Earnouts: the real value of disagreement in mergers and acquisitions

Anna Battauz, Stefano Gatti, Annalisa Prencipe, Luca Viarengo
Bocconi University

Abstract

Earnout agreements link part of the payment of an acquisition to the future performances of the acquired company. They are structured as real options on the future value of the target, and should be valued as such. However, the models used so far do not take into consideration two peculiar sources of risk that affect these contracts: the risk of the bidder's default before the earnout expiration (counterparty risk) and the risk of litigation that might arise in connection to these contracts (litigation risk). We develop an option pricing model that fills this gap. The performed sensitivity analysis and the presented case study show that counterparty risk and litigation risk are significant, because they might have a remarkable impact on the earnout values. The relevance of the model is also given by recently issued accounting standards, which now require contingent payments to be valued at fair value.

Keywords: earnout, real options, M&A, counterparty risk, default, litigation.

JEL codes: G12, G13, G33, G34, K41.

This version[1]: July 2016

[1] The paper was awarded with the 3rd Best FEBS 2012 PhD Paper Prize at the 2nd International Conference of the Financial Engineering and Banking Society, London 2012.

1 Introduction

Merger or acquisition transactions always involve complex negotiations regarding each single detail of the agreement. The crucial point of such negotiation is the value of the company to be acquired, and thus the price that the bidder has to pay to the target company's shareholders. However, divergence in opinions between the parties can prevent the closing of the deal. Earnouts are contracts that might smooth this tension, by linking part of the payment of the acquisition to the performances of the target following the closing of the deal. Earnouts are generally used in transactions where substantial uncertainties exist about the future performance of the acquired entity. They help reducing information asymmetry and valuation risk for both the bidder and the target, help closing the expectation gap between the counterparts, and allow the buyer and the seller to share the risk associated with the future of the business.

Earnouts are often structured as real options on a predetermined parameter related to the profitability of the acquired company (e.g. EBITDA or revenues) or to the achievement of certain targets or milestones (e.g. successful completion of specified contracts or passing FDA trials)[2]. If the realization of the parameter exceeds a given threshold, or if the agreed milestones are achieved, additional payments are made to the former shareholders of the target entity.

Differently from most real options studied in the field of corporate finance, earnouts are affected by two peculiar sources of risk that could influence their final payoff, which however have been neglected by the literature on these contingent payments: counterparty risk and litigation/measurement risks. Counterparty risk concerns the fact that earnouts will be honored only if, and up to the point to, the bidder is creditworthy. Earnouts are options that expire several years after the moment in which they are written, that is at deal closing[3]. For this reason, the risk of default of the bidder might not be negligible. Litigation/measurement risk arises because,

[2] Cain et al. (2011) show that, out of a sample of 498 earnouts, 86% are based on accounting measures, 12.2% are structured on non financial milestones, 1.2% are linked to stock prices, and the 0.6% to other parameters.

[3] Cain, Denis and Denis (2011) show that the average horizon is 3 years.

after the closure of the deal, the former shareholders of the target lose control over the target company and on the measurement of its performance. In such a case, they have to trust the evidence produced by the bidder on the realized performance of the target and on the fact that the best effort was made to realize the conditions that trigger the earnout payment. As the performance indicators used in designing earnout agreements are mainly accounting figures, there is always a certain degree of risk related to earnings management. This does not necessarily imply an opportunistic intent of the bidder, as subjectivity and flexibility are natural characteristics of accounting figures. The problem is that earnout agreements are often based on measures that are not perfectly measurable. In addition, such agreements are by nature incomplete. No contract can provide for every possible dispute that may arise on the meaning or the enforcement of the contract itself[4]. This implies that the parties may be forced to settle the question on their own or to take legal steps. This is clearly costly, and these costs should be properly taken into consideration in the valuation of earnouts.

In this paper, we propose a valuation model for earnout liabilities that takes explicitly into consideration the characteristics of these contracts, including counterparty risk and litigation risk. Arzac (2005), Bruner (2001, 2004) and Caselli, Gatti and Visconti (2006), recognize the optionality structure of these contracts, and claim that earnouts should be valued as ordinary European calls. However, their models do not consider all the risks associated to earnout agreements.

Since they are effectively part of the up-front payment of the acquisition, an accurate valuation of these provisions is useful and necessary for the parties involved in the transaction. In addition, the model we propose is relevant and timely because the recently revised accounting standards on business combinations (i.e. FASB ASC 805 in US and IFRS 3 in Europe) require contingent payments to be estimated at the acquisition date and recorded at fair value[5]. Fair value is defined as the price

[4] Remarkable, in this sense, are the words of a judge that had to settle a dispute on the payments related to an earnout: "An earnout often converts today's disagreement over price into tomorrow's litigation over outcome". Judge Trevis Laster, Airborne Health, Inc. and Weil, Gotshal & Manges LLP v. Squid Soap, LP, C.A. No. 4410-VCL (Del. Ch. Nov. 23, 2009). Airborne acquired Squid Soap in 2007, paying 1 million dollars upfront and including an earnout capped at 26.5 million dollars. This case is going to be discussed later in the paper.

[5] According to the current version of FASB ASC 805-30-25-5 and IFRS 3 (p. 39), that affects

that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date, based on the same assumptions that market participants would use when pricing the asset or the liability in their economic best interest(FASB ASC 820 and IFRS 13). The standards add that when measuring the fair value of a liability, an entity should take into account the effects of its counterparty risk and any other factor that might influence the likelihood that the obligation will or will not be fulfilled.

There has been significant diversity in practice and lively debate among practitioners in search for the best practice to valuate earnouts. While some experts seem to recognize to some extent the need to consider counterparty risk (e.g., Ernst&Young, 2010; Thompson and Schnorbus, 2010), litigation risk has to a large extent been ignored. Moreover, no clear guidance has been provided so far on how to estimate the fair value of earnout liabilities by either academics or practitioners. As a consequence, best practices on how to measure earnout at fair value are still to be developed. A survey we carried out among US companies in the period 2009-2011, i.e. after the implementation of the new standards, shows that in 48% of cases, there is no information on how the fair value of earnout was estimated. Among those who provide this kind of information, the large majority estimate the fair value through a very basic discounted-cash-flow (DCF) model (34% of cases) or probability-weighted DCF (57% of cases). Only a very small percentage (9%) of them employ more sophisticated models. Unfortunately, even in these cases, financial reports do not indicate clearly how the parameters used in the models were defined, therefore it is impossible to know whether and to what extent they took into consideration counterparty risk and litigation/measurement risk. Partially similar results were found on a survey conducted among European companies applying IFRS 3(R). In this case, 82% of acquirers do not specify the model utilized to estimate the fair value of earnouts. Only 4% used a DCF model, while only 16% declare that they use option models or other models for

the financial reports starting from fiscal year 2009, "the acquirer shall recognize the acquisition-date fair value of contingent consideration as part of the consideration transferred in exchange for the acquiree". If the contingency is classified as a liability, it will be remeasured at fair value at each reporting date until the contingency is resolved, with the change in value reported in the income statement and, therefore, affecting the earnings.

the valuation.

In order to build our model, we take the pricing of European calls as a baseline, but we enrich this framework in order to capture the remaining sources of uncertainty associated to these contracts. Counterparty risk is included in the picture by explicitly modeling the possibility that the bidder gets bankrupt, thus being unable to pay in full the liability arising from the earnout. In order to do this, we model the joint dynamics of the assets and the liabilities of the bidder and the performance parameter of the target via correlated geometric Brownian motions. In order to include litigation risk, we model explicitly the choice of the sellers between: 1) accepting the bidder's payment based on the reported target performance; 2) taking legal steps if they believe the reported performance is the result of earnings management. The payoff following the second choice depends on the decision of the judge, , with a number of implications in terms of uncertainty and legal costs. The sellers decide to go to court if they expect to get more from the trial than from the initial offer of the bidder.

We show that the reduction in value that results when considering counterparty risk and litigation risk can be dramatic. The more the bidder is levered and the less the profitability of the bidder and the target are correlated, the higher the impact of the counterparty risk on the value of the earnout. The relevance of litigation risk will be higher the easier it is for the bidder to manage earnings, the more uncertain is the outcome of the trial and the longer is its length. Similarly, higher direct cost of litigation, like attorneys' fees, will reduce the value of earnouts. We perform sensitivity analyses on the initial values of the data of our model to show how they impact our results.

Apart from contributing to the literature on earnout valuation, our paper is related to the literature on vulnerable options, which deals with the valuations of options for which the payment of the final payoff is affected to the counterparty default (see for instance Johnson and Stulz, 1987; Hull and White, 1995; Jarrow and Turnbull, 1995; Klein, 1996; Klein and Inglis, 2001. We add to this literature by proposing a method to include and to value litigation risk. Our paper is also a contribution to the literature on the determinants and effects of the risk of litigation (e.g., Francis, Philbrick and

Schipper, 1994; Brown, Hillegeist and Lo, 2005; Rogers and Stocken, 2005; Kim and Skinner, 2011), and to the literature related to litigation risk and managerial reporting behavior (e.g., Trueman, 1997; Evans and Sridhar, 2002; Caskey, 2010; Laux and Stocken, 2012).

The rest of the paper is organized as follows. Section 2 presents a review of the relevant literature, section 3 briefly describes the structure of earnouts, section 4 presents the model, while Section 5 and 6 present evidence of the relevance of our model and a case study, respectively. Section 7 concludes.

