

# Simulated firm valuation - Monte Carlo simulation applied to the Ohlson (1995) model: Case KONE Corporation

Accounting  
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Sampo Riikonen  
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# **SIMULATED FIRM VALUATION**

Monte Carlo simulation applied to the Ohlson  
(1995) model: Case KONE Corporation

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Sampo Riikonen  
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## Abstract

### Objectives of the study

The objective of the thesis is to study whether applying Monte Carlo simulation to the famous and ground-breaking Ohlson (1995) model generates accurate and plausible market values of equity capital in relation to the actual closing stock prices. Additionally, the study examines the additional value the simulated Ohlson (1995) model provides investors with if any.

### Research methods

The study is conducted as a case study, in which the expected stock prices generated by the simulated Ohlson (1995) model are compared with the actual closing prices of KONE Corporation's class B share at the publishing dates of the company's financial statements in 2007–2015. Additionally, the study includes a preliminary and supplementary regression analysis, the purpose of which is to examine the value relevance of the key variables of the Ohlson (1995) model – earnings and book value of equity.

### Empirical results

The results of the conducted regression analysis include a preliminary indication that the expected stock price generated by the simulated Ohlson (1995) model is going to be substantially higher than the actual closing price for the FY2008. Apart from the FY2008 and FY2009, the simulated Ohlson (1995) model generated plausible, consistent and suggestive expected stock prices, but the additional value created by the constructed valuation model is founded on the results' visualization and investor discretion.

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**Keywords** Residual income valuation, Monte Carlo simulation, equity valuation, the Ohlson (1995) model, value relevance of accounting numbers, financial statement analysis, scenario and sensitivity analysis

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## Tiivistelmä

### Tutkimuksen tavoitteet

Tutkimuksen tavoitteena on tarkastella, tuottaako Monte Carlo -simulaation soveltaminen Ohlsonin (1995) lisäarvomalliin tarkkoja ja uskottavia oman pääoman markkina-arvoja suhteessa toteutuneisiin osakkeiden päätösarvoihin. Lisäksi tutkimuksessa tarkastellaan, minkälaista lisäarvoa sijoittajien näkökulmasta simuloitu Ohlsonin (1995) lisäarvomalli tuottaa.

### Tutkimusmenetelmät

Tutkimus on tehty tapaustutkimuksena, jossa simuloitun Ohlsonin (1995) lisäarvomallin tuottamia osakkeiden odotusarvoja verrataan KONE Oyj:n B-osakkeen toteutuneisiin päätösarvoihin tilinpäätöksen julkaisupäivänä vuosina 2007–2015. Tutkimus sisältää myös Ohlsonin (1995) lisäarvomallin komponenttien – nettotuloksen ja oman pääoman kirja-arvon – arvorelevanttiutta käsittelevän regressioanalyysin, jonka tarkoituksena on pohjustaa ja täydentää simuloitun arvonmääritysmallin tuloksia ja mahdollisia löydöksiä.

### Tulokset

Jo suoritetun regressioanalyysin perusteella voidaan perustellusti olettaa, että vuoden 2008 osakkeen markkina-arvo tulee tilinpäätöksen julkistamispäivänä olemaan alhaisempi, mitä simuloitu Ohlsonin (1995) lisäarvomalli osakkeen odotusarvoksi tuottaa. Vuosien 2008 ja 2009 tuloksia lukuun ottamatta simulointi tuotti uskottavia, johdonmukaisia ja suuntaa-antavia odotusarvoja KONEen B-osakkeelle, mutta rakennetun arvonmääritysmallin konkreettinen lisäarvo lepää selvästi tulosten visualisoinnin harteilla.

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**Avainsanat** Ohlsonin (1995) lisäarvomalli, Monte Carlo simulaatio, oman pääoman arvomääritys, tilinpäätösinformaation arvorelevanttius, tilinpäätösanalyysi, skenaario- ja herkkyysanalyysi

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# **1. Introduction**

## **1.1 Background of the study**

Initially the topic derived from a corporate finance manager at PricewaterhouseCoopers Oy, who lately had spent a lot of time trying to deepen his understanding of how to incorporate probability calculus into firm valuation. During my studies at Aalto University School of Business, I have encountered quite a few firm valuation models and methods as well as done my fair share of the probability calculus, yet the fundamental question how to combine these two fascinating areas for real life purposes acted as the trigger for the thesis.

