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Acquiring a Company: Assessing the Maximum Affordable Price

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In this paper, a potential purchaser (valuation object) is interested in acquiring a company (valuation object), pursuing wealth maximisation. Thereby, he acts in a real imperfect market. Having weighed the pros and cons of the purchase and basically agreed to engage in the transaction, the buyer enters into price negotiations. In order to sustain his economic interest, he must conduct a business valuation that assesses the maximum affordable price. The buyer may afford to pay this critical price without being put in a worse situation than if the purchase had not occurred. The purpose of our paper is to introduce an innovative way to fulfil the described valuation task by applying the so-called "state marginal price model" under realistic imperfect market conditions. We show how removing the short-term credit upper limit alters the critical price of the same company noticeably.

JEL Codes: D46, G31 and G34

1. Introduction

A *business valuation* is based on the future uncertain cash stream expected from the buyer's point of view. The purchase promotes the interest of the potential buyer (valuation subject) as long as the *price* paid for the company (valuation object) does not exceed the *subjective value* he associates with it. The price constitutes the negotiation outcome, whereas the value results from its marginal utility regarding a predefined subjective aim (Baum, Crosby & MacGregor 1996; French 2011). The valuation process depends on the target function (usually wealth or income maximisation) as well as on the decision field, which consists of all the available valuation subject action opportunities.

The adequacy of a given price can only be judged after conducting a business valuation. To avoid any economic disadvantage, the presumptive buyer has to compute the decision value as a *maximum price* (marginal or critical price) he may afford to pay (Laux & Franke 1969; Matschke 1975; Hering 2014; Olbrich, Brösel & Hasslinger 2009; Toll 2011; Hering, Toll & Kirilova 2014). To fulfil this, our research motivation is to introduce an innovative way to conduct an investment theory-based business valuation.

Applying investment theory, models were developed to compute subjective decision value. Those models can either be general, as shown in this paper, or partial. In a perfect capital market, the *Fisher-Separation* (Fisher 1930) would hold and the marginal price would be relatively easily obtained applying a partial model (Hering 2014; Ballwieser & Hachmeister 2013). The future earnings value would then be calculated

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without minding the entire complex valuation subject decision field, as the interest rate would be exogenous. In a real imperfect market, the simultaneous consideration of the interdependent investment, financing, and consumption decisions is inevitable. The valuation subject consumption preference is expressed in the predefined structure of withdrawals and is no longer separable from the money's time value. It affects the temporal distribution and the level of the individual withdrawals as well as the investment and financing decisions. Thus, each period's shadow prices (the endogenous marginal interest rates), which are required for the partial model, can only be determined for the specific conflict situation as a general model solution by-product (Hirshleifer 1958; Dean 1969).

The *purpose* of our paper is to introduce a decision value calculation, which manages to handle the realistic conditions (market imperfections), rather than rely on perfect market assumptions. For the sake of simplicity, all modelling is done under the premise of certainty. The presumptive buyer pursues wealth maximisation.

Our paper is organised as follows: In chapter two the difference from previous studies and the relevance of our paper will be explained. On this basis we introduce an innovative way to determine the decision value for a company acquisition under realistic conditions using the "state marginal price model" in chapter three. To show the proposed company valuation method's practical applicability we will compute an example in chapter four. Finally, chapter five summarises our findings, discusses the limitations of the applied model and concludes the paper with scope for further research.

2. Literature Review

The scientific debate between the advocates of the finance- and the investment-based valuation theories has been going on for more than sixty years (for a comprehensive overview, see Brösel, Toll & Zimmermann 2012). However, the apologists of the *Anglo-Saxon finance-based valuation theory* (e.g., Fisher 1930; Markowitz 1952; Modigliani & Miller 1958; Sharpe 1964; Black & Scholes 1973; Cox, Ross & Rubinstein 1979; Miles & Ezzell 1980; De Angelo 1981; Rodrigues 2013; Trigeorgis & Ioulianou 2013; Sweeney 2014) seem not to acknowledge the existence of a feasible theory for imperfect market conditions. Accordingly, they assume a fictitious perfect market. Subsequently, their methods cannot take into account the individual expectations of the specific valuation subject. Instead, they pursue the futile quest for the one "true" value that has to be generally valid (Hering, Toll & Kirilova 2013). Therefore, they are not able to compute the critical price under realistic market conditions. This valuation task can only be fulfilled using *investment theory-based business valuation methods*. That is why we have introduced an alternative way to conduct a business valuation for a company purchase that considers both existing market imperfections and individual expectations of the presumptive buyer.