2 Literature on earnouts

The literature on M&A is extremely vast an diverse (e.g.: Shim and Okamuro, 2011; Owen and Yawson, 2010; Lian and Wang, 2012; Beltratti and Paladino, 2013; de La Bruslerie, 2013). Our paper is related to the one that focuses on earnouts. Kohers and Ang (2000) and Datar, Frankel and Wolfson (2001) show that these contracts are used in around 4% of M&A deals[6], mainly to reduce information asymmetries. If a portion of the payment is made contingent on the performances of the target, it is easier to reach an agreement because part of the uncertainty related to the actual value of the acquired company will be solved at the time the payment is due. The reason for this is clear: earnouts allow to switch from an ex ante to an ex post valuation of the target. These contracts, indeed, are mainly present in acquisitions affected by a great deal of uncertainty on the side of the target, such as in the case of firms with strong growth opportunities, e.g. start-ups, or relevant information asymmetry issues. This could be the case, for example, of the acquisition of private companies, companies with high level of intangible asset, or firms working in an industry different from the one in which the bidder operates. Ragozzino and Reuer (2009) find similar results focusing on privately held targets: earnouts are part of the payment for 5% of the deals in their sample, and are mainly used for cross industry acquisitions.

[6]The first paper is focused on M&A that took place between 1984 and 1996, in which the target was a US company. The authors found that, in their sample of 9,784 deals, retrieved from SDC, 5.61% of them was structured using an earnout. The second is based on the same dataset but it was focused on M&A deals happened worldwide in the period 1990-1996. Out of 39,706 transactions, 1,637, that is the 4.12%, involved the use of earnouts.

Kohers and Ang (2000) discuss an additional purpose that earnouts sometimes serve. In case the managers of the target are also shareholders, these contracts could induce them not only to keep their office, but also to make their best effort to boost the performances of the company.

Cain, Denis and Denis (2011) delve deeper in the contractual specifications of earnouts. They find that the proportion of the earnout payment with respect to the total consideration is positively related to measures of the importance of managerial effort on the growth (and so on the value) of the target, and negatively related to the precision with which those efforts can be measured. In addition to this, they show evidence that the choice of the underlying parameter is made to maximize its ability to track the value of the target and the effort put in boosting its business. Furthermore, the length of these contracts is positively associated with the importance of R&Ds in the industry of the target, in line with the intuition that these contracts are meant to solve uncertainties affecting the target company, while the volatility of returns in the target industry shows the opposite relation.

Since earnouts are helpful in reducing the information asymmetry on the side of the bidder, their use are expected to have a positive effect on post closing returns on the shares of acquirers. This is, indeed, what Kohers and Ang (2000) and Barbopulos and Sudarsanam (2012) find, analyzing a sample of US and UK acquisitions, respectively.

Allee and Wangerin (2013) focused their attention on the impact of the issuance of SFAS 141(R) on the use of these contracts by US public firms. SFAS 141(R) required the valuation of contingent liabilities related to earnouts at fair value. The authors show that the introduction of the new accounting standards had a negative impact on the use of these contracts by public firms. They claim that this depends on the fact that these contracts could increase earnings volatility. Since the market seems to price earning predictability at a premium (De Angelo, De Angelo and Skinner, 1996; Barth, Elliot, Finn, 1999; Graham, Harvey and Rajgopal, 2005), an increase in earnings volatility might reduce the market valuation of the acquirers. Cadman, Carrizosa, and Faurel (2014), who studied US acquisitions as well, claim instead that the percentage of deals including earnouts did not change sensibly after the issuance of SFAS 141(R).

Finnerty, Jiao and Yan (2012) show that convertible securities used as means of payment could be substitutes of earnouts, in that they might reduce information asymmetry about the bidder's value while at the same time mitigating the information asymmetry about the target's value.

The literature on the valuation of earnouts is scant. To the best of our knowledge, Arzac (2005), Bruner (2008, 2004) and Caselli, Gatti and Visconti (2006) are the only contributions on this issue. However, all these contributions consider earnout agreements as vanilla European calls.

Given our aim to consider the effect of counterparty and litigation risk on the value of these contracts, our paper is related to other streams of literature that never crossed the one focused on earnouts. The study of the effect of counterparty risk on the value of options gave origin to the literature on vulnerable options. The seminal paper by Johnson and Stulz (1987) provides a model that links the value of an option not only to the realizations of the underlying security, but also on the value of its writer. The basic idea is that, as the final payment of the option cannot exceed the wealth of the writer of the option itself, its value is going to be a function of the creditworthiness of the writer. Further extensions of this work are provided by Hull and White (1995), Jarrow and Turnbull (1995), Klein (1996) and Klein and Inglis (2001). The model proposed in our paper shows some similarities to the one presented by Klein (1996), in that it takes explicitly into account the impact of the correlation between the value (thus the creditworthiness) of the writer and the value of the underlying, and it explicitly defines the event of default.

With respect to litigation risk, previous studies have already shown its impact on the value of securities or on the pricing of services. A relevant example is the literature related to IPO underpricing. Hughes and Thakor (1992) build a model to explain how the risk of litigation related to the potential underperformance of a stock, and the costs arising in connection with it, could explain the underpricing of IPOs: underpricing is an insurance against litigation. The lower the issue price, the lower the risk of future underperformances and the lower the potential damage to buyers, and thus the lower the probability of litigation. Lowry and Shu (2002) confirm empirically this idea, showing that the impact of litigation costs in IPOs: the average settlement payment to investors of the cases brought to court corresponded to 11% of the total proceeds raised with the IPO. Other papers have studied empirically the probability of litigation. For example Krishnan, Masulis, Thomas and Thompson (2012) find that between 1999 and 2000 the percentage of deals that lead to litigation was 12%. This study however, as well as the preceding ones, is focused on the litigation related to the closing of the deal, not to the ones that may follow. The determinants of litigation risk are the focus of other papers such as Francis, Philbrick and Schipper (1994), Brown, Hillegeist and Lo (2005), Rogers and Stocken (2005) and Kim and Skinner (2011), who consistently show that the highest risk of litigation belongs to the technology, services and healthcare sectors, which are exactly the sectors in which earnouts are used more frequently.

Our paper is also related to the theoretical literature on the relation between litigation risk and managerial reporting behavior. Trueman (1997) shows that managers change their reporting behavior in response to the risk of lawsuit arising from disclosure obligations, being less biased towards good news if litigation risk is relevant. Evans and Sridhar (2002) show how potential shareholder litigation can interact with the incentives provided by capital and product markets to make company disclosures more credible. Caskey (2014) provides an analytical model that shows how the price of securities can be affected by the risk of class action lawsuits arising from the release of news that contradicts a manager's earlier report. Laux and Stocken (2012) model the reporting behavior of managers an in the presence of litigation risk and overoptimism on the future prospects of the company.

3 How do earnouts work?

In this section we want to give an overview of the features of earnout contracts, in order to ease the exposition of the model in the following section.

3.1 The benchmark parameters

Earnouts may be written on many different benchmark parameters. These should be identified clearly, and be measurable with precision to avoid future disputes. Moreover, they should be apt to capture the key point that was at the origin of the difference in valuation that divided the parties.

One parameter can be given by sales. For example, the earnout can provide for the former target's shareholders to receive, for a given number of years, a payment corresponding to the difference between the realized sales and an established threshold. Sales can be suitable, for example, for cases in which the disagreement between buyer and seller is on the capability of the target to expand its activity in new markets. The advantage of this parameter is that it is easy to compute and it is less prone than other accounting figures to earnings management, while the disadvantage lies in the fact that it can build wrong incentives, that is to increase the revenues not caring about the profits. Other parameters can be net or gross profits, EBIT or EBITDA or free cash flows. Pros of these parameters lie in the fact that they can reflect the ability of the target to contribute to the profitability of the group of firms in which it has been integrated, cons clearly are the ease with which they can be subject to earnings management.

It is necessary to notice that earnouts might also be linked not to performance indicators, but on the realization of specific events (in this case they are known as cash or nothing). It is possible, for example, that the uncertainty on the value of the target is related to the development of a new product, or to the obtainment of a patent, or to passing FDA trials. Under these hypothesis the earnout could make part of the payment for the acquisition contingent on the realization of these events. This kind of parameters is mostly suitable for the acquisition of pharmaceutical or high tech companies.

In our paper we will focus on the earnout linked to performance indicators, which are the most prevalent (see for example Kohers and Ang (2000)), because we want to highlight the impact of counterparty risk and litigation risk on real option valuation.

Earnouts linked to specific events are simpler to valuate[7], and our analysis can be easily extended to them.

3.2 The time horizon

Earnouts specify an horizon over which the performances of the target should be measured, or before which the objectives set in the contract must be reached. According to Cain, Denis and Denis (2011), the average horizon is 3 years, but the variability of the time span is huge. It is usually claimed that, since earnouts have an optionality structure, the longer the horizon the higher the value of these contracts. This is true only if we ignore counterparty risk. As we will see, the longer the horizon, the higher the probability that the bidder goes into default. This risk clearly has an opposite effect on the value of the earnout, thus the effect of time on the value of this contract depends on the net effect of these two elements.