## **1.2 Objectives and contribution**

A famous quote from Warren Buffett, one of the world's most respected and recognized investment bankers, states: "Price is what you pay. Value is what you get." This underlines the fundamental nature of business and acts as a prerequisite for trade per se: a potential buyer is willing to buy a commodity only if the buyer considers the commodity's value higher than its price. Respectively, a seller is willing to sell the commodity if the seller considers the price higher than the commodity's value. Therefore, for example, a potential acquisition of a firm's equity capital depends fully on the relationship between the equity's value and the price asked for it. In other words, the acquisition is not executed if the buyer or the acquirer considers the equity's value less than the price asked for it. As the equity's value is ultimately determined by its ability to create wealth to its shareholders by generating income, the acquirer needs to determine how much income it requires for the acquisition to be more valuable than the price. In this respect, the thesis quotes Sir John Hicks (1939): "Income is the amount the firm can consume during a period and still be as well off at the end of the period as at the beginning." In this respect, the Hicksian concept of economic income defines the absolute minimum amount of income the acquisition should yield in order to be considered valuable. So the acquisition has to generate income in order to be considered valuable, but for how long? And how much is enough so that a firm can be as well off at the end of the period as at the beginning? Is the current income level sufficient also in the future or should the firm expect a growth at some rate? What is the probability that it actually grows at that expected rate for the next five years? What are the assumptions behind this and where do they come from? What if the economic conditions get worse or the firm records a substantial loss during the forecasting period? What is the opportunity cost of investing in

this particular firm and should the value be based on the expected distribution of wealth or is it sufficient just to pay attention to the book value of equity regardless of the distribution?

The essential purpose of this thesis was to study different equity valuation methods in the light of probability calculus and the usefulness of historical accounting numbers, which was eventually conducted by combining the famous Ohlson's residual income valuation model or the Ohlson (1995) model into the widely applied Monte Carlo simulation method. In order to generally assess the practical functionality of this simulated Ohlson (1995) model, KONE Corporation's stock prices for the financial years (hereinafter also referred as "FY") 2007-2014 were recalculated and then compared to the actual market prices. Additionally, the functionality of the simulated Ohlson (1995) model and the sensitivity of its variables were assessed by conducting scenario and sensitivity analyses in the light of estimating the upcoming closing stock price for the FY2015. Thus, by expanding the application of historical accounting numbers through the Ohlson (1995) model into the incorporation of uncertainty with the help of Monte Carlo simulation, the thesis studied whether this combination provides investors with accurate and valuable additional information regarding the fundamental value of the firm.

As, according to Barth et al. (2001), the primary focus of financial statements is equity investment, the main focus group of the study is private and institutional investors focusing on equity valuation. Although the study may provide some valuable insights to the case company KONE Corporation as well, the study primarily focuses on the value relevance of historical accounting numbers in the light of the users of financial statements. The thesis bases its analyses on publicly available information or audited financial statements instead of the case company's internal accounts and e.g. daily records of sales.

There are two options how to approach the empirical results of the thesis (OU and Penman, 1989). The first approach assumes that the observed market value is sufficient for determining a firm's value or that the equity markets are efficient (the so-called efficient market hypothesis or "the EMH"). Thus, the market value of a firm acts as a benchmark against which to evaluate the conducted analysis and the feasibility of the simulated Ohlson (1995) model. In this approach, the final interpretation discusses whether the Ohlson (1995) model solely or combined with Monte Carlo simulation captures the information contained in the stock price. The second approach complies with the assumptions of traditional

fundamental analysis, according to which a firm's value is indicated in its published financial statements. Due to the stock price deviations and ultimate gravitation towards the fundamental value, a financial statement analysis discovers values of a firm that are not yet included in the stock prices. Thus, the intrinsic value of a firm derived from published financial statements serve as a benchmark against which the conclusions and interpretations about possible over- or underpricing of the stock are conducted.

In other words, it is basically a question of whether to

- (i) rely on the market values and study the feasibility of the valuation models; or to
- (ii) place trust in the valuation models and study the possible under- or overpricing of a firm.

The thesis is founded on the first approach. Therefore, the research questions of the thesis are as follows:

- (i) Does the simulated Ohlson (1995) model generate accurate and plausible expected stock prices in respect of KONE Corporation?
- (ii) Does the simulated Ohlson (1995) model provide investors with valuable additional information on the stock prices of KONE Corporation?

The empirical results of the thesis, which are discussed in more detail in the fourth chapter, indicate that the simulated Ohlson (1995) model generates relatively accurate yet biased and quite plausible expected stock prices in relation to the actual stock prices of KONE Corporation. Therefore, it captures some of the information contained in the stock price. According to the results, the model can be deemed as a functional firm valuation tool results of which are suggestive by nature. This is discussed in more detail in the examination of the results from the financial years 2007-2014.

Furthermore, the simulated Ohlson (1995) model provides investors with additional information regarding their adhered presumptions about a firm valuation. The simulation model visualizes the scenario-specific outcomes by positioning them on a probability distribution chart, on the grounds of which investors may question their adhered views on the matter. This is disclosed especially in the results concerning the years 2008 and 2009 as well as in the results of the scenario and sensitivity analyses conducted for the FY2015.