In order to calculate the decision value in the context of a *company acquisition*, the state marginal price model will be introduced below (Hering 2014). This model combines the advantages of the mixed integer model of Laux/Franke (1969) with the two-step procedure of Jaensch (1966) and Matschke (1975).

Laux/Franke (1969) calculated the marginal price of a certain cash stream within an imperfect capital market by applying the multi-period simultaneous planning approaches of Hax (1964) and Weingartner (1963). In this manner, they introduced an obviously advantageous price into their linear optimisation model. Subsequently, Laux/Franke

(1969) vary this price parametrically until the change in ownership of the valuation object becomes disadvantageous. This means that the variable representing the company purchase is no longer part of the optimal investment and financing programme (Laux & Franke, 1969). As a result, the model of Laux/Franke (1969) *requires a numerically extensive mixed-integer parametric optimisation*.

The models of Jaensch (1966) and Matschke (1975) handle this problem by determining the decision value in a two-step procedure. *The first step* is to calculate – as a so-called *base programme* – the investment and financing programme, which maximises the target function value (income EN or asset value GW) under unchanged property conditions regarding the valuation object. Subsequently, in a *second step,* the valuation object has to be integrated into the investment programme of the presumptive buyer. Then, the maximum affordable price as an immediate payment is searched. Hence, the decision field is changed by adding the valuation object at a price p and additionally supplemented by the condition that at least the target function contribution of the base programme must be achieved again. The result of this second step is the so-called *valuation programme* with its optimal value p* that indicates the requested upper price limit (i.e. decision value or marginal price).

As opposed to Laux/Franke (1969), the models of Jaensch (1966) and Matschke (1975) *suffer from the blemish* that the imperfect capital market is not considered in the lapse of time. Instead, a single accumulated number of success is assigned to each multi-period investment and financing object (Matschke 1975). The *state marginal price model combines the advantages* of these models in a way that allows to determine the marginal price as an immediate payment under imperfect capital market conditions by setting up a base and a valuation approach without being dependent on the mixed-integer parametric optimisation as the model of Laux/Franke (1969). The English-speaking scientific literature up to now provides only a few papers discussing the marginal price calculus (Hering, Olbrich & Steinrücke 2006; Olbrich, Brösel & Hasslinger 2009; Matschke, Brösel & Matschke 2010; Brösel, Matschke & Olbrich 2012; Hering, Toll & Kirilova 2013). Our paper creates new knowledge by providing a deep case analysis for the applied method. We show how removing the short-term credit upper limit alters the critical price of the same company noticeably.

3. The Methodology and Model

A presumptive buyer is interested which price is acceptable from his point of view. Anglo-Saxon finance-based valuation methods assume a fictitious perfect market and fail to take into account the individual expectations and preferences. Consequently, such methods are not able to calculate the critical price under realistic market conditions. Therefore, we have introduced an innovative way to determine the decision value for a company aquisition under realistic conditions using the "*state marginal price model*" in this chapter. The valuation process depends on the target function as well as on the decision field.

In the following sections it is assumed that the valuation subject pursues the target *wealth maximisation*, wherefore he strives for the greatest possible GW (Hering 2014; Hering 2008; Toll 2011). GW is the sum of the weighted withdrawals $w_t \cdot G_t$ for each point in time t. The weightings w_t reflect the consumption preference of the valuation subject. For an adequate spending opportunity, a fixed income stream can also be considered. The autonomous cash flow b_t results from the predetermined payments (e.g., from current business operations and existing loan obligations) and is independent of the available objects j. To ensure the existence of the company beyond the planning horizon n, the autonomous cash flow b_n has to additionally consider a sufficient terminal asset as a fictive withdrawal. This terminal asset represents the present value of a perpetual annuity and thus allows the continuation of the desired dividend level.

Furthermore, the following assumptions are made: The planning period extends n years, whereas t = 0 defines the valuation and decision point in time. In the baseline situation, investment and financing objects j are available for the valuation subject (j = 1, ..., m). This also includes the opportunity of borrowing money, the opportunity to invest money in financial assets as well as an unlimited cash management. The cash stream of the object j is determined as follows: $\mathbf{g}_j := (g_{j0}, g_{j1}, \ldots, g_{jt}, \ldots, g_{jn})$. Each investment or financing object j could be realised x_j^{max} times. The liquidity constraints have to ensure that at any time t the sum of all cash flows from the realised investment and financing objects as well as from autonomous payments suffice to enable the desired withdrawal. The variables G_t and x_j are limited to non-negative quantities.

