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# Earnouts in mergers and acquisitions: A game-theoretic option pricing approach

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ABSTRACT

This paper presents a valuation approach for merger and acquisition (M&A) deals employing contingent earnouts. It is argued that these transactions have option-like features, and the paper uses a game-theoretic option approach to model the value of such claims. More specifically, the paper examines the impact of uncertainty on the optimal timing of M&A using earnouts, and it also investigates the impact of uncertainty on the terms of the earnout. Optimal earnout and initial payment combinations are endogenously derived from the model, and testable hypotheses are developed. The theoretical contribution of this paper is a dynamic decision-making model of the invest-to-learn option generated upon investment in an acquisition. The paper also offers practical implications for the design of acquisitions employing earnouts.



## 1. Introduction

For almost a century, merger and acquisition (M&A) deals and the factors that give rise to them have been the subject of intense interest in the business economics research domain. One of the key challenges parties face is coming to terms on a price that serves both buyer and seller. For example, parties to prospective M&A deals often diverge in their expectations about future revenue gains or cost savings that a target might realize once a deal is consummated. Earnouts specify deferred payments from bidder to target that are tied to certain performance targets, so they represent a useful tool to address uncertainty in the valuation process by enabling parties to share risk. There appears to be an increasing usage of such contingent contracts in acquisition transactions, with more than 7000 deals since 2000 using earnouts, or roughly 1.5% of deals reported worldwide.[1]

Despite the potential value of earnouts in facilitating acquisitions, little is known about this type of contingent contract in the M&A research domain. Some empirical studies exist that examine firms' motives to employ earnouts, yet there is a lack of analytical modeling of the valuation and timing of acquisition transactions employing earnouts. In particular, the few traditional approaches used to value earnouts have the limitation of underestimating their value because they neglect their option-like features. A separate literature exists on the timing of M&A bids and value of flexibility, yet the implications of contingent future payments such as those introduced by earnouts have been neglected in this stream of analytical work. We therefore wish to join and extend these research streams in the M&A literature by examining in more detail how contingent earnouts are structured and by presenting an option valuation model for acquisitions involving earnouts.

The remainder of the paper is organized as follows: Section 2 provides a brief literature review that summarizes current theory and findings on earnouts. Section 3 presents the game-theoretic option valuation model. We first introduce the basic structure of the model, value earnout payments (Section 3.1), determine optimal cooperation levels by targets (Section 3.2), and finally analyze initial timing and deal structuring decisions (Section 3.3). Section 4 offers a summary of the comparative static results and derives testable hypotheses. Section 5 concludes by laying out several directions for future research on the design and implications of earnouts in acquisitions.

## 2. Literature review

In what follows we will define an earnout as "an arrangement under which a portion of the purchase price in an acquisition is contingent on achievement of financial or other performance targets after the deal closes" (Bruner and Stiegler, 2001, p. 1). Hence, for acquisition deals involving earnouts, only a fraction of the total consideration is paid up front, and the remaining payments are deferred and contingent upon meeting certain performance targets.

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In contrast to other areas of the M&A literature, research on earnouts is still in its infancy. As of yet, studies have predominantly been empirical analyses of firms' motives to employ earnouts in acquisition transactions. This work has noted that such contingent contracts are useful to reduce the risk of adverse selection when the target possesses private knowledge on its resources and prospects (e.g. Kohers and Ang, 2000; Datar et al., 2001). This theory therefore suggests that an earnout can offer a remedy to the adverse selection problem because it transfers overpayment risk from a less informed buyer to the target (Ragozzino and Reuer, 2009). Earnouts might also help address the inverse adverse selection problem – where the buyer is better informed than the target – by granting the latter a part of the future potential upside of a transaction (e.g. Dari-Mattiacci et al., 2010). A second potential motive for earnouts is to reduce moral hazard problems during post-merger execution. Here, earnouts provide incentives for target management to stay and to put forth efforts in order to receive the deferred, contingent payments (see e.g. Krug and Hegarty, 2001; Kohers and Ang, 2000). However, it should be noted that earnouts may also create other agency problems. For example, during post-merger implementation the buyer might have an incentive to influence performance in such a way to reduce the earnout payment in the near term, or a target might take steps to enhance short-term income to receive earnout payments at the expense of the business' longer term interests (e.g., cutting R&D, reducing maintenance activities, etc.). In addition, contracting costs and inefficiencies tied to earnout implementation and monitoring might prohibit their usage (e.g. Datar et al., 2001; Caselli et al., 2006). Apart from addressing certain adverse selection or moral hazard concerns, earnouts can also enable the acquirer to retain its financial flexibility, which can be of particular importance if the buyer possesses valuable growth opportunities that necessitate additional funding after a particular transaction is executed (Del Roccili and Fuhr, 2001).

Previous research on earnouts has also investigated particular facets of the design of these contingent contracts. For instance, an important task during negotiations is to find the right balance between the portion of the purchase price that will be paid up front and the portion that will be tied to future performance. It has been suggested that the initial payment represents the amount both seller and buyer agree upon (e.g. Bruner and Stiegler, 2001), while the contingent payments reflect the degree to which the acquirer and target have valuation differences. An increase in the earnout ratio, or the sum of all earnout payments in relation to the maximum price paid, reduces risk to the acquirer, while a higher initial cash payments reduces the target's risk. Recent studies confirm there is substantial heterogeneity in the relative importance of deferred, contingent payments in deals involving earnouts. Bruner and Stiegler (2001), for instance, report that earnouts account for 15–88% of the consideration paid, and Cain et al. (2011) indicate that earnout payments on average represent 33% of the total transaction value. Part of this heterogeneity is due to the characteristics of the target. For instance, Kohers and Ang (2000) find that the fraction of earnout payment to total deal value is higher if the target is privately owned (i.e., 44% on average). According to Cain et al. (2011), higher earnout payments are also observed if the target possesses high growth opportunities and is exposed to greater uncertainty. A second important facet of the earnout contract is the earnout period, or the time frame during which performance is measured and deferred payments made based upon certain profitability targets (e.g., operating profits, EBIT, cash flows, etc.). Kohers and Ang (2000) report an earnout period ranging from 2 to 5 years. Cain et al. (2011) report greater variance in earnout periods, which range from 1 month to 20 years, but the average earnout period is 2.57 years.