Although the three hypotheses of the thesis were all ultimately rejected as they were, the author deems the simulated Ohlson (1995) model as an extremely valuable firm valuation tool. As expected, the constructed simulation model didn't generate stock prices identical to the observed market values. Thus, in statistical terms, the model is somewhat biased. Nevertheless, on the grounds of historical accounting numbers and assumptions based on them, it still provides quite strong and plausible approximations against which an investor may benchmark his or her views on the matter.

### **1.3 Structure of the thesis**

After the introduction, the second chapter or the literature review covers the prior studies and academic research conducted on the Ohlson (1995) model and discusses its influence on modern financial accounting and contribution to firm valuation theory. The model's general applicability, its challenges and presented criticism towards the model are also discussed in the literature review. Additionally, the literature review covers the fundamentals of Monte Carlo simulation and the related prior academic research on the matter. The thesis discusses also the recognized benefits and disadvantages of the chosen simulation method and presents various application opportunities in the light of stock valuation.

The third chapter covers the methodology of the studies and introduces briefly the case company KONE Corporation and the Industrials sector it carries out its business activities in. Additionally, the methodology of the three main analyses conducted in the thesis are introduced in this chapter. The chapter discusses the motivation behind the study, its restrictions, how the analyses and valuation models were structured and eventually conducted, presents the applied assumptions and presents the cautions one has to take into account if the methodology is applied further.

The fourth chapter covers the presentation and interpretation of the empirical results of the analyses conducted in the study.

The empirical results act as a basis for the fifth chapter or further discussion whether or not the model is worth simulating in the first place and if so, whether the simulated Ohlson (1995) model provides investors with any valuable additional information on the differences between the true, observed values and the estimated stock prices.

The conclusions chapter presents possible managerial suggestions and potential research questions for further academic studies. It also revises the restrictions and applied assumptions and connects them to the potential research questions for future.

## **2 Literature review**

First, the thesis goes through the essential concepts and discusses the conducted research on value relevance of historical accounting numbers, forecasting in firm valuation, the Ohlson (1995) model and the fundamentals of Monte Carlo simulation and the traditional methods for analysing uncertainty.

### **2.1 Value relevance of historical accounting numbers**

Value relevance of accounting information is being defined as the ability of information disclosed by financial statements to capture and summarize firm value (Kargin, 2013). In practice, value relevance can be measured by the statistical relations between information presented in financial statements and market values of a stock. According to this widely accepted paradigm, accounting data that better explain contemporaneous return (or price) are more “value relevant” (Lee, 1999). Additionally, value relevance is closely related to the concept of earnings quality, since it uses securities market reaction to measure the extent to which financial statement information assists investors to predict future firm performance (Scott, 2009). However, the concept of value relevance of accounting information and the value relevance studies should be distinguished from one another. Barth et al. (2001) point out an important remark that value relevance studies are designed to assess whether particular accounting amounts reflect information that is used by investors in valuing firms’ equity, not to estimate firm value. This issue of usefulness is discussed in more detail below.

So what can be said about the previous empirical research on the statistical relations between the historical accounting numbers and observed market values? The role of accounting numbers in valuation has been fundamental interest of analysts, investors and researchers alike (Richardson et al., 2004). The famous Ball and Brown study (1968) blazed new trails in the field of accounting research by presenting the first scientifically documented paper on how share price responds to reported net income. The findings proved – something that today is considered quite intuitive – scientifically, that accounting earnings are valued positive by investors: higher (lower) earnings imply higher (lower) values. In their study, Ball and Brown first measured the information content of earnings, that is, whether the earnings reports were regarded as good news (GN; higher earnings than a year before) or bad news (BN; lower earnings than a year before). Then the market return on the shares of the sample firms near the time of each earnings announcement were



evaluated. The study shows, that the average abnormal security market return in the month of earnings announcement was strongly positive with the GN sample firms and strongly negative with the BN sample firms. This so-called narrow window study consisting of the month of earnings announcement was then repeated for a wide window study consisting of 11 prior months and six following months of the earnings announcement. The rest, as they say, is history. Underlining the recognized significance of the famous Ball and Brown study, e.g. Ohlson (1991) states the following: “Without exaggeration, it can be said that the Ball-Brown (1968) paper has had an enormous influence on modern empirical accounting research.”

### **2.1.1 Value relevance of earnings and book values**

Additionally, more contemporary studies have complemented the findings many decades after the ground-breaking findings of Ball and Brown (1968). For example, Dechow et al. (2014) argue that no other single event has been found to explain more of the cross-sectional variation in stock returns than the earnings announcement, which highlights the value relevance of the announcement and especially the impact of earnings. Ohlson (1995) supports the initial statement and points out that earnings are tied to the long-run cash distributions paid on securities, and so they are clearly value relevant. However as for the cash flows per se, Biddle et al. (1997) find that both earnings and residual income are relatively more informative than cash flows. Thus, earnings and residual income seem to be better indicators of performance than cash flows. Additionally, the combined value relevance of earnings and book values of equity – or the key variables of the Ohlson (1995) model – has not declined the past forty years<sup>1</sup> but appears to have increased slightly (Collins et al., 1997). Collins et al. (1997) also state that although the value relevance of earnings has declined, it has been replaced by increasing value relevance of book values of equity. These two statements are studied in more detail in the empirical part of the thesis in the light of the Finnish publicly listed sample firms.

