R , as both of these parameters tends to increase the severity of adverse selection in the primary market.

3.3.3 Face Value of CDO

The issuer invest at a net return r any proceeds from the sale of the CDO. Hence, he will choose the face value of the CDO, F , in such a way to maximize the issue price P_1 . Notice that F enters in the same way in the expressions (6) and (7) for the issue price. Hence, the choice of F is independent on the choice of transparency (to be analyzed in the next section). As both expressions are strictly increasing in F , the issue price is maximized for $F = V_H$, which verifies assumption (1) made about the face value of the CDO.

3.4 Choice of transparency

Which regime will the issuer choose to maximize the issue price P_1 ? This boils down to the comparison between expressions (6) and (7).

Figure 2 illustrates the issuer's optimal choice in various parameter regions. The probability of the liquidity shock π is measured along the horizontal axis, and the informational rent in the secondary market R along the vertical axis. In the lowest region where $R \leq 2C$, the issuer will choose no transparency. The secondary market is perfectly liquid, because the profits from information do not compensate for the cost of information collection. Hence, the issuer's only concern is to avoid underpricing in the primary market, which is achieved by choosing low transparency.

In the intermediate region where $R \in (2C, 2C + \Delta]$, the discount associated with high transparency is ξR , whereas the discount with low transparency is $\pi(R - 2C)$.

Hence, the regime with low transparency dominates if $R(\pi - \xi) < 2\pi C$. This condition is always met if $\pi < \xi(\Delta + 2C)/\Delta$. Therefore in this parameter region issuers will go for low transparency if the probability π of investors requiring liquidity and their reservation value of liquidity Δ are low, and/or when there is adverse selection in the primary market, as measured by ξ , is severe – which, recalling $\xi = \mu/(2 - \mu)$, occurs if the proportion μ of sophisticate investors is relatively large. Intuitively, if there is little demand for secondary market liquidity and/or adverse selection would seriously hinders primary market liquidity, issuers will therefore focus on the need to avoid underpricing in the primary market, thereby choosing low transparency, at the cost of sacrificing secondary market liquidity. When this condition is not met, i.e. for values of $\pi > \xi(\Delta + 2C)/\Delta$, the choice about transparency also depends on the magnitude of the informational rent R : since the discount required for liquidity trading to occur is increasing both in the probability of liquidation π and in the magnitude of their loss to informed traders R , low-transparency will be chosen only if an increase in π is compensated by a reduction in R . Graphically, we have to remain to the left of the curved locus $R = 2\pi C/(\pi - \xi)$.

In the top region where $R > 2C + \Delta$, the secondary market freezes if there is low transparency at the issue stage. So, with low transparency the issuer will bear the expected liquidity cost $\pi\Delta$, while saving the underpricing cost ξR . Therefore, low transparency is preferred if $\pi\Delta < \xi R$, that is, to the left of the increasing line $R = \pi\Delta/\xi$; conversely, high transparency is preferred to the right of that line. Therefore, as in the intermediate case, also here issuers choose low transparency if π and Δ are low and/or ξ (i.e. μ) is high, that is there is low demand for secondary market liquidity and/or the supply of primary market liquidity would be low if ratings were transparent.

In conclusion, high transparency is optimal in the shaded region in Figure 2 where the probability of the liquidity shock is sufficiently large. It is easy to see that this shaded region would vanish if $\pi < \xi(\Delta + 2C)/\Delta$, since then the downward-sloping curve would lie above the horizontal line $2C + \Delta$: if π and Δ are sufficiently small

and/or ξ sufficiently large, issuers will never choose transparent ratings. Conversely, a transparency region always exists if the abscissa of its leftmost point A, $\pi = \xi(2C + \Delta)/\Delta$, is strictly smaller than 1. Recalling that $\xi = \mu/(2 - \mu)$, this is seen to be equivalent to the condition $\Delta/C > \mu/(1 - \mu)$. In line with our previous results, this condition is more likely to be met the larger is the reservation price of liquidity Δ and the smaller the fraction of informed traders μ , but it is also more likely to be met if the cost C of gathering private information is small, so that adverse selection in the secondary market is expected to be severe.