3.3 Amount of and limits to the payments

Having defined the parameter upon which the earnout is structured and the horizon over which the latter is going to be measured, it remains to specify the link between the measure of performance and the contingent payment. The contingent payment can be proportional to the performance indicators chosen. What normally happens is that a threshold is fixed, and the payment is set to be a multiple of the difference between the realization of the parameter and the threshold. Otherwise the earnout can provide for a fixed amount that should be paid if the parameter chosen reaches a given level. This makes the earnout more similar to a binary option. To avoid the risk of unexpected high payments to be made by the bidder, caps to the maximum possible payout are frequently set.

3.4 Earnouts with multiple objectives

The basic structure of earnouts envisages the case in which one performance objective is defined and one payment is made according to the realization of the parameter

[7] Using DCF for example.

chosen. However, earnouts may be more complex than that. They could provide for different objectives to be reached at different time horizons, each of them implying a potential future payment.

3.5 Means of payment

The most common means of payment of earnouts is cash. This is consistent with the aim of these contacts, which is to solve issues arising from information asymmetry. For this reason, choosing other means of payment, like stocks, which in contrast pose problem of asymmetric information on their value, would undermine the utility of these instruments. Nevertheless, it may happen that earnouts are paid using shares.

4 The model

As we said in the introduction, we start taking the perspective of the holder of the option in order to value these contracts. In order to be as general as possible in our discussion, we want to characterize earnouts as generic derivatives on the parameter chosen in the contract. Thus, we set X to be the earnout value at maturity, with $X = F(S(T))$, where F is a deterministic function of the realization of the terminal underlying parameter S at T, the time in which the performance of the target company has to be measured.

This approach accommodates the various specifications that these contracts can take. If the earnout is structured as an ordinary option on the parameter chosen, with strike price K, F would take the following form:

$$X = F(S(T)) = (S(T) - K)^{+} = \begin{cases} S(T) - K & if \quad S(T) > K \\ 0 & if \quad S(T) \leq K \end{cases}$$

Two other examples can be earnouts structured as binary options or as piecewise linear functions of the underlying parameter, respectively:

$$X = F(S(T)) = \begin{cases} a & if \quad S(T) > K \\ 0 & if \quad S(T) \leq K \end{cases}$$

$$X = F\left(S\left(T\right)\right) = \begin{cases} a_1 S(T) & if \quad K_1 \leq S(T) < K_2 \\ a_2 S(T) & if \quad K_2 \leq S(T) < K_3 \\ a_3 S(T) & if \quad K_3 \leq S(T) < K_4 \\ a_4 & if \quad K_4 \leq S(T) \end{cases}$$

with $a, K_i,\ a_i > 0$ for $i = 1, ..., 4$. Clearly, the earnout would be fully paid out only if the bidder has not gone bankrupt before time T, or if the earnout and/or the other liabilities contracted by the bidder do not trigger the default at time T. For this reason we need to model also the ability of the bidder to pay its debts. In order to do this we compare the value of bidder's assets and its outstanding liabilities.

4.1 The primitives of the model

In our model, uncertainty is described by the historical probability space $(\Omega, \mathbb{P}, (\mathcal{F}_t)_t)$, by a $3-$dimensional standard Brownian motion $W^{\mathbb{P}}$. The three independent component of the Brownian $W^{\mathbb{P}}$ represent the diffusive risk that affects the fundamental variables of our problem: the performance process S, the debt process D, and the value of assets of the bidder V. The processes are lognormally distributed, according to the following stochastic differential equation:

$$\frac{dS(t)}{S(t)} = \mu_S dt + \sigma_S dW^{\mathbb{P}}(t),$$
$$\frac{dV(t)}{V(t)} = \mu_V dt + \sigma_V dW^{\mathbb{P}}(t),$$
$$\frac{dD(t)}{D(t)} = \mu_D dt + \sigma_D dW^{\mathbb{P}}(t),$$

where μ_V, μ_S, μ_D, the drift of the processes, are real positive constants, and σ_S, σ_V, σ_D are volatility vectors belonging to $\Re^3_+$. The reason why we want to model also debt as a stochastic process will be clear in the next section.

The correlation of these processes is represented in the following matrix:

Correlation	S	V	D
S	1	$\rho_{V,S}$	$\rho_{D,S}$
V	$\cdot$	1	$\rho_{D,V}$
D	$\cdot$	$\cdot$	1

$$\text{where} \quad \rho_{i,j} = \frac{\sigma_i \cdot \sigma_j}{|\sigma_i| \cdot |\sigma_j|} \qquad \text{with } i,j = S, V, D.$$

The correlation $\rho_{V,S}$ describes the dependence structure between the bidder assets and the target performance. Synergies arising from the acquisition are thus parsimoniously embedded in our framework. The management of the acquired firm selects a *subjective stochastic discount factor* to evaluate future risky cash-flows. Given the subjective prices of risk, collected in the vector $\theta \in \Re^3$, the management selects an equivalent probability measure $\widehat{\mathbb{P}}$, the *valuation measure*, and a discount rate $\widehat{r}$. Girsanov results for diffusion processes (see for example Protter (2004)) allow to write the dynamics of fundamental processes with respect to the valuation measure $\widehat{\mathbb{P}}$ as follows:

$$\begin{aligned} \frac{dS(t)}{S(t)} &= (\mu_S - \sigma_S\theta)\, dt + \sigma_S d\widehat{W}(t), \\ \frac{dV(t)}{V(t)} &= (\mu_V - \sigma_V\theta)\, dt + \sigma_V d\widehat{W}(t), \\ \frac{dD(t)}{D(t)} &= (\mu_D - \sigma_D\theta)\, dt + \sigma_D d\widehat{W}(t), \end{aligned} \tag{1}$$

where $\widehat{W}$ is a $3-$dimensional standard Brownian motion[8] with respect to the valuation measure $\widehat{\mathbb{P}}$.

The parameter θ captures the attitude of the former shareholders of the target

[8]The density of the probability $\widehat{\mathbb{P}}$ with respect to $\mathbb{P}$ is

$$L(T) = \frac{d\widehat{\mathbb{P}}}{d\mathbb{P}}$$

given by

$$L(t) = \exp\left(-\frac{1}{2}\left|-\theta\right|^2 t - \theta W^{\mathbb{P}}(t)\right).$$

towards risk. If $\theta = 0$, all the subjective prices of risk are null and the acquired firm is risk-neutral ($\widehat{\mathbb{P}} = \mathbb{P}$). If $\theta \in \Re^3_+$, the firm is averse to the diffusive risk.

If all the primitive processes S, V and D are *spanned by traded assets*, the prices of risk θ correspond to the market ones, the discount rate $\widehat{r}$ equals the risk-free rate r, and $\widehat{\mathbb{P}}$ becomes an *equivalent martingale measure.* However, this does *not* imply that the discounted processes $\{S(t)e^{-rt}\}$, $\{V(t)e^{-rt}\}$, and $\{D(t)e^{-rt}\}$ are $\widehat{\mathbb{P}}$-martingales. Indeed, this is true if and only if S, V, and D coincide with the values of *traded* self-financing portfolios at *any* date t, which is seldom the case for real asset values (see Battauz and alii, 2012 and 2015). It follows that, even under the spanning condition, the risk-adjusted percentage drifts of S, V, and D

$$\widehat{\mu}_S = \mu_S - \sigma_S\theta$$
$$\widehat{\mu}_V = \mu_V - \sigma_V\theta$$
$$\widehat{\mu}_D = \mu_D - \sigma_D\theta$$

typically differ from the discount rate $\widehat{r}$.

4.2 Valuing earnout as ordinary European options

If we do not consider counterparty risk and litigation risk, so we stick to the valuation models commonly used, we can value the earnout as a ordinary European call:

$$E_{ord}(0) = e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] \tag{2}$$

where $\widehat{\mathbb{E}}\left[\cdot\right]$ denotes the expectation under the valuation measure $\widehat{\mathbb{P}}$. But doing this struggles with common sense. It would be hard to believe that someone would attribute the same value to a promise of payment made by a big unlevered company and to the same promise made by a small and highly levered firm. So we need to augment the model in such a way that it enables us to capture the effect of the creditworthiness of the writer on the value of the option.

4.3 Step 1: including counterparty risk

In order to include counterparty risk we have to divide the cases in which the bidder is creditworthy at time T from the cases in which it is not. Since the earnout is going to add itself to the liabilities of the bidder, the ability of this company to repay its debt will depend also on that.

We want to consider two sources of counterparty risk. The first is the one related to the asset side: there is always the risk that the business of the bidder might experience periods of financial straits. This is captured by the assets of the bidder being modelled as a stochastic process. The second one is related to the liability side. Once the deal is closed, there is nothing that prevents the bidder from increasing its leverage. The former shareholders of the target have no influence on the financing decisions of the bidder, on the contrary they are subjected to them. This is why also debt is modelled as a stochastic process.

In order to tackle this issue, we define the event of default in the following way:

$$\{\text{default}\} = \{V(T) < X + D(T)\}$$

That is, the bidder goes default if the value of assets is lower than the value of liabilities, which includes also the payment due for the earnout.

Then we can define an indicator function for distress, $\mathbb{I}_{def}$, and an indicator function for creditworthiness, $\mathbb{I}_{def^C}$. These indicator functions allow us to distinguish between the payment that the sellers can get if the bidder remains solid and the one that they can get in case of default. We call $\widehat{X}$ the final payoff of the earnout that considers the possibility of the bidder going default:

$$\begin{aligned} \widehat{X} &= X \cdot \left(\mathbb{I}_{def^C} + rec \cdot \mathbb{I}_{def}\right) \\ rec &= \left(\frac{(1-\alpha)V(T) - \delta_S D(T)}{X + (1-\delta_S)\, D(T)}\right) \end{aligned}$$

where rec is the fraction of the earnout the former shareholders of the target get in case of default, δ_S is the fraction of total debt which is senior with respect to the earnout and α is the value lost in the process of liquidation in case of distress.