Although the reported earnings acts as the most explanatory variable in terms of explaining the market value of a firm, Dechow et al. (2014) have contributed to the claim by pointing out that there are clearly other accounting and non-accounting determinants of stock prices, including balance sheet values such as goodwill (captured by accounting) and non-financial

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<sup>1</sup> The sample firms are selected from the period 1953-1993.

indicators such as customer satisfaction (not yet captured by accounting). In this respect, Lundholm (1995) links the non-accounting information to the concept of value relevance quite well. Lundholm states that although decision-makers may not always think of non-accounting information as becoming earnings in the next period, it must become earnings sometime in the future if it is value relevant.

### **2.1.2 Usefulness of historical accounting numbers**

In addition to value relevance of accounting numbers, Dechow et al. (2014) remark that on the issue of usefulness, the answer is more complex. For example, Hung (2001) states that the definitions of value relevance discussed above do not take into account whether investors truly use the value relevant information to set market prices, which refers to the issue of usefulness presented above. Hung's statement is yet somewhat interesting, because supposedly if the market prices efficiently reflect all the publicly available information (the so-called semi-strong form of EMH), one could ask how the usefulness and more closely the actual usage of this particular information can be ignored. In this respect the thesis refers to the definitions of semi-strong form of EMH as follows: "An efficient securities market is one where the prices of securities traded on that market at all times reflect all information that is *publicly* known about those securities." According to Scott (2009), market prices are in fact efficient with respect to *publicly* known information, which does not rule out the possibility of inside information.

According to Ball and Brown (1968), information is useful if publishing the information causes changes in a stock price. In respect of the term information per se, Scott (2009) states that information is evidence that has the potential to affect an individual's decision. Moreover, Lev (1989) brings out the definition of information in information (communication) theory and states that information is considered useful "if individuals act as if they use a specific information item". For elaborative purposes, the author considers that the issue of usefulness can be studied by combining Lev's (1989) remarks to the famous model of information hierarchy<sup>2</sup> as follows: A message (data; or facts, figures and observations) is said to convey information (information; or data with interpretation) if it causes a change in the receiver's probability distribution (knowledge; or information in context, with understanding and meaning), which will trigger an action (wisdom; knowledge

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<sup>2</sup> Data – Information – Knowledge – Wisdom (the so-called DIKW-model)

with insight). In the context of the thesis, historical accounting numbers on KONE Corporation's financial statements are nothing more than plain numbers (data) before a reader of the financial statements is able to interpret and associate those particular numbers with something concrete (annual sales for example). As this information derived from the data on annual sales is compared with the prior years' figures, the reader acquires knowledge on the matter. Thus, the information in that particular context forms an understanding on the matter, based on which the reader may, for example, ultimately decide on whether or not to buy KONE Corporation's shares. The wisdom on the matter derives from the acknowledgement of uncertainty involved, which is in the very core of this thesis.

## **2.2 Forecasting on the grounds of historical accounting numbers**

Essential task of valuation is forecasting (Lee, 1999). Worth mentioning and underlining already at this stage of the thesis, valuation is inherently prospective and it emphasizes the concept of making an educated guess (Lee, 1999). As Ohlson (1995) phrases it, it is a setting of "objective beliefs".

Both earnings and book value of equity are considered value relevant because they assist in predicting future dividends (Amir, 1993). Although reported earnings acts as the most explanatory variable in terms of explaining the market value of a firm (Dechow et al., 2014), Richardson et al. (2004) point out that historical accounting numbers used in "a fundamental analysis exercise" are not sufficient statistics in terms of determining expected payoffs and therefore the true value of a firm. Additionally, it has been said that investors tend to overweight information in analysts' earnings forecasts and underweight information in current earnings and book values (Dechow et al., 1999). However, if the historical accounting numbers per se are insufficient and investors tend to rely more on analysts' forecasts than studying the financial statements themselves, one could ask where the analysts get their assumptions from. Nevertheless, empirical tests of the Ohlson (1995) and Feltham-Ohlson model conclude that analyst forecasts capture future earnings better than historical accounting numbers combined with a linear information dynamics (Richardson et al., 2004). This emphasizes the importance of careful analysis of the historical accounting numbers, which is also in the very core of the thesis.