These results are summarized in the following:

Proposition 2 *Issuers choose high transparency in the region $R \in [2\pi C/[\pi - \mu/(2 - \mu)], 2C + \Delta]$, whose magnitude is increasing in the probability of liquidation π and in the reservation value of liquidity Δ , and is decreasing in the fraction of sophisticated investors μ . This region is non-empty if and only if $\Delta/C > \mu/(1 - \mu)$, while it disappears if $\pi < [\mu/(2 - \mu)][(\Delta + 2C)/\Delta]$.*

Based on the optimal choice of transparency by CDO issuers described above, we can finally write the expression for the equilibrium CDO price in the primary market:

$$P_1 = \begin{cases} pV_H + (1 - p)\bar{V}_\lambda & \text{if } R \leq 2C; \\ pV_H + (1 - p) [\bar{V}_\lambda - \pi(R - 2C)] & \text{if } \begin{matrix} R \in (2C, 2C + \Delta] \\ \text{and } R < 2\pi C/(\pi - \xi) \end{matrix} \\ pV_H + (1 - p) [\bar{V}_\lambda - \xi R] & \text{if } R \in [2\pi C/(\pi - \xi), 2C + \Delta] \\ pV_H + (1 - p) (\bar{V}_\lambda - \pi\Delta) & \text{if } R > 2C + \Delta. \end{cases}, \quad (8)$$

where only the third expression corresponds to the high transparency regime, in which the price contains a discount for the winner's curse problem in the primary market.

4 Social Efficiency

The social cost of the secondary market shutdown may exceed its private cost if the shadow value of liquidity exceeds the private value perceived by investors hit by a

liquidity shock. In this case, the social value of stage-3 liquidity is $(1 + \gamma)\Delta$, where γ measures the intensity of the liquidity externalities. Suppose that the government could mandate transparency to issuers: in which parameter regions, will it be socially efficient to mandate high transparency?

To investigate this issue, we must define what is social surplus in the model. Recall that the capital raised by the issuer is invested in some new profitable undertaking, producing a net return $r > 0$. Hence, the proceeds from securitization P_1 enter the social welfare weighted by r .

With no transparency, social welfare is:

$$W = r[pV_H + (1 - p)(\bar{V}_\lambda - \xi R)], \quad (9)$$

whereas without transparency it is:

$$W = \begin{cases} r[pV_H + (1 - p)\bar{V}_\lambda] & \text{if } R \leq 2C; \\ r\{pV_H + (1 - p)[\bar{V}_\lambda - \pi(R - 2C)]\} & \text{if } R \in (2C, 2C + \Delta]; \\ r[pV_H + (1 - p)(\bar{V}_\lambda - \pi\Delta)] - (1 - p)\pi\gamma\Delta & \text{if } R > 2C + \Delta. \end{cases} \quad (10)$$

The socially optimal choice of transparency depends on the comparison between expressions (9) and (10). This is best done comparing Figures 2 and 3: the only difference from the private choice of transparency characterized by Proposition 2 is in the top region ($R > 2C + \Delta$), where the secondary market freezes if there is low transparency at the issue stage. So, in the absence of transparency the issuer will bear the expected liquidity cost $r\pi\Delta$, while saving the underpricing cost $r\xi R$. However, from a social perspective, the freeze of the secondary market generates a further social cost due to the negative externality $\gamma\pi\Delta$.

Figure 3 shows that the area where high transparency is socially optimal is greater than the area where high transparency is privately optimal. Within the top region where low transparency triggers a secondary market freeze, high transparency is socially – though not privately – preferred whenever $(r + \gamma)\pi\Delta > r\xi R$, that is, to the right of the increasing line $R = \pi\Delta(r + \gamma)/(r\xi)$, that is, if there is a great social and

private need for secondary market liquidity (γ , π and Δ high) and/or the supply of primary market liquidity is not strongly impaired by transparent ratings (ξ and R are low). Conversely, high transparency is both privately and socially preferred when the opposite conditions hold: if $(r + \gamma)\pi\Delta < r\xi R$, mandating transparent ratings would be detrimental. To summarize:

Proposition 3 *Mandating high transparency can increase welfare if (and only if) (i) the secondary market would otherwise be inactive and (ii) the condition $(r + \gamma)\pi\Delta > r\xi R$ is satisfied.*

5 Extensions

In this section we consider two extensions. First, we allow the issuer to choose the size of the assets to be securitized. Second, we allow the issuer to sell two securities with different risk profile, also known as “tranching”.