Given the contingent payments that earnouts entail, several articles have noted that earnout contracts resemble real options discussed in the domain of corporate finance and economics (Bruner and Stiegler, 2001; Caselli et al., 2006). In general, a real option represents a right to undertake a managerial action, such as to expand, abandon, or switch use of an asset without been obligated to do so. A detailed introduction to real options can be found in Trigeorgis (1996a) and Dixit and Pindyck (1994), and applications of real option methodology in the context of operations research include Pennings and Lint (2000), Martzoukos and Trigeorgis (2002), and Clark and Easaw (2007). As Myers (1977, 1987) first noted, traditional investment appraisal techniques such as the net present value (NPV) method are not capable of capturing the value of flexibility, which require the use of option pricing theory and derivative pricing methods. Since Myers' pioneering work, a growing body of research has applied the real options approach to analyze mergers and acquisitions. The vast majority of real option models in the acquisition literature built upon the analogy between takeover opportunities and exchange options. The first paper to recognize this was by Margrabe (1978), who notes that takeover deals typically provide the participants an option to exchange one asset (the shares in the initial firm) for another (shares in the new entity) (see also Pawlina, 2002). While in his model takeover timing is set exogenously, recent studies account for endogenous timing of takeovers and also relate timing to the negotiated terms of the acquisition (e.g. Lambrecht, 2004). Moreover, the framework has been used to analyze the behavior of stock returns in mergers and acquisitions (e.g. Morellec and Zhdanov, 2005; Hackbarth and Morellec, 2008).

Because these recent studies do not account for the deferred, contingent payments involved in earnouts, opportunities exist not only to use option pricing to value acquisitions involving earnouts and evaluate alternative contract designs, but to consider the implications of subsequent contingent payments on takeover timing. In so doing, we also advance a recent stream of research that uses options theory to examine stepwise investment behavior and investment timing (see e.g. Kort et al., 2010; Kim et al., 2008; Trigeorgis, 1996b). Our findings reveal that the parties will tend to postpone the M&A settlement the larger the transaction costs, the greater the uncertainty of the target's cash flows, the longer the earnout period and the higher the performance targets. Because the buyer is not confronted with the deferred payment at the time the M&A deal is settled, an earnout is commonly considered as being costless to the acquirer. An earnout is not costless, even if it is structured to be out of the money at the time of the settlement, and this has implications for the optimal contract design. In particular, the results show that an increase in uncertainty as well as an increase in the earnout period lead to an increase in the earnout portion of the deal.

## 3. The model

We will focus on an M&A transaction between a buyer and a target. Both are assumed to be risk neutral and discount with the riskless interest rate $r > 0$. The target company generates a net cash flow (or earnings) stream of $x(t)$ per time period, and we assume that these cash flows are uncertain and that their time-varying pattern can be formally expressed by an arithmetic Brownian motion (ABM) process:

$$dx(t) = \alpha dt + \sigma dW, \quad x(0) = x_0, \tag{1}$$

with $\alpha, \sigma \in \mathbb{R}^+$ and $dW$ as a standard Brownian motion. Eq. (1) states that changes in the cash flows are normally distributed with mean $\alpha dt$ and variance $\sigma^2 dt$ over a time interval of length $dt$.[2] For

[2] Consequently there exists a possibility that cash flows can become negative at a future point in time.

simplicity, assuming an infinite investment horizon, the value of the target can be expressed as follows:

$$V(x_0) = \mathbb{E}\left[\int_0^{\infty} x(s)e^{-rs}ds\right] = \int_0^{\infty}(x_0 + \alpha s)e^{-rs}ds = \frac{x_0}{r} + \frac{\alpha}{r^2}. \tag{2}$$

Furthermore, we assume that the acquisition requires sunk transaction costs of $I_T \in \mathbb{R}^+$ at the time $\tau_1$ of its initiation. In return the buyer is able to create synergies and so increases the target's cash flow $x$, and as a consequence its value $V(x)$, by the factor $\Theta > 1$. Due to the necessity of the acquirer to retain the target firm's human capital and its efforts more broadly, for example to maintain relationships with customers and to prevent the interruption of new product development, these synergies critically depend on the post-takeover cooperation of the target. Obviously, cooperation is not costless, so let $I_C \in \mathbb{R}^+$ denote the cooperation costs of the target. We model the synergies as a positive, monotonous increasing and concave function of these cooperation costs. Specifically,

$$\Theta(I_C) = \theta_1 + (1 + I_C)^{\theta_2}, \tag{3}$$

where $\theta_1 \in \mathbb{R}^+$ and $0 \leqslant \theta_2 < 1$. The fixed component $\theta_1$ reflects synergies that arise independent of the target's cooperation, whereas the variable part $(1 + I_C)^{\theta_2}$ accounts for those synergies that are conditional upon the post-takeover cooperation of the target. Because such efforts are not directly observable by the acquirer, they cannot be contractually fixed with certainty, so a potential moral hazard problem arises. Specifically, the moral hazard problem is increasing with $\theta_2$, whereby $\theta_2 = 0$ would mean that there is not any moral hazard problem. However, the use of an earnout contract that consists of a two part payment structure can reduce the moral hazard problem (e.g. Krug and Hegarty, 2001; Kohers and Ang, 2000).

The buyer pays the target an upfront payment $I \in \mathbb{R}$ at the time $\tau_1$ of the acquisition. Additionally, the target gets a single payment (the earnout-payment $Q \in \mathbb{R}^+$) if its cash flow meets some pre-specified performance benchmark $\Omega \in \mathbb{R}^+$ at the end of a pre-specified time period of length $T \in \mathbb{R}^+$. Thus, at time $\tau_2 := \tau_1 + T$ the buyer has to pay the target $Q\mathscr{H}(\Theta(I_C)x(\tau_2) - \Omega)$ where $\mathscr{H}(\ldots)$ denotes the Heaviside function, which takes the value of one when its argument is positive and zero otherwise. If the target cooperates, the synergies can increase and the benchmark is more likely to be met. Therefore, the earnout-structure of the deal gives the target an incentive to cooperate in the post-takeover phase. However, a higher earnout payment $Q$ will also increase the transaction costs, for example accountants and lawyers are paid per rata. Therefore, we model the transaction costs as a positive and monotonous increasing function of the earnout payment. We choose

$$I_T(Q) = \bar{I}_T + Q\tilde{I}_T, \tag{4}$$

with $\bar{I}_T, \tilde{I}_T \in \mathbb{R}^+$. Here $\bar{I}_T$ reflects the fixed transaction costs and $Q\tilde{I}_T$ reflects the transaction costs that depend on the earnout payment $Q$. We assume that the upfront payment as well as the earnout payment, if it is paid, represent sunk costs to the buyer and the cooperation costs represent sunk costs to the target.