### **2.2.1 Decomposing the income statement**

Although the thesis focuses on analysing the value relevance of the bottom-line items of both an income statement and a balance sheet and constructs the simulated valuation model based on them, several empirical findings indicate that decomposing earnings improves forecasts (Lipe, 1986; Fairfield et al., 1996). The improvements, however, are not large but still statistically significant. For example, Lipe (1986) has found that reported earnings (per share) do not provide a complete summary of accounting information, which means that some information is lost when the components are aggregated into earnings. Supported by Fairfield et al. (1996), reported earnings alone may not communicate all the information in accounting data for evaluating firm profitability.

Lipe (1986) studied whether the components explain more of the variation in returns than is explained by earnings alone. The results show significant additional explanatory power, which indicates significant cross-component differences in the magnitude of the return reactions associated with the component shocks, a result consistent with the view that each component provides a different piece of information to the stock market. Each component provides a different piece of information to the stock market, which indicates two things:

- (i) Reported earnings per share (EPS) do not provide the complete summary; and
- (ii) Additional information is shown to be consistent with market participants reacting to differences in the time-series properties of the components.

Financial statement analysis textbooks often suggest that financial statement users should focus on net income before "nonrecurring" items (Fairfield et al., 1996). Practicing accountants and financial analysts often suggest that certain components or subtotals on the income statement provide more information than others regarding firm profitability.

So what are the components derived from disaggregation of income statements? Lipe (1986) classifies income statement line items into the six commonly reported components as follows: gross profit; selling, general and administrative expense; depreciation expense; interest expense; income taxes; and other items. In addition to the six components presented by Lipe (1986), Fairfield et al. (1996) supplements the set with the following additional components: minority income; non-operating income; special items; discontinued operations; and extraordinary items.

According to Fairfield et al. (1996), discontinued operations and extraordinary items can be ignored in forecasting future profitability. Extraordinary items and discontinued operations are found to be uninformative regarding future earnings. Additionally, the transactions may have large measurement errors, may violate the matching principle, and are less likely to be representative of normal operations or to recur in the future. This disaggregation is, however, excluded from the analyses conducted in the thesis.

### **2.2.2 Balance sheet values in forecasting**

As stated by Dichev (2008), balance sheet's assets represent the future economic benefits to be captured by a firm whereas its liabilities stand for the firm's future economic obligations. Theoretically, Fair Value Accounting (hereinafter also referred as "FVA") states that if all the items in a firm's balance sheet would be valued at their current fair (market) value, the balance sheet would represent the firm's value as a whole (e.g. Ohlson, 1991; Dechow et al., 2014). Due to the snapshot nature of the information on the balance sheet of a company, this is rarely the case. However, one could think of an unlevered investment fund that uses market valuation for its assets, "marketable securities" (Ohlson, 1991). Additionally, for example goodwill as a balance sheet item can be considered to equal the present value of future expected abnormal earnings (Ohlson, 1995), which acts as an excellent example of a balance sheet item that complies with the theoretical framework of FVA. This acts well as a practical example of a firm that is valued based on its balance sheet without taking its disaggregated earnings into consideration. It is yet noteworthy, that the estimation of fair value is subject to managerial discretion and often there is no active market quotation for similar assets. Furthermore, the use of FVA has increased over time and is shifting the role of accounting way from summarizing past transactions and toward forecasting future transactions. (Dechow et al., 2014).

Although the discussed disaggregation may provide investors with some additional information on the fundamental value of a firm's equity, the thesis focuses on the aggregated earnings and book value of equity, each of which are regarded as the key variables of the Ohlson (1995) model discussed in more detail below.

## 2.3 The Ohlson (1995) model – residual income valuation

The Ohlson (1995) model is a widely recognized and respected landmark with profound impact on financial accounting and valuation theory (e.g. Lundholm, 1995; Lo and Lys, 2000). The model's significance derives from its ability to specify the relation between market values of equity and accounting information such as earnings and book values on a theoretical basis (Dechow et al., 1999; Myers, 1999).

The Ohlson (1995) model is a residual income valuation (hereinafter also referred as “RIV”) model based on historic accounting numbers and predetermined and required rate of return for a shareholders' equity capital, which expresses value of a firm as the sum of the book value of its equity and the present value of future abnormal earnings. The model relies on accrual accounting data as opposed to the dividend discount model and the discounted cash flow models that rely on cash flow data (Petersen and Plenborg, 2012). The model is based on the following three crucial and fundamental assumptions:

- (i) The Ohlson (1995) model is based on the neoclassical framework in security valuation, according to which the value of a firm equals the present value of its expected returns;
- (ii) The clean surplus relation; and
- (iii) The linear information dynamics model.

After the following presentation of the three assumptions, the thesis discusses some of the criticism and concerns related to the model.