Both these extensions change the model in a critical way. The basic tradeoff between the liquidity of the primary and secondary market exists only because the sophisticated investors are not numerous (and wealthy) enough to buy the entire CDO issue, that is $\mu M w < E(x | q)$. Because of this assumption, uninformed investors are needed for the CDO to be successfully sold. Since uninformed investors cannot process the information on q , the result is that high transparency comes at the cost of adverse selection problem in the primary market.

Changing the size of the pool of assets and tranching the CDO issue are ways to alleviate the dearth of sophisticated capital. If they accept a sufficient downsizing of the CDO issue, issuers can eliminate the need for unsophisticated investors, thereby eliminating the illiquidity cost of high transparency. But this comes at the cost of selling a smaller portfolio of claims. By tranching the issue in different securities with different degrees of risk, the issuer can obtain the same result while reducing the downsizing cost. Creating two sets of securities, each with different sensitivity

to complex information, induces investors with different degrees of sophistication to sort themselves out and buy different securities.

5.1 Restraining the Issue Size

Consider the case of an issuer who can choose at the beginning of stage 1 to scale down the pool of credits to sell. Specifically, assume that instead than selling the entire pool x , he can choose to sell a fraction $s \in [0, 1]$ of the pool, whose payoff is sx . Our starting assumption was that sophisticated investors are not numerous or wealthy enough to buy the entire CDO issue, that is $\mu Mw < E(x | q)$. Now, if the issuer can select the fraction of pool to sell, he could choose a fraction s such that $\mu Mw \geq E(sx | q)$ or $s \leq \mu Mw / E(x | q)$. After substituting for the value of $E(x | q)$ from (7) and assuming that $F = V_H$ (as discussed in section 3.3.3), the cutoff value of s is:

$$\bar{s}(q) = \mu Mw / \{pV_H + (1 - p)[V_L + \lambda q(V_H - V_L)]\}.$$

An issue of size $s \leq \bar{s}(q)$ can be fully financed by sophisticated investors. An issue with size $s > \bar{s}(q)$ cannot be placed without attracting unsophisticated investors as well. Notice that the cutoff value $\bar{s}(q)$ is strictly decreasing in q . The reason is that the value of the pool is strictly increasing in q . As q increases, the sophisticated investors need to be wealthier to buy the whole CDO.

How does the issuer choose s ? It is immediate to see that the issuer will choose to scale down the issue only if he also intends to choose high transparency. Indeed, reducing the size of the pool has no benefits in the case of low transparency. There are three cases to consider.

First, for any $s > \bar{s}((1 - \sigma)/2)$, independently of the realization of q , sophisticated investors cannot buy the entire CDO issue. Hence, the issuer face the trade-off studied in Section 3 and his best option is to set $s = 1$.

Second, for any $s \leq \bar{s}((1 + \sigma)/2)$, independently of the realization of q , sophis-

ticated investors can (and will) always buy the entire CDO issue. Hence, the issuer will face no trade-off in the choice of transparency, will choose high transparency and set $s = \bar{s}((1 + \sigma)/2)$. This generates the payoffs

$$P_1 = \bar{s}((1 + \sigma)/2)[pV_H + (1 - p)\bar{V}_\lambda]. \quad (11)$$

Third, for intermediate values of s , that is, for $s \in (\bar{s}((1 + \sigma)/2), \bar{s}((1 - \sigma)/2)]$, sophisticated investors can buy the entire issue if $q = (1 - \sigma)/2$ at a price $s\{pV_H + (1 - p)[V_L + \lambda(1 - \sigma)(V_H - V_L)/2]\}$. If instead, $q = (1 + \sigma)/2$, sophisticated investors are not wealthy enough to buy the entire issue and therefore unsophisticated investors are needed. However, the unsophisticated investors cannot distinguish between the two scenarios and can only participate in both cases or in none. Hence, for the issue to be sold, the price must be as in (7). This implies that this third case is identical and dominated by the first case examined above.