The fundamental time steps within the model are illustrated in Fig. 1. The model starts at $\tau_0 = 0$ with the negotiations between the buyer and the seller. As we will see in Section 3.3, both parties negotiate cooperatively and it is optimal for them to wait with the initiation of the deal until the target's cash flow $x(t)$ reaches a threshold value $x^*$. Hereby, the optimal timing $\tau_1^*$ of the acquisition is determined. At the same time the synergies are created and the earnout period of length $T$ starts. Furthermore, as we will see in Section 3.2, the target is choosing its optimal cooperation level $I_C^*$ immediately after $\tau_1^*$. At $\tau_2$, the end of the earnout period, the buyer has to pay the earnout premium, if the performance benchmark $\Omega$ is met.

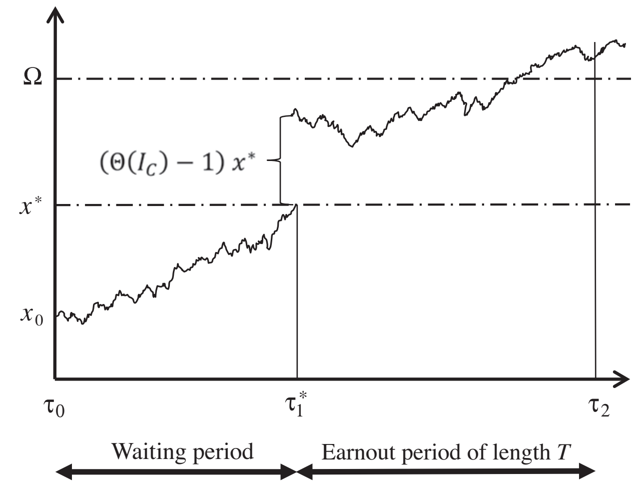


**Fig. 1.** An overview on the fundamental time steps of the earnout model.

In the following sections the corresponding investment decision problem is solved recursively by means of dynamic programming. Hence, we will begin with the derivation of the earnout option value in stage three. In stage two, we will analyze the decision of the target regarding its optimal cooperation level, i.e. the amount of cooperation costs it bears. In stage one, we will analyze the game-theoretic timing and implementation of the earnout deal.

### *3.1. Stage 3: Earnout payment*

Due to the contingent payment feature of an earnout, it can be interpreted as an option written on the underlying target cash flow $x(t)$. Ruling out arbitrage opportunities, the associated return on the earnout option value $F$ has to equal its expected increase in value $\mathbb{E}[dF]$. Put formally, the Bellmann equation results in:

$$rFdt = \mathbb{E}[dF]. \tag{5}$$

Applying Itô's Lemma we get the following partial differential equation:

$$\frac{1}{2}\sigma^2 F_{xx} + \alpha F_x - rF + F_t = 0, \tag{6}$$

In order to derive a solution for $F(x, t)$, with $\tau_1 \leqslant t \leqslant \tau_2$, we have to consider the following boundary conditions:

$$F(x, \tau_2) = Q\mathscr{H}(\Theta(I_C)x(\tau_2) - \Omega), \tag{7}$$

$$F(0, t) = 0. \tag{8}$$

Eq. (7) states that the earnout option generates a single payment of size $Q$ once the pre-specified target at $t = \tau_2$ is met, i.e. $\Theta(I_C)x(\tau_2) \geqslant \Omega$. Otherwise, the earnout option expires worthless. As an illustration, the earnout clause implemented in the Ebay-Skype transaction had a cash-or-nothing option like feature. That is, a single cash payment is made, contingent on the future cash flow development of Skype (Caselli et al., 2006). Certainly, other payment profiles are possible, but this would only increase the complexity without changing the general findings.

In order to account for the retention feature of earnouts, we will rely upon the pricing of corporate incentive stock option arrangements. In such settings the options are assumed to start either at-, out-, or in-the-money. Hence, we will assume that the option starts out-of-the money and that the cash flows have to increase by $((\psi - 1)\cdot\ 100)$-percent with $1 < \psi$ to get at the money. Thus, the buyer has to make the cash payment only if the uncertain cash flow is greater than $\Omega = \psi x(\tau_1)$ at the end of the period $[\tau_1, \tau_2]$ of length $T$. Consequently, solving Eq. (6) for $F$ yields[3]:

$$F(x,t) = e^{-r(\tau_2 - t)} Q N(d(x,t)), \tag{9}$$

with $N(\ldots)$ as the cumulative distribution function (cdf) of the normal distribution and

$$d(x,t,I_C) = \frac{(\Theta(I_C) - \psi)x + \alpha(\tau_2 - t)}{\sigma\sqrt{(\tau_2 - t)}}. \tag{10}$$

### 3.2. Stage 2: Optimal cooperation level

Directly after the acquisition occurs at $\tau_1$, the target aims to maximize $QN(d(x, \tau_1, I_C))e^{-rT} - I_C$ by choosing its optimal cooperation level $I_C^*$. Here $N(d(x, \tau_1, I_C))$ is the probability that the earnout payment is paid and $e^{-rT}$ discounts the earnout payment on its value at the time of the acquisition. The optimal cooperation level $I_C^*$ therefore is zero or it is the solution to the equation

$$\frac{\partial}{\partial I_C}(QN(d(x,\tau_1,I_C))e^{-rT} - I_C) = 0, \tag{11}$$

which is equivalent to

$$Qn(d(x,\tau_1,I_C))e^{-rT}\Theta'(I_C)\frac{x}{\sigma\sqrt{T}} - 1 = 0, \tag{12}$$

with $n(\ldots)$ as the probability density function (pdf) of the normal distribution.[4] Hence, $I_C^*(Q,x)$ can be interpreted as an implicit function of the earnout payment and the cash flow.