Therefore, in the case in which the bidder is creditworthy the former shareholders of the target receive the full payment arising from the contract. In case of default, however, their payment is reduced by the factor $\left(\frac{(1-\alpha)V(T)-\delta_S D(T)}{X+(1-\delta_S)D(T)}\right)$.

The ratio $\frac{V(T)-\delta_S D(T)}{X+(1-\delta_S)D(T)}$ captures the fact that in case of default the portion of the earnout that can be paid out depends on the importance of the claim with respect to the others, both in terms of seniority and relative dimensions. Indeed, the claim related to the earnout is going to be paid after the satisfaction of senior debt (this is expressed in the numerator) and in proportion to the value of the claim with respect to the other junior creditors (this is expressed in the denominator).

The factor $(1-\alpha)$ captures the cost of distress. It is well known that in case of default the value of the assets of a company is further reduced by the costs of liquidation and the fact that the procedure may last years, thus reducing the actual value of the creditors claim (see for example Andrade and Kaplan (1998) or Almeida and Philippon (2007)). This effect is captured by α.

Under these conditions, the value of the earnout becomes:

$$\begin{aligned}
E_{\text{vuln}}(0) &= e^{-\hat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right] = e^{-\hat{r}T}\widehat{\mathbb{E}}\left[X\cdot\left(\mathbb{I}_{def^C}+rec\cdot\mathbb{I}_{def}\right)\right] \\
&= e^{-\hat{r}T}\widehat{\mathbb{E}}\left[X\cdot\left(\mathbb{I}_{def^C}\pm\mathbb{I}_{def}\right)+rec\cdot X\cdot\mathbb{I}_{def}\right] \\
&= e^{-\hat{r}T}\widehat{\mathbb{E}}\left[X\cdot 1-X\cdot\mathbb{I}_{def}+rec\cdot X\cdot\mathbb{I}_{def}\right] \\
&= e^{-\hat{r}T}\widehat{\mathbb{E}}\left[X\cdot 1-X\cdot\mathbb{I}_{def}\left(1-rec\right)\right] \\
&= \widehat{\mathbb{E}}\left[e^{-\hat{r}T}X\right]-\widehat{\mathbb{E}}\left[e^{-\hat{r}T}X\cdot\mathbb{I}_{def}\left(1-rec\right)\right].
\end{aligned}$$

Denoting with

$$CVA = \widehat{\mathbb{E}}\left[e^{-\hat{r}T}X\cdot\mathbb{I}_{def}\left(1-rec\right)\right] \tag{3}$$

we get that

$$E_{\text{vuln}}(0) = \widehat{\mathbb{E}}\left[e^{-\hat{r}T}X\right]-CVA \tag{4}$$

That is, including counterparty risk in the picture entails correcting the value of the earnout for the potential inability of the bidder of paying fully what due. Equation

(4), indeed, shows that the value of the earnout, including counterparty risk, is equal to the valuation of the earnout using the simple option pricing method minus a credit value adjustment, CVA defined in Equation (3), which reflects the creditworthiness of the bidder.

The valuation of an earnout using the simple option pricing method, that is not considering counterparty risk, is an upper bound to the valuation given by considering it as a vulnerable option. If the value of the bidder is very high compared to the one of the target, if leverage is very low, and if the correlation between the two company is perfect or almost perfect, the risk that the bidder will not be able to pay the additional payment for the acquisition would be very small, thus the CVA would be negligible.

This model describes better the forces driving the final payoff, and thus the value, of earnouts than considering it as an ordinary option. The only minor disadvantage of this model is that it has no closed form solution. It needs to be solved numerically.

4.3.1 The effect of the parameters on the value of the earnout

In order to show the impact of the parameters on the value of earnouts, we refer to an actual contract, stipulated for the acquisition of The Center for Pain Management by Paincare holdings. To obtain the information needed on the earnout, we retrieved the acquisition contract from the SEC filings database.

In December 2004, Paincare holdings, a company that provides highly specialized health services, acquired The Center for Pain Management, a company which owns several hospitals in Maryland. There was considerable uncertainty on the profitability of CPM since it was a private company. For this reason, the final agreement provided for an upfront payment of \$6.37 million in cash and \$10.69 in stocks, plus an earnout, linked to EBITDA, providing for three contingent payments, one for each of the 3 years following the acquisition. The total payment for the earnout was capped at \$13,75 million.

The earnout formula was the following:

$$E(t)=\begin{cases} \$4{,}58 \text{ million} \quad if \quad EBITDA_t \geq 5,5 \\ \$4{,}12\left(\frac{EBITDA_t}{5{,}5}\right) if\, 5,5 > EBITDA_t \geq 4,8 \\ \$3{,}20\left(\frac{EBITDA_t}{5{,}5}\right) if\, 4,8 > EBITDA_t \geq 4,1 \\ \$2{,}30\left(\frac{EBITDA_t}{5{,}5}\right) if\, 4,1 > EBITDA_t \geq 3,5 \end{cases} \text{with } t=1,2,3$$

As a base case for our analysis, we focus on the option structured on the third year after the acquisition, and we use the actual parameters of the two companies involved, which are summarized in the following table. We obtained these data from Compustat and CRSP: we are going to give more details on this in a later section.

V	160	$\rho_{S,V}$	0.41	$\|\sigma_V\|^2$	0.3
D	47	$\rho_{S,D}$	0.6	$\|\sigma_D\|^2$	0.3
S	3.5	$\rho_{D,V}$	0.3	$\|\sigma_S\|^2$	0.3
K	5.5	δ_S	0.02	r_f	0.03

As for the cost of distress, α, we obtained it from Moody's ultimate recovery database: the average cost of distress on senior unsecured bonds, computed over all the observations in the database, is 51.6%. Thus, we set α to 0.5.

Given these parameters, we run Monte Carlo simulations to assess the value of the earnout on the EBITDA obtained three years after the closing. The following table shows the result of the application of the vanilla option pricing method and the one that includes counterparty risk. The numbers between brackets represent the radius of the confidence interval of the estimation, corresponding to a confidence level of 95%.

	Vanilla	Counterparty risk
Earnout value	899.9	782.8
	(3.0)	(2.8)

Notice that, in our valuation, for comparison with the literature, we use as valuation measure the risk-neutral one, i.e. $\widehat{\mathbb{P}}=\mathbb{Q}$, as discount rate the risk-free one $\widehat{r}=r_f$, and assume the risk-neutral drifts of all the processes V, D, and S coincide with the risk-free interest rate.

The following tables help us to see how the value of the earnout, including counterparty risk, changes in relation to modifications in the parameters. All the parameters, apart from the ones specified in the tables, are set to our base case.

Let us first study the effect of (initial) debt and time.

Debt\Horizon	1y	2y	3y	4y	5y	6y
10	660.2	853.5	891.6	892.4	869.4	836.7
	(2.7)	(2.9)	(3.0)	(3.0)	(2.9)	(2.9)
47	643.3	737.5	782.8	713.0	671.2	623.0
	(2.6)	(2.8)	(2.8)	(2.7)	(2.7)	(2.6)
90	570.8	650.6	644.8	624.6	595.2	566.2
	(2.4)	(2.5)	(2.5)	(2.4)	(2.4)	(2.3)

The table shows that the value of the earnout decreases as debt increases. Clearly, this is because the likelihood of the bidder experiencing default increases with it, thus, the probability that the payoff gets reduced by the factor rec grows. With respect to time, it is easy to provide the intuition why its impact on the value of the contract can be either positive or negative. The longer the horizon, the higher the probability that the earnout will be in the money at expiry. However, time might increase also the likelihood of the bidder going default. Thus, the net impact of time on the value of the earnout depends on which of the two conflicting effects is stronger. Since the second effect grows stronger with the level of debt, as this parameter increases, the horizon at which time ceases to have a positive influence on the value of the earnout shortens.

$\rho_{S,V} \setminus \rho_{D,V}$	0	0.3	0.7	1
0	647.9	681.6	782.6	785.3
	(2.5)	(2.5)	(2.7)	(2.7)
0.2	699.7	733.0	834.9	889.9
	(0.0026)	2.7)	(2.9)	(3.0)
0.41	748.6	782.8	866.5	899.5
	(2.7)	(2.8)	(2.9)	(3.0)
0.6	787.1	821.1	882.4	899.6
	(2.8)	(2.8)	(3.0)	(3.0)
0.8	807.8	855.1	894.4	899.8
	(2.8)	(2.8)	(3.0)	(3.0)

With respect to the correlation between the parameter and the value of the bidder, it is possible to see that it has a positive impact on the value of the earnout. This is because the lower the correlation, the higher the probability that when S is high, V is low and thus the higher the probability that when the earnout payoff is high the bidder will be in financial distress. Also the correlation between bidder's assets and liabilities has the same influence on the contract value. This implies that when the value of the assets is low, debt is likely to be high, and thus the portion of the earnout payment that will be satisfied, captured by rec, reduces.