### 2.3.1 The 1<sup>st</sup> assumption – present value of future earnings

The Ohlson (1995) model is presented in the equations (1) and (2) as follows:

$$MV_{t-1} = BV_{t-1} + \sum_{t=1}^{\infty} \frac{RI_t}{(1 + r_E)^t} \quad (1)$$

or

$$MV_{t-1} = BV_{t-1} + \sum_{t=1}^{\infty} \frac{NI_t - r_E * BV_{t-1}}{(1 + r_E)^t}, \quad (2)$$

where  $MV_{t-1}$  is the (market) value of a company or its shareholders' equity at time zero (the initial moment of valuation or decision-making),  $BV_{t-1}$  is the book value of a company's equity capital at the beginning<sup>3</sup> of the financial period,  $RI_t$  is the residual income (residual income is discussed in more detail below) for the financial period  $t$  and  $r_E$  is the shareholders' required rate of return or the discount rate for the company's equity capital. In the equation (2)  $NI_t$  is the net income or earnings for the period  $t$ . The Ohlson (1995) model can also be presented in terms of financial ratios as follows (Plenborg, 2002):

$$MV_{t-1} = BV_{t-1} + \sum_{t=1}^{\infty} \frac{(ROE_t - r_E) * BV_{t-1}}{(1 + r_E)^t}, \quad (3)$$

where  $ROE_t$  is the return on equity or  $NI_t/BV_{t-1}$ <sup>4</sup>.

The first assumption of the Ohlson (1995) model is derived from the general neoclassical framework in security valuation, according to which the value of a firm equals the present value of expected future dividend stream (e.g. Ohlson, 1995; Dechow et al., 1999) or as Lipe (1986) phrases it, "the future expected benefits accruing to its equity holders". The fundamental idea of security valuation or the general discounted cash flows method (hereinafter also referred as "the DCF-method") is presented below as follows:

$$V_{t-1} = \sum_{t=1}^{\infty} \frac{FCF_t}{(1 + r)^t} \quad (4)$$

In the equation (4) above,  $V_{t-1}$  is the value of a security at time zero,  $FCF_t$  is the free cash flow at time  $t$  and  $r$  is the required rate of return for the security. Although the presented Williams' model (1938) above is easily considered fundamental in valuation research, Lundholm (1995) states that the Ohlson (1995) model's representation of earnings (or the concept of residual income) is "a great improvement over previous models that define earnings simply as the terminal dividend plus noise". On the other hand, Dechow et al. (1999) point out that the Ohlson (1995) model is "just a restatement of the dividend-discount model which in no way depends on the properties of accounting numbers other than through the clean surplus relation" and emphasize that a firm is still being valued by discounting future dividends. However, one has to acknowledge the fact that the essence of the William's

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<sup>3</sup> The current financial year's opening balance or the prior year's closing balance

<sup>4</sup> Alternatively, an average of opening and closing book values of equity could be used as the equation's denominator. Additionally, NI before minority interest can be applied.

model (1938) is equivalent to that of the residual income valuation model. This is also supported by Plenborg (2002) as well as Levin and Olsson (2000), who point out that the RIV and DCF approaches are theoretically equivalent and should yield identical firm value estimates if applied properly and consistently. The fundamental idea of the Ohlson (1995) model and its foundations in the William's model (1938) are supported by Lo and Lys (2000), who state that “rejecting the RIV is logically equivalent to concluding that stock prices do not represent the present value of expected cash flows”.

As regards to the valuation model applied in the thesis' analyses, the author makes a few notable adjustments to the Ohlson (1995) model yet respects its fundamentals. The adjusted valuation model applied in the thesis is presented as follows:

$$MV_{t-1} = BV_{t-1} + \sum_{t=1}^n \frac{NI_t - r_E * BV_{t-1}}{(1 + r_E)^t} + \frac{T_n}{(1 + r_E)^n} \quad (5)$$

In comparison with the Ohlson (1995) model presented at the beginning of the chapter, the equation (5) above includes an assumption of a constant, long-run growth from the final year  $n$ . Thus, the assumption of infinite periods  $\infty$  is rejected and replaced with a fixed number of years for the purpose discussed in more detail below. In other words, the adjusted model takes the concept of terminal value into account “to complete the valuation” (Dechow et al., 1999). The terminal value or the horizon value (Olsson and Levin, 1998) is based on the famous Gordon Growth Model and is presented below as follows:

$$T_n = \frac{RI_n(1 + g)}{(r_E - g)} \quad (6)$$

In the equations (5) and (6) above,  $n$  is the last year of the reference period (replacing the infinite number of years),  $g$  is the growth rate in perpetuity expected for the final year's residual income. The famous Warren Buffett quote “Our favourite investment period is forever” acts as an essential part of the assumption behind the terminal value. In other words, the basic assumption behind the concept of terminal value is that the expected development of a company holds forever (Levin and Olsson, 2000). However, one has to keep in mind that the concept of terminal value is not applicable in fixed-term projects of five years or so due to the temporary nature of its period. Additionally, Monte Carlo simulation must terminate after a finite number of iterations (Pedersen, 2013), which is why



the empirical part of the thesis does not apply infinite number of iterations or years in the following stock valuations. Additionally, in accordance with the IAS<sup>5</sup> 36:33 “Cash flow projections should be based on reasonable and supportable assumptions -- “ and “presumes that budgets and forecasts should not go beyond five years“. In this thesis, a forecast period of five years is applied and adjusted with the terminal value in order to imitate Buffett’s famous quote.