### 3.3. Stage 1: Timing and deal structuring decisions

In the first stage, i.e. at time $\tau_0 = 0$, the acquirer and the target have to agree on the terms of the takeover, i.e. they have to agree on the timing $\tau_1$ of the takeover, the amount $Q$ of the earnout payment and the amount $I$ of the upfront payment. We will assume that the parameter $\psi$ of the performance benchmark and the length $T$ of the earnout period are given exogenously.[5] Furthermore, we assume for simplicity that the acquisition can be exercised at any time and that its possibility exists infinitively long.[6] Although both parties know that the target will choose the cooperation level $I_C^*(Q,x)$ non-cooperatively, nevertheless it is optimal for both companies to decide cooperatively about the terms of the takeover taking into account that the target will choose the cooperation level $I_C^*(Q,x)$.[7] Combining the previous results and considerations we get the following lemma:

**Lemma 1.** *Performed at time $\tau_1$ the takeover generates a combined surplus of*

$$((\Theta(I_C^*(Q,x(\tau_1))) - 1)V(x(\tau_1)) - I_C^*(Q,x(\tau_1)) - I_T(Q))e^{-r\tau_1},$$

*which has to be maximized by the optimal choice of $Q$ and $\tau_1$, which will be denoted as $Q^*$ and $\tau_1^*$.*

However, following real option theory the possibility to perform the takeover is an option to invest, where $I_T(Q)$ and $I_C^*(Q,x(\tau_1))$ represent the sunk investment costs. Hence, it pays to wait for new information and to perform the acquisition as soon as the target's cash flow reaches a critical threshold $x^*$.

Since the option to invest, i.e. $f(x)$ does not provide current cash flows, its only benefit is a capital gain. Thus, in the continuation region the Bellman equation results in:

$$rf\,dt = \mathbb{E}[df]. \tag{13}$$

Applying Itô's Lemma and the following two transformations $df/dV = df/dx \cdot dx/dV$ and $d^2f/dV^2 = d^2f/dx^2 \cdot r^2$ to Eq. (13) yields:

$$\frac{1}{2}\sigma^2 f_{xx} + \alpha f_x - rf = 0. \tag{14}$$

The solution to Eq. (14) is of the form $f(x) = A_1 e^{\lambda_1 x} + A_2 e^{\lambda_2 x}$ with $A_1, A_2$ as constants to be defined and $\lambda_{1,2} = -(\alpha/\sigma^2) \pm \sqrt{(\alpha/\sigma^2)^2 + 2r/\sigma^2}$ where $0 < \lambda_1$ and $\lambda_2 < 0$.

For cases in which the net cash flow becomes infinitely negative, the value of the option to invest into the target becomes zero. Hence:

$$\lim_{x\to-\infty} f(x) = 0, \tag{15}$$

and as a consequence $A_2 = 0$. Following Dixit and Pindyck (1994) the option to invest should be given up once no additional gain is possible due to further postponement. With $x^*$ as the critical cash flow level that triggers investment, it follows that the optimal acquisition timing is

$$\tau_1^* = \inf\{t \geqslant \tau_0 | x(t) \geqslant x^*\}, \tag{16}$$

and that the following conditions have to hold:

$$f(x^*) = (\Theta(I_C^*(Q,x^*)) - 1)V(x^*) - I_C^*(Q,x^*) - I_T(Q), \tag{17}$$

$$f_x(x^*) = \frac{\partial}{\partial x^*}((\Theta(I_C^*(Q,x^*)) - 1)V(x^*) - I_C^*(Q,x^*)). \tag{18}$$

Eqs. (17) and (18) are the value matching and smooth-pasting conditions, respectively. Eq. (17) indicates that upon exercising the option the parties receive the synergy value $(\Theta(I_C^*(Q,x^*)) - 1)V(x^*)$. In return they have to pay the transaction costs and cooperation costs. Upon solving equation (15) under the boundary conditions (17) and (18) we get

$$\begin{aligned} f(x) = {} & (((\Theta(I_C^*(Q,x)) - 1)V(x) - I_C^*(Q,x) - I_T(Q)))\mathscr{H}(x \geqslant x^*) \\ & + (((\Theta(I_C^*(Q,x^*)) - 1)V(x^*) - I_C^*(Q,x^*) \\ & - I_T(Q))e^{\lambda_1(x-x^*)})\mathscr{H}(x < x^*). \end{aligned} \tag{19}$$

Combining Lemma 1 and Eq. (19) we can state our first proposition:

**Proposition 1.** *To get a Pareto-efficient earnout deal, the parties have to choose $Q^*$ and $x^*$ in a way to get*

$$\max_{Q,x}(((\Theta(I_C^*(Q,x)) - 1)V(x) - I_C^*(Q,x) - I_T(Q))e^{\lambda_1(x_0 - x)}),$$

[3] Eq. (6) represents a linear parabolic differential equation. Appropriate transformation rules, i.e. $\Lambda = \sigma^2(\tau_2 - t)$ and $u(x, \Lambda) = e^{(\kappa\Lambda + \eta x)}F(x, \Lambda)$ with $\eta = \frac{\alpha}{\sigma^2}$ and $\kappa = \frac{1}{\sigma^2}\left(\frac{\alpha^2}{2\sigma^2} + r\right)$ reduce the problem to solving the classical heat equation, i.e. $u_\Lambda = 1/2u_{xx}$. A detailed derivation of the results is provided by the authors on request (see also Navin, 2007, p. 81ff).

[4] In general the optimal cooperation level of the target is neither optimal for the acquirer nor socially efficient.

[5] Maybe they are determined by technical or practical reasons or they have already been negotiated by the parties. However, we analyze the consequences of changes in $\psi$ and $T$ in Section 4.

[6] Of course, in a typical contracting situation both parties are well aware of the fact that the pre-acquisition phase cannot be infinitely long. However, since the parties do not know ex ante how long it will take to settle the deal the problem is not only similar to a situation with an uncertain stopping time but also with uncertain time to maturity as well. One way to implement a stochastic time to maturity would be to introduce a Poisson-process in stage one of the model. This approach could accommodate random events affecting negotiation processes, such as a target closing a deal with a competing bidder. For an implementation of a Poisson-process in the real option framework see e.g. Martzoukos and Trigeorgis (2002) and Pennings and Lint (1997).