$\|\sigma_V\|^2 \setminus \|\sigma_D\|^2$	0.1	0.2	0.3	0.4
0.1	880.4	844.2	803.5	761.2
	(3.0)	(2.9)	(2.8)	(2.7)
0.2	863.2	833.8	793.3	759.5
	(2.9)	(2.9)	(2.8)	(2.7)
0.3	848.9	816.1	782.8	756.4
	(2.9)	(2.8)	(2.8)	(2.7)
0.4	831.3	803.7	778.4	751.3
	(2.9)	(2.8)	(2.8)	(2.7)

The last table captures the fact that both the volatility of bidder's assets and liabilities are factors of risk. While the volatility of the underlying has a positive impact on the value of an option, because unfavorable realizations of the parameter have limited effect on the final payoff, which is bounded to zero, while favorable realizations increase the payoff, the opposite happens for the volatility of the writer of the option. Positive realizations of the value of V will have limited impact on the payoff, because the payoff is bounded to the realization of X, while negative realizations of V, that lead to default, do have a negative impact on the payoff. In a figurative way, we can say that, while $|\sigma_S|^2$ is good variance, $|\sigma_V|^2$ is bad variance. Analogous reasoning holds for $|\sigma_D|$: in the case in which assets and liabilities are less than perfectly correlated, an high variance of liabilities reduces what is left to creditors' satisfaction in case of default.

4.4 Step 2: including litigation risk

As we said in the introduction, after the closing of the deal, the former shareholders of the target loose booth control over their company and the possibility to verify its performances directly. In our option pricing framework, this means that earnout are options structured on an underlying that cannot be precisely measured. For this reason, disagreement might arise at the moment in which the earnout has to be paid out.

Disagreement can have two origins. The first is the fact that the sellers might mistrust the accounting reports provided by the bidder, since it is possible that the figures were subject to earnings management for the purpose of reducing the earnout payment. The second is related to the fact that, if the performances of the target are disappointing, the sellers are not able to distinguish between the possibility that the bidder did not put enough effort in managing the business of the target or if they were overconfident in estimating the future profitability of their company.

Thus, if the performances of the target company at the end of the earnout period, as reported by the bidder, are lower than what expected by sellers, they might blame the bidder, and decide to go to court to obtain what they think they deserve. Clearly, doing that is costly, mainly for three reasons. The first one is that the trial has direct and indirect costs that need to be paid, as lawyers' fees, the time spent to arrange the trial, the cost of the trial itself. The second one relates to the fact that the proportion of the claim that the judge will grant is not known in advance, and even being right in their allegation does not guarantee the former shareholders of the target to win the suit[9]. This is very understandable: in assessing the profitability of the target company, the judge suffers from an asymmetry of information with respect to the bidder that is even stronger than the one affecting the sellers. Despite asking for documents, opinions and appraisals, this is an issue that the judge cannot overcome. Hence the proportion of the claim that the judge will grant is deemed to be uncertain. The last thing that has to be considered is the length of the trial. Since, if the judge grants, at least in part, the claim of the plaintiffs, the payment is going to be postponed to the end of the trial, the length of the trial itself is going to have a negative influence on the present value of the payment that they will receive.

Thus, the target's former shareholders would take legal steps only if what they expect to get from the trial, net of the costs related to it, is higher than what the bidder is willing to pay.

We model these issues by defining two functions: $\lambda_{notrial}$, which we call the mistrust function, captures the fact that the sellers expect the bidder to try to lower the payment due for the earnout, and λ_{trial}, that we call the litigation function, describes the fraction of the earnout that could be granted by the judge in a trial.

Before specifying the form taken by these functions, let us see how we model the decision of the sellers to go to court and how this affects the value of the earnout. The actual earnout payout, i.e. the earnout payout as proposed by the management of the bidder, is:

$$\widetilde{X} = \lambda_{notrial} \cdot \widehat{X} \leq \widehat{X},$$

[9]Whether merit matters in trials on M&A is a topic of debate in the literature. See for example Alexander (1991) or Romano (1991).

with $\lambda_{notrial} \in (0,1)$. If they go to trial at date T, the shareholders get

$$\lambda_{trial} \cdot \widehat{X}$$

Therefore, the former shareholders of the target go to trial at date T if it is convenient, i.e. if:

$$\lambda_{trial} \cdot \widehat{X} > \lambda_{notrial} \cdot \widehat{X} \quad \text{iff} \quad \lambda_{trial} > \lambda_{notrial}$$

The indicator function of going to trial is $\mathbb{I}_{trial} = \mathbb{I}_{\lambda_{trial} > \lambda_{notrial}}$. Therefore, the earnout payoff, adding to the counterparty risk the issues arising from lack of measurability, is:

$$\lambda_{trial} \cdot \widehat{X} \cdot \mathbb{I}_{trial} + \lambda_{notrial} \cdot \widehat{X} \cdot \mathbb{I}_{trial^C}$$

Thus, the value of the earnout becomes:

$$\begin{aligned}
E_{lit}(0) &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\lambda_{trial} \cdot \widehat{X} \cdot \mathbb{I}_{trial} + \lambda_{notrial} \cdot \widehat{X} \cdot \mathbb{I}_{trial^C}\right] \\
&= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\pm\widehat{X} + \lambda_{trial} \cdot \widehat{X} \cdot \mathbb{I}_{trial} + \lambda_{notrial} \cdot \widehat{X} \cdot \mathbb{I}_{trial^C}\right] \\
&= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X} - \widehat{X}\left(\mathbb{I}_{trial^C} + \mathbb{I}_{trial}\right) + \lambda_{trial} \cdot \widehat{X} \cdot \mathbb{I}_{trial} + \lambda_{notrial} \cdot \widehat{X} \cdot \mathbb{I}_{trial^C}\right] \\
&= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X} - \widehat{X} \cdot \mathbb{I}_{trial}\left(1 - \lambda_{trial}\right) - \widehat{X} \cdot \mathbb{I}_{trial^C}\left(1 - \lambda_{notrial}\right)\right]
\end{aligned}$$

From the last equation we see that the risk of litigation diminishes the earnout value:

$$E_{lit}(0) = e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right] - e^{-\widehat{r}T}\left(\widehat{\mathbb{E}}\left[(1 - \lambda_{trial}) \cdot \widehat{X} \cdot \mathbb{I}_{trial}\right] + \widehat{\mathbb{E}}\left[(1 - \lambda_{notrial}) \cdot \widehat{X} \cdot \mathbb{I}_{trial^C}\right]\right) \tag{5}$$

The quantity

$$LitVA = e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1 - \lambda_{trial}) \cdot \widehat{X} \cdot \mathbb{I}_{trial}\right] + e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1 - \lambda_{notrial}) \cdot \widehat{X} \cdot \mathbb{I}_{trial^C}\right] \tag{6}$$

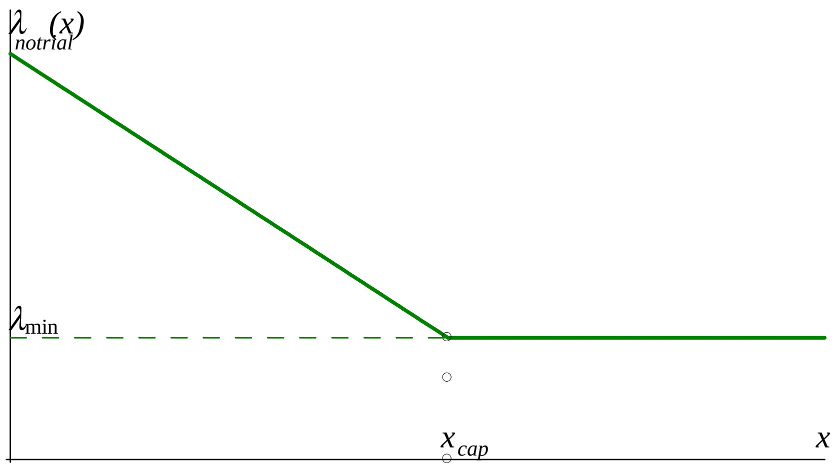
can be thought as a *litigation value adjustment.* The $LitVA$ includes two elements: the adjustment for the costs and the risks of going to trial, $e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1 - \lambda_{trial}) \cdot \widehat{X} \cdot \mathbb{I}_{trial}\right]$, and the risk of having to accept the reduced payment $\lambda_{notrial}\widehat{X}$ instead of $\widehat{X}$, when going to trail is not convenient: $e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda_{notrial})\cdot\widehat{X}\cdot\mathbb{I}_{trial^C}\right]$.

4.4.1 The specifications of the mistrust and the litigation functions

Let us now go to the specifications of $\lambda_{notrial}$ and λ_{trial}. The fraction of the earnout $\widehat{X}$ the bidder is willing to pay depends on the outcome of the earnout. The higher the outcome, the more significant the temptation for the bidder to pursue a lower outflow. For simplicity, we select a piecewise linear function:

$$\lambda_{notrial}(x)=\begin{cases}1-\alpha_\lambda x & \text{for } x\in[0;x_{cap}]\\ \lambda_{\min} & \text{for } x>x_{cap}\end{cases}$$

where x_{cap} is the cap usually set in earnout contracts as a limit to future payments[10].



The parameters to be chosen are:

$$\alpha_\lambda>0$$

$$\lambda_{\min}\in(0;1)$$

that is, what needs to be chosen is in how the bidder will try to reduce the earnout payment, in terms of percentage and maximum reduction.