The choice of size is thus down to the comparison between $s = 1$ with payoff (8) and $s = \bar{s}((1 + \sigma)/2) \equiv \hat{s}$ with payoff (11). The result of the comparison is described in the following proposition (whose proof is in the Appendix):

Proposition 4 *If sophisticated investors have limited capital ($\mu < \hat{\mu}$), reducing the size of the CDO issue is ineffective. For intermediate values of the wealth of sophisticated investors ($\mu \in [\hat{\mu}, \hat{\mu})$), it is optimal to reduce the size of the CDO issue to \hat{s} only if $R > 2C + \Delta$ and $\pi \geq [pV_H + (1 - p)\bar{V}_\lambda](1 - \hat{s})/\Delta(1 - p)$. If sophisticated investors are very wealthy ($\mu > \hat{\mu}$), choosing \hat{s} is optimal over in a larger area: when $\pi > \xi(1 + 2C/\Delta)$ and $R > 2C + \Delta$; and when $R \in [2\pi C/(\pi - \xi), 2C + \Delta)$, where $\hat{\mu} \equiv [1 - (1 - p)\Delta/\bar{V}]\{pV_H + (1 - p)[V_L + \lambda(1 + \sigma)(V_H - V_L)/2]\}/(Mw)$, $\hat{\mu} \equiv [1 - \xi(2C + \Delta)(1 - p)/\bar{V}]\{pV_H + (1 - p)[V_L + \lambda(1 + \sigma)(V_H - V_L)/2]\}/(Mw)$, and $\hat{s} = \mu Mw/\{pV_H + (1 - p)[V_L + \lambda(1 + \sigma)(V_H - V_L)/2]\}$*

5.2 Tranching

Now let us allow the issuer to sell two securities (tranching): senior claims S with face value F^S and payoff x^S and junior claims J with face value F^J and payoff x^J . In case of default, senior claims will be paid first and in total before junior claims are paid. The first claims are sold at a price P^S and the second ones at a price P^J . Will tranching increase the proceeds from the issue?

Recall the payoffs of the underlying assets: they pay V_H , if there is no default (that is, with probability p); $V_L + \lambda(V_H - V_L)$ in the state of default with small losses (which happens with probability $(1-p)q$); and V_L otherwise. Clearly, the payoff of the security cannot be lower than V_L . Hence, the issuer can sell a senior claim on the portfolio for a face value $F_S \leq V_L$ at a price $P^S = F^S$, since everybody agrees that the senior claim is safe. It is in the interest of the issuer to sell as much as possible of this claim. Hence, we $F^S = P^S = V_L$.

To maximize his proceeds the issuer can also sell a second claim with face value $F^J = (V_H - V_L)$ that pays 0 with probability $(1-p)(1-q)$, $\lambda(V_H - V_L)$ with probability $(1-p)q$ and $(V_H - V_L)$ with probability p . This second claim will have an uncertain value which depends on q . Its expected payoff is $E(x^J|q) = [p + (1-p)q\lambda](V_H - V_L)$.

There are three cases to consider. First, if $\mu M w < E(x^J|q) = (1 - \sigma)/2$, independently of the realization of q , sophisticated investors cannot buy the entire junior issue. Hence, tranching has no benefit in this case as the issuer needs to price the junior claim at a discount to attract unsophisticated investors.

Second, if $\mu M w \geq E(x^J|q) = (1 + \sigma)/2$, independently of the realization of q , sophisticated investors can buy the entire junior issue. Therefore, in this case tranching is very valuable when combined with high transparency: investors will sort themselves depending on their degree of sophistication. Sophisticated investors will buy the junior security to exploit their informational advantage, while unsophisticated investors will invest in the senior claim to avoid their informational disadvantage. The junior

claim will be priced at $P^J = E(x^J|q)$, without any discount from its expected value. Hence, the issuer will face no tradeoff in the choice of transparency: they will choose high transparency and tranching.

Third, for intermediate values of μMw , that is, for $\mu Mw \in [E(x^J|q = (1 - \sigma)/2), E(x^J|q = (1 + \sigma)/2))$, sophisticated investors can buy the entire issue if $q = (1 - \sigma)/2$ at a price $E(x^J|q = (1 - \sigma)/2)$; but, if instead $q = (1 + \sigma)/2$, sophisticated investors are not wealthy enough to buy the entire issue and therefore unsophisticated investors are needed. However, the unsophisticated investors cannot distinguish between the two scenarios and can only participate in both cases or in none. Hence, for the issue to be sold, the price must be discounted for the adverse selection problem in the primary market: $P^J = E(x^J) - (1 - p)\xi R$ as in (7). In this case too tranching is not beneficial.

Notice that tranching is always associated with high transparency: tranching is not beneficial with low transparency, because there is no sorting in that case. With low transparency, the proceeds from securitization are the same as without tranching. Moreover, tranching is both privately and socially efficient.