[7] Every non-cooperative solution cannot generate a greater combined surplus than the Nash-bargaining solution Nash (1950) which is Pareto-efficient. Because the parties can negotiate any upfront payment it is possible to generate to every given outcome of a non-cooperative negotiation a cooperative solution that generates for both parties at least the same surplus.

*which is the maximal expected combined surplus of both parties.*

Now, we can consider the exact payoffs of both parties. Let $f_B(x_0, Q^*, x^*)$ and $f_T(x_0, Q^*, x^*)$ denote the option value at time $\tau_0$ of the possibility to perform the acquisition of the buyer and the target respectively. For the buyer we get

$$f_B(x_0,Q^*,x^*) = ((\Theta(I_C^*(Q^*,x_0))V(x_0) - F(Q^*,x_0) - I_T(Q^*) - I))\mathscr{H}(x_0 \geqslant x^*) + ((\Theta(I_C^*(Q^*,x^*))V(x^*) - F(Q^*,x^*) - I_T(Q^*) - I)e^{\lambda_1(x_0-x^*)})\mathscr{H}(x_0 < x^*) \quad (20)$$

and for the target we get

$$f_T(x_0,Q^*,x^*) = ((-V(x_0) + F(Q^*,x_0) - I_C^*(Q^*,x_0) + I))\mathscr{H}(x_0 \geqslant x^*) + ((-V(x^*) + F(Q^*,x^*) - I_C^*(Q^*,x^*) + I)e^{\lambda_1(x_0-x^*)})\mathscr{H}(x_0 < x^*), \quad (21)$$

with $F(Q^*, x^*)$ as the expected value of the earnout payment discounted based on the timing of the acquisition (see Eq. (9)). Of course, we have

$$f(x_0,Q^*,x^*) = f_B(x_0,Q^*,x^*) + f_T(x_0,Q^*,x^*). \quad (22)$$

The optimal upfront payment $I^*$ is now determined by means of the Nash-bargaining game. In particular, we have to solve $\max_I \{f_B(x_0, Q^*, x^*, I) f_T(x_0, Q^*, x^*, I)\}$ under the boundary condition of Eq. (22).[8] It follows that $f_B(x_0, Q^*,x^*) = f_T(x_0,Q^*,x^*)$. Inserting Eqs. (20) and (21) into this result and solving for $I$ yields the optimal upfront payment $I^*$. The following proposition summarizes the solution:

**Proposition 2.** *The optimal upfront payment is*

$$I^*(x_0,Q^*,x^*) = \left(\frac{(\Theta(I_C^*(Q^*,x_0))+1)V(x_0)+I_C^*(Q^*,x_0)-I_T(Q^*)}{2} - F(Q^*,x_0)\right)\mathscr{H}(x_0 \geqslant x^*) + \left(\frac{(\Theta(I_C^*(Q^*,x^*))+1)V(x^*)+I_C^*(Q^*,x^*)-I_T(Q^*)}{2} - F(Q^*,x^*)\right) \times \mathscr{H}(x_0 < x^*). \quad (23)$$

## 4. Comparative static results

Unless noted otherwise we will assume the following values: $r = 0.05$, $\alpha = 0.03$, $\sigma = 0.2$, $\psi = 2$, $T = 2$, $x_0 = 1$, $\theta_1 = 0.2$, $\theta_2 = 0.25$, $\bar{I}_T = 0.25$ and $\tilde{I}_T = 0.1$. As we have seen, the parties will initiate the M&A deal once the observed asset value $x(t)$ hits an optimal threshold $x^*$. As illustrated by Fig. 2, $x^*$ increases the higher the uncertainty of the target's performance and the higher the transaction costs $I_T$. This is due to two effects. First, under uncertainty it pays to wait for new information because making an irreversible investment too early has opportunity costs. Consequently, the more uncertain the target firm's performance, the stronger the tendency of the parties to postpone the acquisition and to wait for new information. The same line of reasoning follows for an increase in $I_T$. Second, for moderate earnout periods $T$ an increase of $\sigma$ raises the probability that the performance benchmark will be met, i.e. $N(d)$ will increase, and that the target management claims the earnout payment in the future.

Although we observe a strict monotonous increasing effect of $\sigma$ on $x^*$, the impact of the increased $N(d)$ on $x^*$ is in general ambiguous (see Fig. 3). As can be seen by Eq. (11) the higher probability of reaching the performance benchmark reduces the necessity of the target to cooperate. Thus, $I_C^*$ decreases. As a direct consequence the synergy coefficient $\Theta$ decreases as well (see Eq. (3)). Following Eq. (11) this can only be compensated by an increased earnout premium $Q^*$, which results in higher transaction costs (see Eq. (4)). Moreover, lower synergies as well as higher sunk costs reduce the combined surplus of the acquisition. Hence the settlement of the deal is postponed, i.e. $x^*$ and therefore $\tau_1^*$ increase. In contrast, as the cooperation costs are also sunk costs, the decreasing $I_C^*$ is increasing the combined surplus of the acquisition. Therefore, $x^*$ decreases. Thus, depending on the model's parameters an increasing probability $N(d)$ either leads to an increase or a decrease of the timing threshold $x^*$.

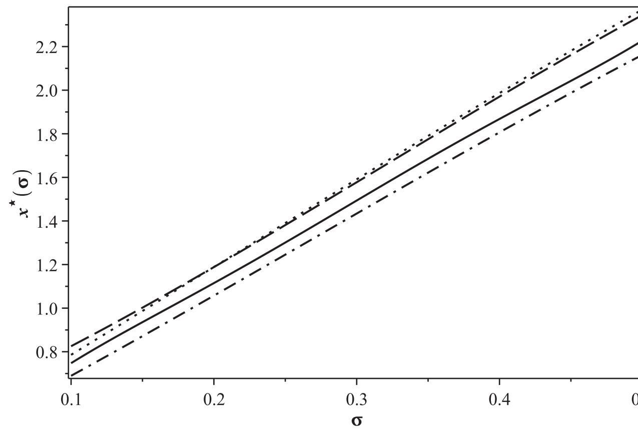


**Fig. 2.** The impact of $\sigma$ on $x^*$. Base case (solid line); increased earnout period, i.e. $T = 4$ (dot line); increased benchmark, i.e. $\psi = 2.2$ (dash line); lower transaction costs, i.e. $\bar{I}_T = \tilde{I}_T = 0.05$ (dash-dot line).