### **2.3.2 The 2<sup>nd</sup> assumption – clean surplus relation**

The second assumption of the Ohlson (1995) model concerns the clean surplus relation (hereinafter also referred as the “CSR”), which is satisfied by accounting data and dividends.

As stated by Ohlson (1995), accounting assigns an important integrative function to the statement of change in the book values of shareholders’ equity or  $\Delta BV = BV_t - BV_{t-1}$ . Under the assumptions of CSR, which Lo and Lys (2000) also referred to as an “accounting system”, all changes in assets and liabilities unrelated to dividends must pass through the income statement. Hence, both earnings and book value of equity are considered value relevant because they assist in predicting future dividends (Amir, 1993). Thus, the basic accounting constructs on the matter are as follows:

- (i) Dividends reduce current book value, but not current earnings; and
- (ii) The penalty of paying dividends on future expected earnings reflects earnings aggregation.

The assumption of CSR can also be presented mathematically as follows in the equation (7) below:

$$BV_t = BV_{t-1} + NI_t - D_t \quad (7)$$

In the equation (7) above,  $NI_t$  is the earnings or the bottom-line item<sup>6</sup> of an income statement and  $D_t$  is the distribution of wealth<sup>7</sup> to a firm’s equity holders. The part  $NI_t - D_t$  in the right-hand side of the equation above, which Ohlson (1995) himself referred as “net

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<sup>5</sup> International Accounting Standards

<sup>6</sup> In order to clarify the terminology used in the thesis, the bottom-line item of an income statement = NI = net income = earnings = profit

<sup>7</sup> Distribution to equity holders = dividends + share repurchases – equity issuances (Pedersen, 2013)

of capital contributions”, represents the retained earnings or the retained surplus for the financial period  $t$ . Retained earnings (the plowback ratio) is the share (percentage) of net earnings not distributed to the shareholders as dividends but reinvested in the company or to pay off its debt, which naturally increases the bottom-line item of a balance sheet  $BV_t$ . In other words, a company’s equity is the capital supplied directly by shareholders of the company and the accumulation of retained earnings. Retained earnings can also be expressed as follows:  $Retained\ earnings_t = Earnings_t - Payout_t$  (Pedersen, 2013). However, Ohlson (1991) states that earnings can be distinguished from dividends, and there is no need for notions such as “payout ratio” or “dividends are paid out of earnings”. This acts as the foundation of the Ohlson (1995) model and the balance sheet approach it represents. According to Dechow et al. (1999), the traditional dividend-discount models often assume too unrealistic dividend-policies, referring to Kothari and Zimmerman’s (1995) assumption of a 100 % payout ratio. This so-called full payout ratio is obviously not the case in real life business but acts solely as a theoretical approach. One of the significant benefits of the Ohlson (1995) model is that it illustrates that valuation models focusing directly on forecasting future abnormal earnings avoid having to forecast the timing of future dividend payments (Dechow et al., 1999), which is consistent with the Ohlson’s (1995) statement of the irrelevancy of the payout ratio.

In order to elaborate the concept of residual income, residual income or abnormal earnings acts as an indicator of a company’s performance. The concept of residual income subtracts the charge for the use of equity capital ( $r_E * BV_{t-1}$ ) from the actual recorded earnings ( $NI_t$ ), which indicates how well or badly the company performance corresponded to the shareholders’ expectations. As stated by Petersen and Plenborg (2012), it is obvious that the estimated market value exceeds the book value of equity only when returns exceed costs of capital. Ohlson (1995) elaborates the terminology by stating that the “normal” earnings should relate to the “normal” return on the capital invested at the beginning of the period. Additionally, residual income can be interpreted as shareholders’ opportunity costs (Magni, 2009), if for example the company performance measured by its actual earnings sets below their required rate of return on (the opening balance of) equity. As for the reference to a company’s financial statements and the concept’s general relation to financial accounting per se, Ohlson (1995) states that a company’s goodwill equals the present value of future

expected abnormal earnings. As discussed above, residual income at time  $t$  can be presented mathematically as follows:

$$RI_t = NI_t - r_E * BV_{t-1} \quad (8)$$

As one can conclude from the equation (8) above,  $RI_t$  may have a negative value. However, losses are likely to be considered temporary since shareholders can always liquidate the firm rather than suffer from indefinite losses. Thus, they are less informative than profits about the firm's future prospects. (Hayn, 1995). Additionally, Hayn (1995) states that "equity holders have a *put option* on the future cash flows of the firm whereby they can sell their shares at a price commensurate with the market value of the net assets of the firm". Assuming an identity between cash flows and earnings and ignoring the liquidation option's value, the value of the firm's equity is the higher of the present value of its expected earnings and its liquidation value. As for the liquidation value, Plenborg (2002) states that if an investor keeps a stock of a company until the company is liquidated, the liquidating dividend becomes the sales price of the stock. The temporary nature of losses and the liquidation value are taken into account in the constructed valuation models and discussed in more detail in the methodology chapter.