In conclusion, we have shown that:

Proposition 5 *Tranching increases the proceeds from securitization when it is associated with high transparency and when sophisticated investors are sufficiently wealthy ($\mu \geq [p + (1 - p)(1 + \sigma)\lambda/2](V_H - V_L)/(Mw)$).*

6 Conclusions

Is there a tension between expanding the placement of complex financial instruments and preserving the transparency and liquidity of their secondary markets? Put more bluntly, is “popularizing finance” at odds with “keeping financial markets a safe place”? The subprime crisis has highlighted the importance of this question for the design of financial regulation.

The answer provided in this paper is that indeed such tension exists, and that it may be particularly relevant to the securitization process. Marketing large amounts of CDOs requires selling them also to unsophisticated investors, who cannot process all the information that is necessary to price them. Indeed, if such information were released, it would put these unsophisticated investors at a disadvantage vis-à-vis the “smart money” who can process such information. This creates an incentive for CDO issuers to negotiate with credit rating agencies a low level of transparency – that is, relatively coarse and uninformative ratings. Ironically, destroying some price-relevant information is needed to enhance the liquidity of the primary CDO market.

However, choosing low transparency at the issue stage comes at the cost of a less liquid secondary market, or even at the cost of the complete of secondary trading. This is because with low disclosure sophisticated investors may try and succeed to gather the missing information. If they succeed, trading in the secondary market will be hampered by adverse selection – which would not occur with high transparency. Although privately optimal, low disclosure may be socially inefficient when the illiquidity of the secondary market has negative spillover effects on the economy, for instance because it precipitates a spiral of defaults and forced liquidations by banks and companies. In these cases, regulation that mandates greater disclosure for credit rating agencies is socially optimal. This model therefore motivates the recent regulatory efforts to increase disclosure of credit rating agencies.

We also show that in some cases such regulation is not needed. First, if the demand of secondary market liquidity is high or adverse selection in the primary market is not severe, the issuers themselves will opt for transparent ratings. Second, the issuers may restrain the size of their CDO issue and sell it only to sophisticated investors, in which case choosing transparent ratings would not hurt primary market liquidity. But issuers would have to accept the cost of marketing a smaller amount of CDOs – a cost that they will be willing to bear only if sophisticated investors can absorb a large enough supply of CDOs. In this case, a superior strategy for issuers is to tranche the issue into an information-sensitive, junior tranche to be sold

to sophisticated investors and a safe senior tranche to be sold to unsophisticated ones. We show that tranching expands the parameter region where issuers choose transparency, and tends to realign their choices with socially optimal ones.

Appendix

Proof of Proposition 4

For $R \leq 2C$, the optimal size is $s^* = 1$. This is because when $R \leq 2C$, there is no adverse selection problem in the secondary market. For $R > 2C$, the comparison depends on the size of \hat{s} . If \hat{s} is small, that is, if $\hat{s} < 1 - (1-p)\Delta/\bar{V}$, where \bar{V} is the expected value of the pool of claims, that is $\bar{V} \equiv pV_H + (1-p)\bar{V}_\lambda$, the optimal choice is $s^* = 1$. The reason is that the payoff with $s = \hat{s}$, $\hat{s}\bar{V}$, is smaller than P_1 given in (8) for all π .

If $\hat{s} \geq 1 - (1-p)\Delta/\bar{V}$, reducing the size of the portfolio may be optimal as shown in Figure 4. There are two cases to consider. In Figure 4, sophisticated investors have relatively little financial resources so that they can buy a stake $\hat{s} < 1 - \xi(2C + \Delta)(1-p)/\bar{V}$. In the region where $R > 2C + \Delta$, one needs to compare the loss from a smaller CDO issue ($\bar{V}(1 - \hat{s})$) coming from $s^* = \hat{s}$ (and high transparency) with the expected liquidity costs in the secondary market ($\pi(1-p)\Delta$) coming from the choice of $s^* = 1$ and low transparency. On the right of the vertical line $\pi = \bar{V}(1 - \hat{s})/\Delta(1-p)$, the payoff from $s^* = \hat{s}$ is greater than the payoff from choosing $s^* = 1$. The opposite happens on the left of the line. In the region where $R < 2C + \Delta$, the comparison is between the choice of $s^* = 1$ and $s^* = \hat{s}$ both with high transparency. In this case, the loss due to illiquid primary market $(1-p)\xi R$ are lower than the loss of profit due to the lower size of the issue $(1 - \hat{s})\bar{V}$, because by assumption $(1-p)\xi R < (1-p)\xi(2C + \Delta) < (1 - \hat{s})\bar{V}$.