Furthermore, the target's cash flows are modeled as an arithmetic Brownian motion (see Eq. (1)). As a consequence, for every $t_a > 0$, the probability of the cash flow growing by a factor $\kappa > 1$ in a given time period $[t_a, t_b]$ depends on the starting level $x(t_a)$ of the cash flow. More precisely, this probability is higher for lower values of $x(t_a)$. Written formally, we get

$$\frac{\partial}{\partial x(t_a)} Prob\left(\frac{x(t_b)}{x(t_a)} > \kappa\right) \leqslant 0. \quad (24)$$

The impact of an increased probability that the earnout payment has to be paid, i.e. $N(d) = Prob\left(\frac{\Theta x(\tau_2)}{x^*} > \psi\right)$, on the investment threshold $x^*$ is in general ambiguous, as we have seen above. However, it is also important to note, as Fig. 3 demonstrates, that the investment threshold $x^*$ has a feedback effect on the likelihood that the earnout payment is paid, such that the effect of $N(d)$ on $x^*$ is either amplified (attenuated) because a lower (higher) level $x(\tau_1^*) = x^*$ of cash flow level at the beginning of the earnout period will further increase (decrease) the likelihood that the earnout has to be paid, i.e. $N(d)$. These amplification and attenuation effects of

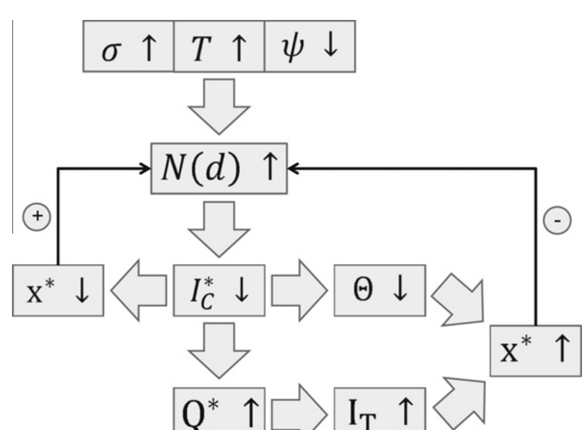


**Fig. 3.** The implications of an increasing probability that the earnout premium has to be paid.

[8] If we would assume different bargaining powers of the buyer and the seller, the upfront payment would be determined by the asymmetric Nash-bargaining solution $\max_I\{f_B(x_0,Q^*,x^*,I)^{\gamma_B} f_T(x_0,Q^*,x^*,I)^{\gamma_T}\}$, where $\gamma_B$ and $\gamma_T$ are the relative bargaining powers of the buyer and the target, respectively.

$N(d)$ on $x^*$ are represented by the positive (+) and negative (−) signs in Fig. 3.

Moreover, the probability $N(d)$ that the cash flow development will fit or outperform the negotiated performance requirements also increases if the earnout period $T$ becomes longer or if the performance benchmark $\psi$ decreases (see Eq. (9)). As can be seen in Fig. 2, a longer earnout period as well as a higher performance benchmark result in an increased threshold $x^*$. This depicts once more the aforementioned ambiguity. If an increased probability to pay the earnout premium is driven by an increase in the length of $T$ we observe that optimal timing of the deal is further postponed. In contrast, if an increased probability to pay the earnout premium is driven by a decrease of the performance benchmark $\psi$ the opposite effect is observed (see also Fig. 3).

As Eq. (18) indicates the possibility of implementing the acquisition represents an option to the parties. In particular, at date $\tau_0$ the firms have the option to optimally initiate the acquisition $\tau_1$ years from now. Here, $\tau_1$ denotes the optimal stopping time (see Eq. (16)), given the aforementioned optimal investment threshold $x^*$. Ceteris paribus, the corresponding option value $f(x)$ is a convex function of the underlying asset value. Thus, an increase in the cash flows increases the option value. Moreover, any increase in either the transaction costs or the cooperation costs increases the overall sunk costs and therefore results in a decrease in the overall option value. The effect of an increase in uncertainty, however, is nonmonotonic (see Fig. 4). First, the option value will increase as uncertainty increases. This is due to the fact that any increase in uncertainty raises the time value of the option, i.e. the opportunity cost of giving up the right to wait. Here, however, an increase in uncertainty affects not only the time value of the option but also its intrinsic value, i.e. the size of the overall sunk costs. Consequently a mixed effect is observed. Further, we see that the option value is negatively affected by the length of time the earnout payment can be deferred and positively affected by the amount of the performance benchmark $\psi$.

Recent literature has highlighted the great variety that exists in the structuring of acquisitions using earnouts. In the following discussion, we explain some of the factors that shape the choice of $I$ and $Q$. Under considerable cash flow uncertainty, an increase in uncertainty results in an increase of the overall option value. As both parties have to share this surplus we can expect that $I$ and $Q$ will increase in uncertainty, too (see also Table 1). Furthermore, as Table 1 indicates, for an initial uncertainty of 20%, roughly 67% of the total deal is paid upfront while 33% of the deal is subject to the future performance of the target firm. If the cash flows of the target firm are characterized by a much higher uncertainty, e. g. 60%, then the buyer will only have to pay 60% upfront. The earnout deal represents now 40% of the deal. The underlying economic rationales are again the dependencies shown in Fig. 3: An increase in uncertainty increases the probability that the earnout premium has to be paid and thus decreases the optimal cooperation level of the target and as a consequence the synergies of the acquisition, too. Since we have structured the problem along a Nash equilibrium, the only way to maintain otherwise decreasing synergies is an additional increase of $Q^*$. Hence, we will observe higher earnout ratios, i.e. $Q/(I + Q)$, in relatively uncertain industries. These results lead to the first hypothesis:

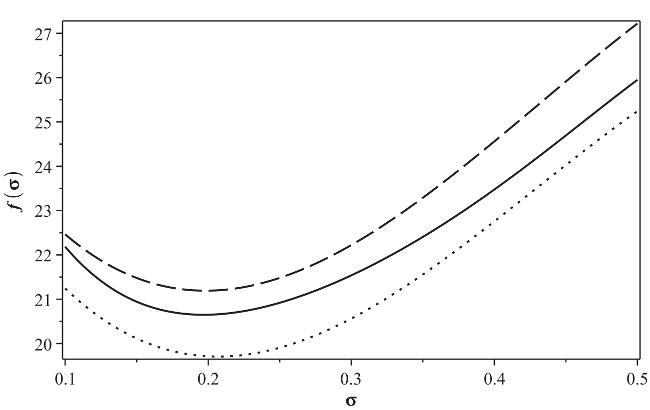


**Fig. 4.** The impact of $\sigma$ on the overall option value $f$. Base case (solid line); increased earnout period, i.e. $T = 4$ (dot line); increased benchmark, i.e. $\psi = 2.2$ (dash line).