[10] If the contract does not provide an upper bound for the payoff of the earnout, as in the case of a standard call option, x_{cap} can be set, for example, equal to the 95%−quantile of the earnout payoff.

We need a further restriction to guarantee that the received payoff is increasing with respect to x :

$$\alpha_\lambda < \frac{1}{2x_{cap}}. \tag{7}$$

While it is reasonable to think that the incentive for the bidder to reduce the outflow is *marginally* increasing in the realized payoff, it would be less reasonable to imagine that an increase in the actual payoff would lower the *total* outflow that the bidder is willing to bear. The derivation of this condition (7) can be found in the appendix.

In the spirit of Beyer (2009), we propose to link the ability of the bidder to manage performance measures to the volatility of this measure and on its distance from the threshold of the earnout, which represents the expectation of the bidder for the realization of the parameter[11]. The intuition behind this is clear: if the measure is noisy, and its realization was higher than expected, the bidder can lower it without the sellers being able to infer this. A possible choice is therefore[12]:

$$\begin{aligned} \alpha_\lambda &= \frac{|\sigma_S|\sqrt{T}}{x_{cap}} \\ \lambda_{\min} &= 1 - |\sigma_S|\sqrt{T} \end{aligned} \tag{9}$$

The function λ_{trial} instead can be specified in this way:

$$\lambda_{trial} = \left(\Gamma e^{-\widehat{r}L_{trial}} - c\right)$$

where Γ is the proportion of the claim that the sellers expect the judge to grant, L_{trial} is the length of the trial, and c is the upfront proportional cost of litigation (e.g.: lawyers' fees). The parameter Γ, assumed to be lower than 1, captures the fact that

[11] Which can be more conservative if compared to the expectations of the sellers.

[12] If the owners/managers of the target company are retained after the closing, the possibilities to manage earnings faced by the bidder are reduced. To incorporate this, it is possible to reduce the factors α_λ and $\lambda_{\min}$ by a parameter $k \in (1, +\infty)$:

$$\begin{aligned} \alpha_\lambda &= \frac{|\sigma_S|\sqrt{T}}{k \cdot x_{cap}} \\ \lambda_{\min} &= \frac{1 - |\sigma_S|\sqrt{T}}{k} \end{aligned} \tag{8}$$

going to court does not imply obtaining in full what requested. This is because the judge suffers from the same information asymmetry on the realization of the parameter that affects the sellers, to which it should be added the fact that there is always a degree of discretionality in determining an accounting figure. For this reason, he or she could decide to indemnify only partially the plaintiff. In addition to that, it is possible that the former shareholders of the target were overconfident in their expectations on the profitability of their company. So it is also possible that the judge, recognizing this, would deny their request. The other issue that going to court pose is that the trial could last several years. Thus, in order to know the current value of what granted by the judge, discounting is necessary.

Using a specific value for λ_{trial} is a choice that simplifies the exposition. It would be easy to extend the model to capture the fact that λ_{trial} is indeed a random variable. Since the proportion of the claim that the judge will grant is likely to be uncertain, λ_{trial} can be thought to as an *independent*[13] random variable, with realizations $0 < \lambda_{trial}^{L} \leq \lambda_{trial}^{M} \leq \lambda_{trial}^{H}$, occurring with probability $\widehat{p}_{trial}^{L} = \widehat{\mathbb{P}}\left[\lambda_{trial} = \lambda_{trial}^{L}\right], \widehat{p}_{trial}^{M} = \widehat{\mathbb{P}}\left[\lambda_{trial} = \lambda_{trial}^{M}\right], \widehat{p}_{trial}^{H} = 1 - \widehat{p}_{trial}^{L} - \widehat{p}_{trial}^{M}$. Because of the independence assumption, formula (5) with a constant λ_{trial} can be immediately extended obtaining

$$E_{lit}(0) = \sum_{l=L,M,H} \left[E_{lit}(0)\right]_{\lambda_{trial}=\lambda_{trial}^{l}} \widehat{p}_{trial}^{l}$$

where $\left[E_{lit}(0)\right]_{\lambda_{trial}=\lambda_{trial}^{l}}$ is the value of the earnout, adjusted for the risk of litigation, with a constant $\lambda_{trial} = \lambda_{trial}^{l}$ in Equation (5).

For simplicity, we stick to the use of a specific average value of λ_{trial}, the results however are clearly robust to this extension.

In order to see the model at work, we apply it on the case of study previously mentioned. The function $\lambda_{notrial}$ is completely specified by the parameters already presented. In order to define the function λ_{trial} we did the following. In a survey over M&A litigations in the horizon between 1996 and 2011, Cornerstone Research[14]

[13] The random variable λ_{trial} is assumed to be independent of all the processes V, S, D with respect to the valuation measure $\widehat{\mathbb{P}}$.

[14] A company specialized in research and consulting on litigations in the field of business.

showed that the settlements related to them how strong heterogeneity: the median clustered by deal value span widely between 2% to a bit more than 53% of the damage subject of the lawsuit. Since settlements are a sort of expectation of what the plaintiff expects to get, because they will reject a settlement only if they think that they can be better off by continuing the trial, we used this as a proxy for Γ. Clearly the survey is not focused on litigation related to earnouts, but it can be a good indicator of what the sellers might expect to get if they start a trial. To be conservative in our estimations, we set Γ to be equal to 53%. As for the length of procedure leading to settlement, it varies between 2 and more than 5 years. We set L_{trial} to be equal to 2 years. With respect to c, the upfront cost of the litigation, namely the attorneys' fees, we set it to 5%, as it was advised to us in a private discussion with a law firm.

For our base case, the value of the earnout including also litigation risk is shown in the following table, that, for comparison, replicates the results previously shown:

	Vanilla	Counterparty risk	Litigation risk
Earnout value	899.9	782.8	405.2
	(3.0)	(2.8)	(1.7)

As it is possible to see, the value of the earnout, under our specifications, gets dramatically reduced.

As we did before, we want to check how the valuation varies in relation to changes in λ_{trial} and $\lambda_{notrial}$. For each of them, we make an element vary. For λ_{trial}, we make Γ vary between 0.3, 0.53, 0.8. For $\lambda_{notrial}$ we make $\alpha_\lambda = \frac{|\sigma_S|\sqrt{T}}{x_{cap}}$ vary between half, 1 and 1.5 times of its size.

$\lambda_{notrial} \setminus \lambda_{trial}$	$\Gamma = 0.3$	$\Gamma = 0.53$	$\Gamma = 0.8$
$2\alpha_\lambda$	251.4	369.3	519.9
	(1.2)	(1.5)	(2.0)
α_λ	317.6	405.2	532.6
	(1.5)	(1.7)	(2.1)
$\frac{1}{2}\alpha_\lambda$	405.7	461.5	550.6
	(1.8)	(1.9)	(2.1)

The results of the valuation procedure are clearly sensible to the parameters chosen, but even in the most favorable conditions the value of the contracts gets strongly reduced in the presence of litigation risk.

4.4.2 Litigation risk and counterparty risk combined

In the previous section, in order to express the value of the earnout, we considered effect of litigation risk on $\widehat{X}$, that is the value of the final payoff already including the counterparty risk. In order to see the effect of both the sources of risk, we can plug the expression for $\widehat{X}$ in the valuation formula previously derived:

$$E_{lit}(0) = e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right] - e^{-\widehat{r}T}\left(\widehat{\mathbb{E}}\left[(1-\lambda_{trial})\cdot\widehat{X}\cdot\mathbb{I}_{trial}\right] + \widehat{\mathbb{E}}\left[(1-\lambda_{notrial})\cdot\widehat{X}\cdot\mathbb{I}_{trial^C}\right]\right)$$
$$with$$
$$\widehat{X} = X\cdot\left(\mathbb{I}_{def^C} + rec\cdot\mathbb{I}_{def}\right)$$

This allows us to express the value of the earnout in the following way (the explicit derivation of the formula is given in the appendix):

$$\begin{aligned} E_{lit}(0) = {} & e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial}\cdot(1-rec\cdot\lambda_{trial})\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial^C}\cdot(1-rec\cdot\lambda_{notrial})\right. \\ & -e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\mathbb{I}_{def^C}\cdot\mathbb{I}_{trial}\left(1-\lambda_{trial}\right)\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\mathbb{I}_{def^C}\cdot\mathbb{I}_{trial^C}\left(1-\lambda_{notrial}\right)\right] \end{aligned} \quad (10$$

This equation shows that there are four terms that correct the value of the earnout computed as an ordinary call. Indeed, the two events that we consider, default and litigation, divide the state space into four partitions. In all these partitions the value of the final payoff gets reduced, as the following table shows:

EO payout	no default	default
no trial	$\lambda_{notrial}\cdot X$	$rec\cdot\lambda_{notrial}\cdot X$
trial	$\lambda_{trial}\cdot X$	$rec\cdot\lambda_{trial}\cdot X$

Thus the four terms that correct the value of the earnout arise as the composition of the litigation value adjustment, discussed in the previous section, and the credit value adjustment, discussed in the one before.

5 Does the model capture reality?

Our model shows that the valuation methods that do not include counterparty risk tend to overestimate the value of earnouts. The overestimation is stronger the lower the correlation between bidder and target, the more the bidder is levered, and the lower the relative value of the bidder with respect to the target. As for litigation risk, an indirect evidence of the significance of litigation risk can be given by the proportion of deals that involve bidder and target that operate in sectors prone to litigation: technology, services and healthcare[15]. In addition to that, we will provide evidence of relevant cases in which earnouts ended in disputes.