If sophisticated investors are relatively wealthier, that is, if they can buy a fraction $\hat{s} \geq 1 - \xi(2C + \Delta)(1-p)/\bar{V}$ of the pool, the area where \hat{s} is the optimal size expands. In such case, represented in Figure 5, the vertical line $\pi = \bar{V}(1 - \hat{s})/\Delta(1-p)$ lies on the left of $\pi = \xi(1+2C/\Delta)$. In the region where $\pi > \xi(1+2C/\Delta)$ and $R > 2C + \Delta$, as before the payoff from high transparency and $s^* = \hat{s}$ is greater than the one from low transparency and $s^* = \hat{s}$. If $R < 2C + \Delta$, the comparison between $s^* = \hat{s}$ (and high transparency) and $s^* = 1$ (and low transparency) depends on the comparison between

the loss of profit due to the smaller size of the issue $(1 - \hat{s})\bar{V}$ and the discount due to low transparency is $\pi(1-p)(R-2C)$. The locus where the issuer is indifferent between these two cases is represented in the figure as the curve $R = 2C + (1 - \hat{s})\bar{V}/[(1-p)\pi]$: below the curve, low transparency and $s^* = 1$ are optimal; above the curve high transparency and $s^* = \hat{s}$ are optimal. If $R > 2\pi C/(\pi - \xi)$, we know from Proposition 2 that low transparency is dominated by high transparency. Hence, the relevant comparison becomes between $s^* = 1$ and $s^* = \hat{s}$ (both with high transparency). The choice of $s^* = 1$ comes with the loss due to illiquid primary market $(1-p)\xi R$, while $s^* = \hat{s}$ comes with lower profits due to the smaller issue size, $(1-\hat{s})\bar{V}$. The locus where the issuer is indifferent between the two is the horizontal line $R = (1 - \hat{s})\bar{V}/[\xi(1-p)]$. We will assume that $2C/(1 - \xi) > (1 - \hat{s})\bar{V}/\xi(1-p)$ so that this line lies before area of high transparency. This implies that in the entire shaded area in Figure 5, the optimal choice is $s^* = \hat{s}$. Notice that this line could be above the area with high transparency found in Figure 2. This happens if $2C/(1 - \xi) < (1 - \hat{s})\bar{V}/\xi(1-p)$. In such case, in the area above the line $s = \hat{s}$, while in the area below the line $s = 1$. ■

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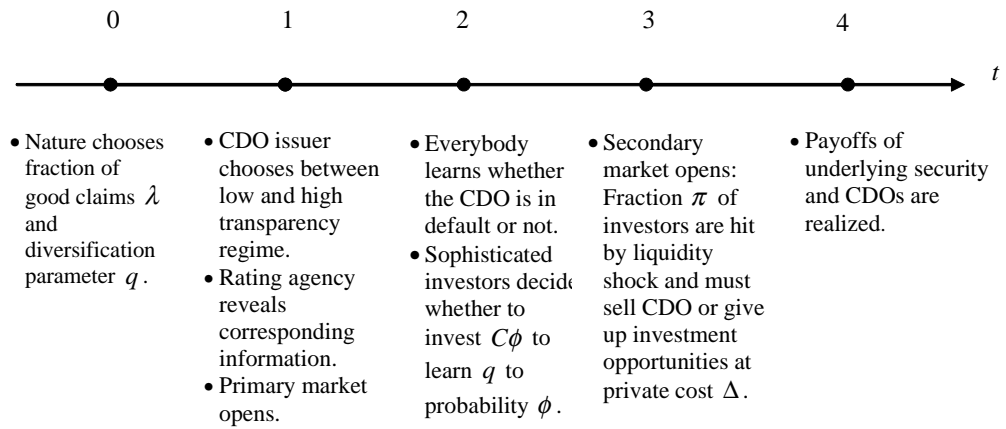