The *base programme* (without the company purchase in question) results from the in Figure 1 presented linear optimisation approach “max GW“ (Hax 1964; Franke & Laux 1968; Hering 2008; Brösel, Matschke & Olbrich 2012; Hering, Olbrich & Steinrücke 2006; Matschke, Brösel & Matschke 2010; Lerm, Rollberg & Kurz 2012; Hering, Toll & Kirilova 2013). The simplex algorithm calculates the optimal solution GW*. Acquiring the company at a price p is then only economically viable if the valuation programme yields at least the optimal target function value GW* of the base programme (Hering, 2014). If the presumtive buyer comes in possession of company K, he receives its cash stream $\mathbf{g}_K := (0, g_{K1}, g_{K2}, \ldots, g_{Kt}, \ldots, g_{Kn})$. For this reason, these cash flows g_{Kt} have to be added to the autonomous payments b_t. In exchange he has to pay the price p at time t = 0.

The decision value is then to be determined (Hering, Olbrich & Steinrücke 2006; Brösel, Matschke & Olbrich 2012). The presumptive buyer has to know which price he can just afford, without the acquisition putting him into a worse position than if he had implemented the available base programme. The answer can be found with the help of the valuation approach “max U“ in Figure 1 (Hering 2014; Toll 2011). The simplex algorithm provides not only the critical price p* but also the buyer’s optimal investment and financing programme (*valuation programme*).

Figure 1: base and valuation approach

$\max. GW;\; GW := \sum_{t=0}^{n} w_t \cdot G_t$	$\max. U;\; U := p$	
$-\sum_{j=1}^{m} g_{j0} \cdot x_j + G_0 \le b_0$	$-\sum_{j=1}^{m} g_{j0} \cdot x_j + G_0 + p \le b_0$	
$-\sum_{j=1}^{m} g_{jt} \cdot x_j + G_t \le b_t$	$-\sum_{j=1}^{m} g_{jt} \cdot x_j + G_t \le b_t + g_{Kt}$	$\forall\, t \in \{1, 2, \ldots, n\}$
	$-\sum_{t=0}^{n} w_t \cdot G_t \le -GW^*$	
$x_j \le x_j^{max}$	$x_j \le x_j^{max}$	$\forall\, j \in \{1, 2, \ldots, m\}$
$x_j, G_t \ge 0$	$x_j, G_t, p \ge 0$	$\forall\, j \in \{1, 2, \ldots, m\}$, $\forall\, t \in \{0, 1, 2, \ldots, n\}$

4. Exemplary Presentation and Findings

Now, a *fictitious example* will be conceived in order to illustrate the procedure presented above. To date, the international scientific literature has only provided examples that calculate the maximum affordable price from a company purchaser's point of view (Olbrich, Brösel & Hasslinger 2009; Matschke, Brösel & Matschke 2010; Brösel, Matschke & Olbrich 2012, Hering, Toll & Kirilova 2013). To create knowledge, our paper provides a deep case analysis, showing, how altering one characteristic of the decision field of the presumptive buyer (removing the short-term credit upper limit) alters the critical price of the same company noticeably.

Matter of interest is firm A aspiring to purchase company K. The management forecasts that the acquisition of company K will be accompanied in the planning period (n = 5) by the cash stream (0, 20, 25, 30, 20, 10) and from the sixth year on by a perpetual annuity in the amount of 5 monetary units (MU). At the valuation date t = 0 company A expects that the previous business activity leads to a perpetually arising deposit excess amounting to 100 MU. The perpetual annuities are taken into account in the example, using the generally estimated interest rate of 5% p.a. for t > n = 5, resulting in $\mathbf{g}_K$ = (0, 20, 25, 30, 20, 110) and **b** = (0, 100, 100, 100, 100, 2 100). In order to reduce the complexity of the example, we assume that firm A has only a few investment and finance options. Firstly, at t = 0 company A can invest in a tangible asset (e.g., a modernisation of the existing production lines) which is associated with the payment stream (–160, 15, 15, 15, 15, 315) and can be realised partially. Secondly, firm A is able to invest an unlimited amount of money in financial assets that promise a return of 5% p.a. For financing, a five-year zero-coupon loan is available at t = 0 provided by the local bank at a 7% annual interest rate restricted to 70 MU. Furthermore, company A can debit a revolving line of credit at a short-term interest rate of 12% p.a. restricted to 100 MU. Company A pursues *wealth maximisation*, striving for a maximum terminal asset value EW at the end of the planning horizon n. Thus, the weightings are w_t = 0 for $0 \leq t < n$ and w_n = 1. Furthermore, for t = 1 to 5 A requires a fixed withdrawal in the amount of 90 MU for dividend payout purposes.