**Table 1**
The impact of $\sigma$ on the optimal choice of $x^*, I_C^*, Q^*, I^*$ and on the earnout ratio (EOR).

| $\sigma$ | $x^*$ | $I_C^*$ | $Q^*$ | $I^*$ | EOR |
|---|---|---|---|---|---|
| 0.2 | 1.12 | 11.4 | 21.3 | 44.1 | 0.33 |
| 0.3 | 1.50 | 13.7 | 30.0 | 55.9 | 0.35 |
| 0.4 | 1.87 | 15.6 | 38.9 | 67.1 | 0.37 |
| 0.5 | 2.23 | 17.3 | 48.1 | 77.6 | 0.38 |
| 0.6 | 2.58 | 18.8 | 57.5 | 87.7 | 0.40 |

**Hypothesis 1.** Ceteris paribus, the higher the uncertainty of the target's cash flow the higher the initial payment, the earnout premium and the earnout ratio.

As alluded to earlier, the length of the earnout period affects the structuring of acquisition deals as well. Table 2 highlights that an increase in $T$ will result in a decrease of the initial payment. Likewise, an increase of the earnout payment is observed. In general, this effect is based on the same forces that determined the size of $I$ and $Q$ in the case of an increase of uncertainty, keeping in mind that in contrast to the latter, an increase in the length of the earnout period erodes the overall value $f(x)$ of the option.[9] Therefore, the "pie" that has to be shared by the parties is shrinking, leading to a lower gain for both parties. Thus, one would expect that the target would get a lower payment in general, i.e. $I$ and $Q$ should decrease if the length $T$ of the earnout period increases. However, we observe that only $I$ decreases while $Q$ increases. This is due to the fact that $T$ increases the incentive to negotiate a higher $Q$ because the probability to receive the earnout increases (see Fig. 3).

As Table 2 reveals, the initial payment will decrease by 12% once the earnout period is prolonged from 2 to 6 years, while the earnout premium increases by 82% thus raising the earnout ratio from 33% to 50%. To conclude, the results suggest that high earnout payments should be observed in combination with long earnout periods. The following hypothesis summarizes the findings:

**Hypothesis 2.** Ceteris paribus, the higher the earnout period the lower the initial payment and the higher the earnout premium and the earnout ratio.

Another important parameter of the earnout contract is the performance benchmark. In the context of the model, any increase in $\psi$ will decrease the probability that the future performance requirements are fulfilled. Consequently, Table 3 reveals that an increase in $\psi$ also increases the initial payment and reduces the earnout payment as well as the earnout ratio. Again this effect is based on the same forces that determined the size of $I$ and $Q$ in the case of an increase of uncertainty (see Fig. 3). Hence, we derive the following hypothesis:

[9] Under considerable cash flow uncertainty, increasing uncertainty is resulting in a higher option value $f$. Hence, the "pie" that has to be shared by the parties is growing, leading to a higher gain for both parties. As a consequence, we expect that the target gets higher payments, i.e. $I$ and $Q$ should increase if uncertainty increases. In contrast, an increasing length $T$ of the earnout period is eroding the option value $f$.

**Table 2**
The impact of $T$ on the optimal choice of $x^*, I_C^*, Q^*, I^*$ and on the earnout ratio (EOR).

| $T$ | $x^*$ | $I_C^*$ | $Q^*$ | $I^*$ | EOR |
|---|---|---|---|---|---|
| 2 | 1.12 | 11.4 | 21.3 | 44.1 | 0.33 |
| 3 | 1.16 | 11.4 | 26.3 | 42.5 | 0.38 |
| 4 | 1.19 | 11.2 | 30.7 | 41.2 | 0.43 |
| 5 | 1.22 | 11.1 | 34.9 | 39.9 | 0.47 |
| 6 | 1.25 | 10.9 | 38.8 | 38.7 | 0.50 |

**Table 3**
The impact of $\psi$ on the optimal choice of $x^*, I_C^*, Q^*, I^*$ and on the earnout ratio (EOR).

| $\psi$ | $x^*$ | $I_C^*$ | $Q^*$ | $I^*$ | EOR |
|---|---|---|---|---|---|
| 1.6 | 0.96 | 6.3 | 25.0 | 23.8 | 0.51 |
| 1.7 | 1.00 | 7.4 | 24.1 | 29.0 | 0.45 |
| 1.8 | 1.04 | 8.7 | 23.1 | 34.2 | 0.40 |
| 1.9 | 1.08 | 10.1 | 22.1 | 39.2 | 0.36 |
| 2.0 | 1.12 | 11.4 | 21.3 | 44.1 | 0.33 |

**Hypothesis 3.** Ceteris paribus, the higher the required performance increase of the target's cash flows, the higher the initial payment and the lower the earnout premium and the earnout ratio.

Finally, it is noteworthy that in absence of any moral hazard problem (i.e. $\theta_2 = 0$), the earnout ratio will be zero. In particular, if $\theta_2 = 0$, we see that Eq. (3) results in $\Theta(I_C) = \theta_1 + 1$. Hence, the synergies do no longer depend on the cooperation costs $I_C$. Thus, we have $\Theta'(I_C) = 0$ which implies that Eq. (12) has no solution. Consequently, $I_C^* = 0$ and therefore $I_C^*$ does no longer depend on the optimal earnout payment $Q^*$. From Proposition 1 we can conclude that in this case an earnout payment greater than zero will generate no positive value but increases the transaction costs $I_T(Q)$ (see also Eq. (4)). Hence, the optimal earnout payment and the earnout ratio are zero, respectively. This means that a limiting case of the model is a simple acquisition.