Figure 1: Time line of the model

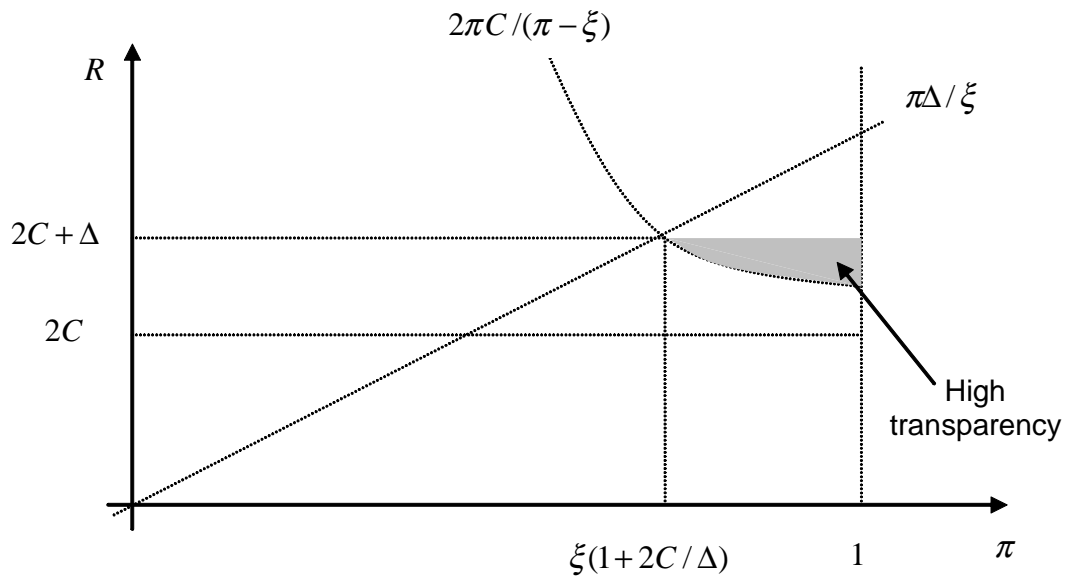


Figure 2: Privately optimal choice of transparency

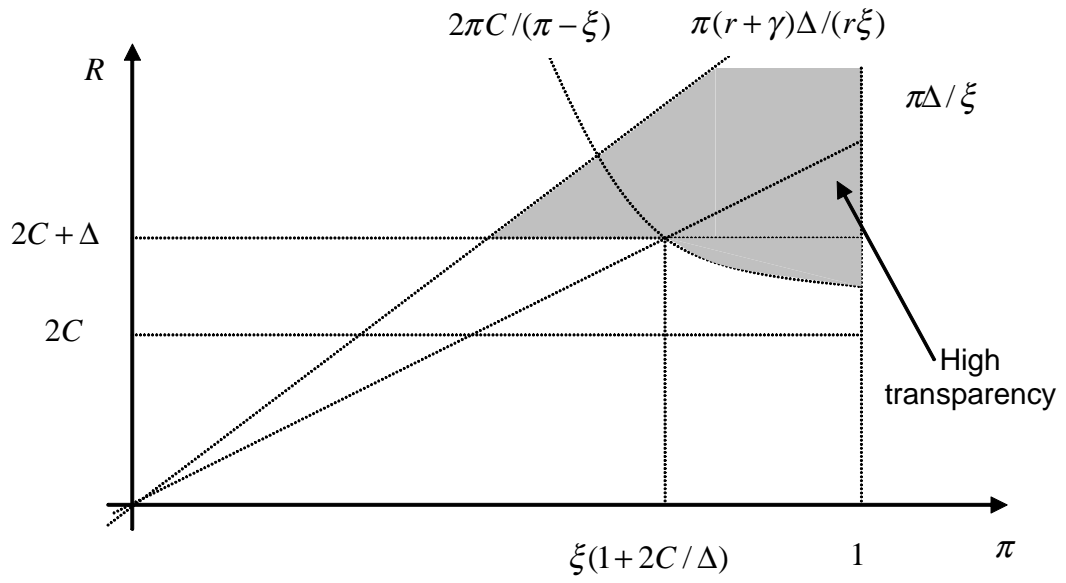


Figure 3: Socially optimal choice of transparency

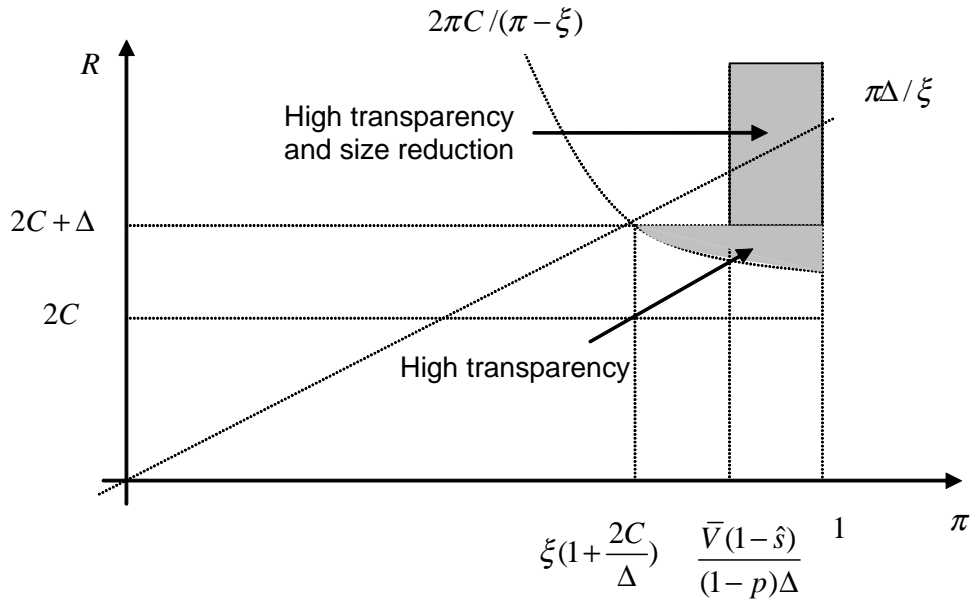