In the baseline situation (without the acquisition of company K), the terminal asset value GW* = EW* = 2 202.0318 MU results from the base approach. Table 1 shows the *base programme*. The tangible asset investment is realised completely. Not only the zero coupon loan is fully utilized, but also every year additional short-term financing is required. Consequently there will be no investments in financial assets.

Table 1: Base programme in the case of a credit limit

Time	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
b_t	0	100	100	100	100	2 100
Tangible asset	–160	15	15	15	15	315
Zero coupon loan	70	0	0	0	0	–98.1786
Revolving line	90	75.8	59.896	42.0835	22.1335	
Repayment		–100.8	–84.896	–67.0835	–47.1335	–24.7896
Fixed withdrawal		–90	–90	–90	–90	–90
Account balance	–90	–75.8	–59.896	–42.0835	–22.1335	2 202.0318

In a *second step*, company K, accompanied by the cash stream $\mathbf{g}_K$, has to be integrated into the investment programme of firm A. In exchange company A has to find out which price it can just afford without violating the terminal asset value EW*. According to the valuation approach, this marginal price p* is 97.6261 MU. The complete *valuation* *programme* (Table 2) can be described as follows: Company K is now included obligatory in the optimal investment and financing programme. As the price paid for company K ties up funds and debt financing is limited, a credit bottleneck takes place in the first year. This funding problem prohibits the tangible asset investment to be executed completely. In the valuation programme only 45.23% of the tangible asset investment can be engaged. Subsequently, both the zero coupon loan (70 MU) and the revolving line (100 MU) are exhausted. In the following three years, just like in the base programme, company A requires short-term debt financing (respectively 75.2, 42.5 and 0.8 MU). In year five, investments in financial assets are possible (35.9 MU). If company A regroups its investment and financing decisions as shown above, it can afford to pay the maximum affordable price p* and still achieve the terminal asset value EW* = 2 202.0318 MU from the base programme.

Table 2: Valuation programme in the case of a credit limit

Time	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
$b_t + g_{Kt}$	0	120	125	130	120	2 210
Marginal price p*	–97.6261					
Tangible asset (45.23%)	–72.3739	6.7851	6.7851	6.7851	6.7851	142.4861
Zero coupon loan	70	0	0	0	0	–98.1786
Revolving line	100	75.2149	42.4557	0.7653		
Financial asset					–35.9279	
Repayment		–112	–84.2407	–47.5504	–0.8572	37.7243
Fixed withdrawal		–90	–90	–90	–90	–90
Account balance	–100	–75.2149	–42.4557	–0.7653	35.9279	2 202.0318

To illustrate how *changes in the decision field* may affect the critical price, the example will now be modified as follows: In addition to the zero coupon loan, the local bank grants an unlimited overdraft facility at a short-term interest rate of 12% p.a. Since the changes in the decision field of company A do not influence the optimal decisions made in the baseline situation, the *base programme* shown in Table 1 remains valid. In the following we will discuss how the removal of the credit limit affects the maximum affordable price and the optimal investment and financing decisions of company A. Due to the improved financing situation, the maximum affordable price for K in the *valuation programme without credit limit* is now 134.2677 MU (compared to 97.6261 MU with a credit limit). Due to the unlimited overdraft facility, no financing bottleneck occurs, and the tangible asset investment can be engaged fully also in the valuation programme. This is financed by further short-term debt (the lucrative zero coupon loan is of course again exhausted) in each year (respectively 224.3; 206.2; 180.9; 147.6; 120.3 MU). Consequently, no investments in financial assets are possible. Table 3 presents these results.