The data that we use in this empirical section comes from different sources. From Thomson One Banker we obtained the information on deals completed between 2001 and 2011 that involved bidders and targets both incorporated in United States for which an earnout agreement was used. This dataset is made of a total of 1947 acquisitions. In order to obtain the information on the capital structure of the companies involved in the acquisitions and on returns of the firms that were publicly traded, we merged this dataset with CRSP and Compustat.

What we want to show is that our model has an impact in general on the valuation of earnouts, because no bidder is perfectly correlated with the target *and* it is unlevered *and* has very deep pockets. But we also want to show that there are cases in which the use of our model might dramatically reduce the valuation of these contracts, because more than one of the conditions previously stated might be met simultaneously.

5.1 Correlation

A first indicator of the correlation between bidders and targets can be given by the comparison of their SIC codes. The following table shows, both divided by year and overall, the proportion of deals for which bidder and target operate in different industries or sectors according to 4, 3 or 2-digit SIC code.

[15] See the already cited Francis, Philbrick and Schipper (1994), Brown, Hillegeist and Lo (2005), Rogers and Stocken (2005) and Kim and Skinner (2011).

Year	N°Obs	N°Diff 4-digits	% Diff 4-digits	N°Diff 3-digits	% Diff 3-digits	N°Diff 2-digits	% Diff 2-digits
2001	148	116	78.37%	105	70.94%	88	59.46%
2002	185	129	69.73%	97	52.43%	83	44.86%
2003	149	106	71.14%	85	44.97%	70	46.98%
2004	189	120	63.49%	97	51.32%	75	39.68%
2005	216	142	65.74%	108	50.00%	87	40.28%
2006	204	146	71.57%	115	56.37%	97	47.55%
2007	234	167	71.37%	138	58.97%	113	48.29%
2008	180	110	61.11%	89	49.44%	74	41.11%
2009	123	75	60.98%	57	46.34%	49	38.84%
2010	135	95	70.37%	76	56.30%	54	40.00%
2011	184	114	61.96%	91	49.46%	80	43.48%
Total	1,947	1,320	67.80%	1,058	54.34%	870	44.68%

As the table shows, the overall percentage of deals involving bidder and targets operating in different sectors or industries is relevant. Even looking at the broadest definition of industry, that is considering two-digits SIC codes, almost half of the deals in which earnouts are used are cross-industry acquisitions. These results are consistent with the evidence in Kohers and Ang (2000), Datar, Frankel and Wolfson (2001), and Cain, Denis and Denis (2011).

It is reasonable to believe that different industries are not perfectly correlated, so this is already evidence of the fact that our model captures the features of actual deals.

However, in order to have a more direct measure of correlation, we adopted the following procedure. Starting from the information on returns of traded stocks in CRSP, we built a proxy of cross industry correlation. For each month in the years between 2001 and 2011, for each group of firms defined by 4-digits SIC codes, we computed the average return. Then we obtained the cross industry correlation for each pair of SIC codes and each month, by computing the correlation of the average returns over the previous 36 months. For each deal in the sample for which we were able to compute the information, we associated the correlation between the industry of the bidder and the industry of the target in the month in which the deal was effective. Over the 1,320 deals involving bidders and targets operating in different industries, we had data to compute the cross industry correlation for 1,126 of them. The table below reports the results.

Correlation by year		Details on the distribution of correlations over the whole sample	
Year	Average correlation		
2001	0.4959	Mean	0.5489
2002	0.5156	Median	0.5840
2003	0.5831	Std. Dev.	0.2556
2004	0.5723	Min	-0.3395
2005	0.5604	Max	0.9549
2006	0.4513		
2007	0.4807		
2008	0.5129		
2009	0.6687		
2010	0.6326		
2011	0.6648		

This table shows that the correlation between bidder and target, given that they operate in different industries, is on average of 0.55, so significantly less than one. Moreover, it reaches very low, sometimes negative values. This again shows that the model that we are proposing might do a better job in valuing earnouts than the ones currently used.

5.2 Leverage

Using the information obtained from Compustat on the financial structure of the bidders, we computed both their book and market leverage, defined as $\frac{\text{Liabilities}}{\text{Assets}}$. We had sufficient information for 1032 deals in our dataset. The average (median) book leverage is 45% (42%), the average (median) market leverage is 29% (25%). These levels are not to high, yet they are sufficient to have an impact on the valuation using our model. What is more interesting to notice, though, is that 84 (149) companies, that is 8.2% (14.5%) of the bidders for which we have this information, has a market (book) leverage equal or higher than 70%.

The table below gives more details on market leverage.

Market leverage			
		Percentiles	
Mean	29.44%	1%	1.76%
Std Dev	21.48%	5%	4.16%
Min	0.06%	10%	6.08%
Max	99.79%	25%	12.52%
		50%	24.87%
		75%	39.82%
		90%	61.02%
		95%	73.48%
		99%	92.18%

The table shows us that there are a number of bidders of deals involving earnouts that are extremely leveraged. In these cases it would be extremely important to use our model not to be fooled by promises made by bidders that face a high risk of default.

5.3 Relative size

Our model converges to an ordinary European call if the value of the bidder, relative to the one of the target, goes to infinity. So, if the size of the bidder is not extremely higher than the size of the target, our model would imply a lower value for earnout contracts. The following table compares the market value of the bidder one month prior to the acquisition to the price paid for the target, including the maximum payment that could arise from the earnouts, by showing their ratio.

Relative size			
		Percentiles	
Mean	101	1%	0.30
Std Dev	1018	5%	1.24
Min	0.024	10%	2.35
Max	27374	25%	5.45
		50%	13.37
		75%	39.12
		90%	118.16
		95%	202.96
		99%	1023.58

As the percentiles show, in a significant portion of deals the size of the bidder is not extremely higher than the size of the target. Again, this is evidence of the fact that our model might be useful for the valuation of most earnout agreements.

5.4 The risk of litigation

A first, indirect way, to show that there is a risk of litigation, is to show that the majority of earnouts is used in deals for which the target is in an industry with a high likelihood of litigation. According to Kim and Skinner (2011), these are the technology, service, pharmaceutical/chemical and financial industries. In our dataset, the percentage of deals for which the target is in one of these industries is 63.48%. The table below provides details on this percentage.

Deals divided by target sector	
Technology	13.30%
Services	41.86%
Pharmaceutical/chemical	8.32%
Financial	6.83%
Total	63.48%

To have a more direct feel of the fact that litigation is a possible result of earnouts, we discuss a few significant cases in which these contingent payments ended in litigation. Different are the sources of the informations on these cases. The most important is Factiva, paired with the verdicts on these cases publicly available and accessible via internet (mainly websites of law firms).

The first case relates to the acquisition by 3M, the well known multinational company, of Acolyte, a UK based company that developed BacLite, a test for MRSA, the acronym for Methicillin-resistant Staphylococcus aureus. The acquisition took place in 2007. Apart from an upfront payment of £10,5 million, the former shareholders of Acolyte were entitled to receive additional payments capped at £41 million. The payments were made contingent on the revenues of the acquired company on the next three years. 3M should have obtained the approval of FDA in order to sell this product also in the US, but FDA trials were never passed. Moreover, other competing products arrived on the market, a few of them cheaper than BacLite. For these reasons, 3M discontinued the production of BacLite in 2008, offering to the former shareholders $1 million in settlement of the earnout contract. The ex shareholders of Acolyte defused the offer, and decided instead to sue 3M, alleging that it breached its contractual obligations to actively market the product, diligently seek regulatory approvals, and provide the technology with the necessary level of financial resources. After a trial that lasted up to 2011, the claimants received damages for $1,3 million, just a bit more than what they would have obtained if they accepted the offer of 3M, but surely a lot less than the maximum earnout payment.

Another case refers to the acquisition of Indeck Capital by Black Hills Corporation. The acquisition took place in 2000, and the parties agreed upon an upfront payment of 38 million dollars in Black Hills shares, and an earnout capped at 35 million dollars. only a portion of the earnout, that is 11,3 million dollars, was due according to the bidder and thus paid. In 2004 the former shareholders of the target went to court, claiming that the bidder did not provide audited documentation of the performances of the target during the earnout period, and thus they did not believe in the prospectuses provided by the bidder. They believed instead that the actual performances of the target were better than what claimed by the acquiror, and thus they had the right to higher earnout payments. In 2008 the court denied all plaintiffs motions.

Another interesting case is the one involving Squid Soap and Airbone Health. Airborne acquired Squid Soap in 2007 with an upfront payment of $1 million, and an earnout capped at $26,5 million. Shortly after the acquisition, the business of the bidder began to deteriorate for reasons that were independent from the acquisition. For this reason, after the deal the bidder was distracted by the necessity of solving these issues and do not made its best effort to manage the acquired company. In 2009 this case was settled, with a partial grant of the allegations of the plaintiff.

These are just three examples of earnouts ended in litigation that we selected to show that the lack of monitoring on the target by its former shareholders play a crucial role for these contracts. There are plenty more. Earnouts are contracts that lay their foundations in disagreement, and, given the difficulties affecting the verification of their outcome, they likely have disagreement as their epilogue.

6 An example of valuation

In this section, we want to go back over our case of study, the earnout used in the acquisition of The Center for Pain Management by Paincare holdings.