Figure 4: Choice of CDO size if $\hat{s} \in [1 - (1 - p)\Delta/\bar{V}, 1 - \xi(1 - p)(2C + \Delta)/\bar{V}]$

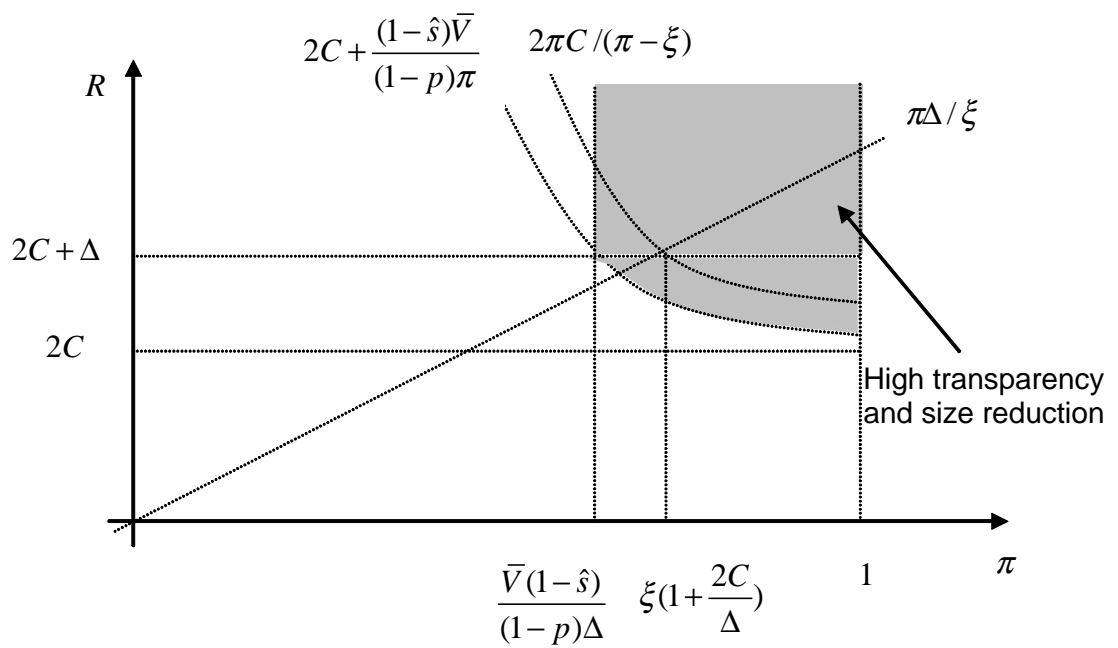


Figure 5: Choice of CDO size if $\hat{s} \geq 1 - \xi(1-p)(2C + \Delta)/\bar{V}$