## 5. Conclusion

Numerous contracting practices have evolved to reduce some of the exchange hazards and uncertainties inherent in M&A transactions. Contingent earnouts in particular have recently attracted attention in the M&A domain. Recent empirical literature has revealed some of the conditions that make earnouts attractive, yet analytical modeling using options theory offers the potential to shed light on the structuring of earnout deals and the drivers of these deal structures. In particular, critical questions have been left unaddressed, such as what influences the right balance between initial payment and the variable payment or how the structure of the earnouts facilitates acquisitions and influences takeover timing. The model presented in this paper is a first attempt to approach these issues formally by taking the option feature of earnout payments explicitly into account. The findings reveal that an earnout is not costless to the acquirer as quite often assumed, even if structured to be out of the money at the time of the settlement. Rather, the associated costs increase significantly if significant uncertainty exists over the target firm's future value. With respect to M&A timing, the results indicate that the parties will tend to postpone the M&A settlement the larger the transaction costs, the greater the uncertainty of the targets cash flows, and the longer the earnout period, while lower performance benchmarks stimulate earlier investment. In addition, the paper addresses several issues germane to optimal contract design in the acquitions context. The results show that an increase in uncertainty leads to an increase in the earnout ratio of the deal. The same effect is observed if the earnout period is prolonged. An increase in the performance benchmark, however, leads to a lower earnout ratio.

While this study provides new opportunities for further empirical research under an option framework, it is not without several limitations that might be addressed in future research. First, earnout payments can take on other forms than single future payments. In particular, Caselli et al. (2006) note that some earnout deals have features of a simple call option with a capped pay-off profile. Furthermore, the deferred payments can be made in the form of stock payments rather than settled with cash. Second, buyers and targets may negotiate several earnout payments during the earnout period. Hence, multiple future contingency payments at different benchmark levels might be considered. One way to implement the latter feature would be to replace the subsequent binary option by a ratchet option. Here, multiple targets can be defined during the maturity of this type of option. Third, differentiating between the asset dynamics of acquirer and target, for instance by using two stochastic processes, would be an additional promising direction to account for synergies and related information uncertainties regarding M&A deals (e.g. Shibata, 2008). Clearly, the game-theoretic negotiations, the resulting valuation formula and the corresponding comparative static analysis are markedly more complex than those in this study. Finally, beyond addressing alternative earnout structuring alternatives and their wealth effects, future studies might empirically examine these topics of acquisition timing and the structuring of such deals.

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## References

Bruner, R.F., Stiegler, S., 2001. Technical Note on Structuring and Valuing Incentive Payments in M&A: Earnouts and Other Contingent Payments to the Seller. Working Paper, Darden Graduate School of Business Administration, University of Virginia.
Cain, M.D., Denis, D.J., Denis, D.K., 2011. Earnouts: a study of financial contracting in acquisition agreements. Journal of Accounting and Economics 51, 151–170.
Caselli, S., Gatti, S., Viscotti, M., 2006. Managing M&A risk with collars, earn-outs, and CVRs. Journal of Applied Corporate Finance 18, 91–104.
Clark, E., Easaw, J.Z., 2007. Optimal access pricing for natural monopoly networks when costs are sunk and revenues are uncertain. European Journal of Operations Research 178, 595–602.
Dari-Mattiacci, G., Onderstal, S., Parisi, F., 2010. Inverse Adverse Selection: The Market for Gems. Amsterdam Center for Law & Economics Working Paper No. 2010-04.
Datar, S., Frankel, R., Wolfson, M., 2001. Earnouts: the effect of adverse selection and agency costs on acquisition techniques. Journal of Law, Economics and Organization 17, 201–238.
Del Roccili, J.A., Fuhr, J.P., 2001. The pros and cons of earnouts. Journal of Financial Service Professionals 55, 88–93.
Dixit, A., Pindyck, R.S., 1994. Investment Under Uncertainty. Princeton Press, Princeton.
Hackbarth, D., Morellec, E., 2008. Stock returns in mergers and acquisitions. Journal of Finance 63, 1213–1252.
Kim, K.H., Hwang, S.T., Oh, H.S., Lee, D.J., 2008. The impact of investment lags on investment decision. European Journal of Operations Research 190, 696–707.
Kohers, N., Ang, J., 2000. Earnouts in mergers: agreeing to disagree and agreeing to stay. Journal of Business 73, 445–476.
Kort, P., Murto, P., Pawlina, G., 2010. Uncertainty and stepwise investment. European Journal of Operations Research 202, 196–203.
Krug, J.A., Hegarty, W.H., 2001. Predicting who stays and leaves after an acquisition: a study on top managers in multinational firms. Strategic Management Journal 22, 185–196.
Lambrecht, B.M., 2004. The timing and terms of mergers motivated by economies of scale. Journal of Financial Economics 72, 41–62.
Margrabe, W., 1978. The value of an option to exchange one asset for another. Journal of Finance 33, 177–186.
Martzoukos, S.H., Trigeorgis, L., 2002. Real (investment) options with multiple sources of rare events. European Journal of Operations Research 136, 696–706.
Morellec, E., Zhdanov, A., 2005. The dynamics of mergers and acquisitions. Journal of Financial Economics 77, 649–672.

Myers, S.C., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147–175.
Myers, S.C., 1987. Finance theory and financial strategy. Midland Corporate Finance Journal 5, 6–13.
Nash, J.F., 1950. The bargaining problem. Econometrica 18, 155–162.
Navin, R.L., 2007. The Mathematics of Derivatives. Wiley, Hoboken.
Pawlina, G., 2002. Real options valuation of managerial flexibility in optimally structured M&A deals. M&A Review 11, 568–575.
Pennings, E., Lint, O., 1997. The option value of advanced R&D. European Journal of Operations Research 103, 83–94.
Pennings, E., Lint, O., 2000. Market entry, phased rollout or abandonment? A real option approach. European Journal of Operations Research 124, 125–138.
Ragozzino, R., Reuer, J.J., 2009. Contingent earnouts in acquisitions of privately-held firms. Journal of Management 35, 857–879.
Shibata, T., 2008. The impacts of uncertainties in a real options model under incomplete information. European Journal of Operations Research 187, 1379–1386.
Trigeorgis, L., 1996a. Real Options: Managerial Flexibility and Strategy in Resource Allocation. MIT Press, Cambridge.
Trigeorgis, L., 1996b. Evaluating leases with complex operating options. European Journal of Operations Research 91, 315–329.