Table 3: Valuation programme in the case of an unlimited overdraft facility

Time	t = 0	t = 1	t = 2	t = 3	t = 4	t = 5
$b_t + g_{Kt}$	0	120	125	130	120	2 210
Marginal price p*	–134.2677					
Tangible asset	–160	15	15	15	15	315
Zero coupon loan	70	0	0	0	0	–98.1786
Revolving line	224.2677	206.1798	180.9214	147.6320	120.3478	
Repayment		–251.1798	–230.9214	–202.6320	–165.3478	–134.7896
Fixed withdrawal		–90	–90	–90	–90	–90
Account balance	–224.2677	–206.1798	–180.9214	–147.6320	–120.3478	2 202.0318

5. Summary and Conclusions

The discussion above demonstrates that a company valuation cannot be executed completely detached from the individual expectations and plannings of the specific valuation subject (Matschke & Brösel 2013). Appraisal always depends on the subjective aim and the decision field of the valuation subject. Even when the same company is being assessed from the perspective of different valuation subjects the decision value may vary, especially if they pursue different types of *prosperity maximisation*. In this paper, we assumed that the valuation subject as a presumptive buyer is interested in purchasing a certain company, pursuing the target wealth accumulation. He desires only a small fixed income stream and the greatest possible terminal asset value at the end of the planning horizon. The example shows that even the same valuation subject may come to diverging limits of concession willingness regarding the same valuation object when the *underlying decision field* changes (Hering, Toll & Kirilova 2013; Matschke & Brösel 2013). The maximum affordable price in exchange for the very same cash stream depends on the available opportunities for action. We have shown that simply removing the short-term credit upper limit alters the maximum affordable price of the same company noticeably.

Valuation methods based on financing theory (e.g., Fisher 1930; Markowitz 1952; Modigliani & Miller 1958; Sharpe 1964; Lintner 1965; Mossin 1966; Black & Scholes 1973; Fama 1977; Banz & Miller 1978; Cox, Ross & Rubinstein 1979; Miles & Ezzell 1980; De Angelo 1981; Myers 1984; Rodrigues 2013; Trigeorgis & Ioulianou 2013; Sweeney 2014) have assumed a fictitious perfect market. These methods do not take into consideration the individual expectations of the specific valuation subject, and they instead seek the one “true” value that must be valid in general (Hering, Toll & Kirilova 2013). For this reason, such methods are not appropriate for determining the critical price under realistic market conditions. Accordingly, such calculations can only be achieved by a *business valuation based on investment theory*, which (as this article shows) can consider the existing market imperfections, as well as the presumptive company purchaser’s individual expectations. These methods can be applied by the potential buyer himself or by an advisor (business valuation specialist), in order to provide an individual assessment of the economic viability of the purchase.

While the ability to model real-life imperfections argues in favour of the state marginal price model, the critical price determination using this general model has also engendered criticism because of its *practical applicability limitations* (Koch 1982; Rollberg 2002; Hering, Toll & Kirilova 2013). In a general model all investment and financing objects are directly included in a simultaneous optimisation approach. As this requires elaborate information gathering and processing, a centralised simultaneous planning with general models is often marked by complexity and clumsiness. Even if it were possible to develop a general model considering all data and interdependences, this model would suffer from a solution defect, since the optimal solution could not be found at economically viable expense.

When applying the presented valuation method to compute the critical price, it is important to bear in mind that future cash flows cannot be forecasted exactly. As a result, the valuation subject should try to make reliable assumptions in order to simplify the complex valuation situation. These simplifications have to be embedded in a conclusive theory. The scientific literature provides up to now only a few investment-oriented valuation approaches (Laux & Franke 1969; Matschke 1975; Hering 2014; Olbrich, Brösel & Hasslinger 2009; Toll 2011; Hering, Toll & Kirilova 2014). To *create knowledge* in the international scientific society, our paper demonstrates how an investment theory-based business valuation for a company acquisition should be done and how little changes in the valuation situation affect the critical price.

Scope for further research can address improving the simultaneous planning model. For example, it is possible to give up the complexity-reducing linear structure. This would require a more general *nonlinear framework* (Pfaff, Pfeiffer & Gathge 2002; Inwinkl, Kortebusch & Schneider 2009). Of particular interest are nonlinear synergy effects (Wright 1936; Markowitz 1952; Ansoff 1965; Perry & Porter 1985; Amihud, Dodd & Weinstein 1986; Goold & Campbell 1998; Eschen & Bresser 2005; Grill & Bresser 2013). Furthermore, determining the critical price could also be done assuming *uncertainty*. For this purpose, a model is needed that takes into account both market imperfections and the uncertain cash flow ambiguity. This could be done by applying simultaneous planning approaches (Weingartner 1963; Hax 1964; Matschke, Brösel & Matschke 2010; Brösel, Matschke & Olbrich 2012; Hering, Toll & Kirilova 2014) in a heuristic combination with the simulative risk analysis (Hurd 1954; Hertz 1964; Loizou & French 2012; Pfnür & Armonat 2013).

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