As we said before, the final agreement provided for an upfront payment of $6.37 million in cash and $10.69 in stocks, plus an earnout, linked to EBITDA, providing for three contingent payments, one for each of the 3 years following the acquisition. The total payment for the earnout was capped at $13,75 million.

The earnout formula was:

$$E(t)\begin{cases} \$4{,}58 \text{ million} \quad if \quad EBITDA_t \geq 5,5 \\ \$4{,}12\left(\frac{EBITDA_t}{5{,}5}\right) if\, 5,5 > EBITDA_t \geq 4,8 \\ \$3{,}20\left(\frac{EBITDA_t}{5{,}5}\right) if\, 4,8 > EBITDA_t \geq 4,1 \\ \$2{,}30\left(\frac{EBITDA_t}{5{,}5}\right) if\, 4,1 > EBITDA_t \geq 3,5 \end{cases} \text{with } t = 1,2,3$$

In the previous sections we focused on the earnout structured over the third year. Now we want to consider the contract in its entirety. The table below shows the value of the earnout when using our valuation method, compared to vanilla option pricing models.

Earnout valuation			
	Ordinary option	Vulnerable option	With litigation risk
Earnout first year	657.8	643.3	522.3
Proportion to ordinary option		97%	80%
Earnout second year	803.9	737.5	471.8
Proportion to ordinary option		92%	59%
Earnout third year	899.9	782.8	405.2
Proportion to ordinary option		88%	49%
Overall	2361.6	2163.6	1399.3
Proportion to ordinary option		92%	59%

As the table shows, even with a conservative choice of the parameters, the difference in the valuation of the earnout, both including only counterparty risk and including also litigation risk, is significant using our model. Overall, the value of the earnout gets reduced by more than 40%.

7 Conclusions

Earnouts can be valuable instruments that make possible the closing of deals even in the presence of disagreement between the parties with respect to the company to be acquired. The valuation of these contracts however is far from being straightforward. It would be easy indeed to be fooled by the optionality value of these contracts, and to value only this aspect. However, two additional sources of risk, counterparty risk and litigation risk, play an important role that should be taken into account, because they reduce the benefits arising from the option structure of these contracts. Since the recently revised US and European accounting standards impose to value these contracts at fair value, having a model that correctly identifies their sources of risk and thus their value is of primary importance. Taking an income approach, we built a model that includes the potential losses arising from the event in which the bidder goes default before the expiration of the earnout and the costs of litigation that might arise in connection to these contracts. The sensitivity analysis performed and the case study presented show that including counterparty risk and litigation risk might have a dramatic impact on the value of these contracts: not including them might distort significantly the information provided in financial statements.

Acknowledgments. We are grateful to Sasson Bar Yosef, Andrea Beltratti, Stefano Bonini, Joao Cocco, Paolo Colla, Leonid Kogan, Fulvio Ortu, Giovanni Puopolo, Linus Siming, and Andrea Sironi for precious comments. We thank seminar participants at the Bocconi Finance Brown Bag seminar, the 2nd International Conference of the Financial Engineering and Banking Society, London 2012, the EAA Annual Congress, Paris 2014. We gratefully acknowledge the financial support received from Fondazione CARIPLO Mobility Grant.

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A Appendix

In the following appendix we denote $\lambda = \lambda_{notrial}$ and $\psi = \lambda_{trial}$.

A.1 Derivation of the valuation formula (10)

Taking into account the counterparty risk embedded in $\widehat{X}$, we obtain:

$$E_{lit}(0) = e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right] - e^{-\widehat{r}T}\left(\widehat{\mathbb{E}}\left[(1-\psi)\cdot\widehat{X}\cdot\mathbb{I}_{trial}\right] + \widehat{\mathbb{E}}\left[(1-\lambda)\cdot\widehat{X}\cdot\mathbb{I}_{trial^C}\right]\right)$$

The three addends can be rewritten as

$$\begin{aligned} e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right] &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\left(\mathbb{I}_{def^C} + rec\cdot\mathbb{I}_{def}\right)\right] = e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\left(\mathbb{I}_{def^C} \pm \mathbb{I}_{def} + rec\cdot\mathbb{I}_{def}\right)\right] \\ &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\mathbb{I}_{def}\cdot(1-rec)\right] \end{aligned}$$

$$\begin{aligned} e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot\widehat{X}\cdot\mathbb{I}_{trial}\right] &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot\left(X\cdot\left(\pm\mathbb{I}_{def} + \mathbb{I}_{def^C} + rec\cdot\mathbb{I}_{def}\right)\right)\cdot\mathbb{I}_{trial}\right] \\ &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot X\cdot\mathbb{I}_{trial}\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot(1-rec)\,X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial}\right] \end{aligned}$$

$$\begin{aligned} e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot\widehat{X}\cdot\mathbb{I}_{trial}\right] &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot\left(X\cdot\left(\pm\mathbb{I}_{def} + \mathbb{I}_{def^C} + rec\cdot\mathbb{I}_{def}\right)\right)\cdot\mathbb{I}_{trial^C}\right] \\ &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot X\cdot\mathbb{I}_{trial^C}\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot(1-rec)\,X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial^C}\right] \end{aligned}$$

so that

$$\begin{aligned} E_{lit}(0) &= e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right] - e^{-\widehat{r}T}\left(\widehat{\mathbb{E}}\left[(1-\psi)\cdot\widehat{X}\cdot\mathbb{I}_{trial}\right] + \widehat{\mathbb{E}}\left[(1-\lambda)\cdot\widehat{X}\cdot\mathbb{I}_{trial^C}\right]\right) \\ &= \underbrace{e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\cdot\mathbb{I}_{def}\cdot(1-rec)\right]}_{e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[\widehat{X}\right]} \\ &\quad - \left(\underbrace{e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot X\cdot\mathbb{I}_{trial}\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot(1-rec)\,X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial}\right]}_{e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi)\cdot\widehat{X}\cdot\mathbb{I}_{trial}\right]}\right) \\ &\quad - \left(\underbrace{e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot X\cdot\mathbb{I}_{trial^C}\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot(1-rec)\,X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial^C}\right]}_{e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot X\cdot\mathbb{I}_{trial^C}\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda)\cdot(1-rec)X\cdot\mathbb{I}_{def}\cdot\mathbb{I}_{trial^C}\right]}\right) \end{aligned}$$

$$
\begin{aligned}
E_{lit}(0) = & e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def} \cdot (1-rec)\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi) \cdot X \cdot \mathbb{I}_{trial}\right] \\
& + e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi) \cdot (1-rec)\, X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial}\right] \\
& - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda) \cdot X \cdot \mathbb{I}_{trial^C}\right] + e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda) \cdot (1-rec)\, X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial^C}\right]
\end{aligned}
$$

In details:

$$
\begin{aligned}
E_{lit}(0) = & e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def} \cdot (1-rec) \cdot (\mathbb{I}_{trial} + \mathbb{I}_{trial^C})\right] \\
& - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi) \cdot X \cdot \mathbb{I}_{trial} \cdot \left(\mathbb{I}_{def} + \mathbb{I}_{def^C}\right)\right] \\
& + e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\psi) \cdot (1-rec)\, X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial}\right] \\
& - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda) \cdot X \cdot \mathbb{I}_{trial^C} \cdot \left(\mathbb{I}_{def} + \mathbb{I}_{def^C}\right)\right] + e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[(1-\lambda) \cdot (1-rec)\, X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial^C}\right] \\
= & e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial}\left(1-rec+1-\psi-(1-\psi)\cdot(1-rec)\right)\right] \\
& - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial^C}\left(1-rec+1-\lambda-(1-\lambda)\cdot(1-rec)\right)\right] \\
& - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def^C} \cdot \mathbb{I}_{trial}\left(1-\psi\right)\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def^C} \cdot \mathbb{I}_{trial^C}\left(1-\lambda\right)\right] \\
= & e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial} \cdot (1-rec\cdot\psi)\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def} \cdot \mathbb{I}_{trial^C} \cdot (1-rec\cdot\lambda)\right] \\
& - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def^C} \cdot \mathbb{I}_{trial}\left(1-\psi\right)\right] - e^{-\widehat{r}T}\widehat{\mathbb{E}}\left[X \cdot \mathbb{I}_{def^C} \cdot \mathbb{I}_{trial^C}\left(1-\lambda\right)\right]
\end{aligned}
$$

A.2 Derivation of condition (7) on α_λ

In order $\lambda_{notrial}(x) \cdot x$ to be an increasing function of x we require $(1-\alpha_\lambda(x-x_\lambda)) \cdot x$ to have positive derivative for $x \in [x_\lambda; x_{cap}]$. This is equivalent to

$$
\begin{aligned}
-\alpha_\lambda \cdot x + 1 - \alpha_\lambda(x-x_\lambda) &> 0 \quad \text{for all } x \in [x_\lambda; x_{cap}] \\
-2\alpha_\lambda \cdot x + 1 + \alpha_\lambda x_\lambda &> 0 \quad \text{for all } x \in [x_\lambda; x_{cap}] \\
-2\alpha_\lambda \cdot x_{cap} + 1 + \alpha_\lambda x_\lambda &> 0 \\
1 - (2x_{cap} - x_\lambda)\,\alpha_\lambda &> 0 \\
\alpha_\lambda &< \frac{1}{2x_{cap} - x_\lambda}
\end{aligned}
$$