### **2.3.3 The 3<sup>rd</sup> assumption – linear information dynamics model**

Next the thesis discusses the linear information dynamics model (hereinafter also referred as the "LIDM"). Both Ohlson (1995) and Lundholm (1995) emphasize that the original empirical implications of the Ohlson (1995) model depend critically on the third and final assumption regarding the abnormal earnings information dynamics. Studies have shown that incorporating information in earnings forecasts of analysts into the information dynamics increases forecast accuracy. (Dechow et al., 1999). However, Lundholm (1995) states that the third assumption of the Ohlson (1995) model is "by far the most controversial". So what is the LIDM and what does it provide us?

The LIDM assumes the stochastic time-series behaviour of abnormal earnings (e.g. Ohlson, 1995; Lo and Lys, 2000; Ota, 1995) via two equations:

$$RI_{t+1} = \omega RI_t + v_t + \varepsilon_{t+1} \quad (9)$$

and

$$v_{t+1} = \gamma v_t + \eta_{t+1}, \quad (10)$$

where  $v_t$  is the value relevant information not yet captured by accounting and not in current abnormal earnings,  $\varepsilon_t$  and  $\eta_t$  are the completely unpredictable, zero mean disturbance terms (or unobserved error terms) and  $0 \leq \omega, \gamma < 1$ <sup>8</sup> and where  $RI_t \equiv NI_t - r_E * BV_{t-1}$ . Worth mentioning, the behaviour of other valuation relevant information or  $E_t(\tilde{v}_{t+1})$  does not depend on current or future dividends or  $RI_t$  but at most on  $v_t$  (Ohlson, 1995). In other words, the equations (9) and (10) above state that both the abnormal earnings and non-accounting information are autoregressive (Lundholm, 1995). Earnings and prices can behave as if they are both endogenously determined because they are jointly affected by information that is difficult to specify explicitly (Beaver et al., 1996).

For the purpose of elaborating the topic, information dynamics describe the formation of residual income or abnormal earnings expectations (Dechow et al., 1999). In other words, the information not yet captured by financial statements or  $v_{t+1}$  is related to the information that previously was “not yet captured” by financial statements and thus acts independently of current or past abnormal earnings. Additionally, value relevant information  $v_t$  cannot “bypass” the financial statements but are fed into the  $RI_{t+1}, RI_{t+2} \dots$  sequence (Ohlson, 1995). As phrased by Lundholm (1995), the non-accounting information or  $v_t$  is an “additive shock to the next period’s abnormal earnings”. As an practical example, consider a firm that manages to close an enormous deal with an important client in period  $t$ . An additive shock affects abnormal earnings in the next period  $t + 1$ . As summarized rather brilliantly by Lundholm (1995), “non-accounting information generates shocks autoregressively and these shocks flow through future abnormal earnings autoregressively”. In terms of value relevance, Ohlson (1995) states that the presented two equations combined with the assumption of the CSR ensure that all value-relevant events will be absorbed by current or subsequent periods’ earnings and book values.

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<sup>8</sup> Completely unpredictable ( $\gamma = 0$ ) or partially predictable ( $\gamma < 1$ ); Absent all sources of abnormal earnings ( $\omega, v_t = 0$ ). (Lundholm, 1995).

### **2.3.4 Criticism and concerns about the Ohlson (1995) model**

A fair amount of reasonable criticism and concerns on the Ohlson (1995) model has been presented in the prior research on the matter (e.g. Lundholm, 1995; Myers, 1999).

The Ohlson (1995) model contains an assumption according to which the (linear) model results in non-intertemporal arbitrage price that results when interest rates are non-stochastic, beliefs are homogenous and individuals are risk-neutral (Lundholm, 1995). Linking the prior statement to the thesis, providing a probability distribution to each key variable – earnings and book value of equity – of the Ohlson (1995) model, the simulation ought to mitigate the aforementioned biases. Additionally, Lundholm (1995) states that the second assumption of CSR does not precisely match the present state of U.S. GAAP, although it is a reasonable approximation. The finding is also supported by Lo and Lys (2000) who pointed out that violations of CSR may be substantial for example due to foreign currency translations.

Although Lundholm (1995) considers the model simplistic, Ohlson's representation of earnings is a great improvement over the previous models that define earnings simply as the terminal dividend plus noise. As stated by Dechow et al. (1999), accounting earnings in the Ohlson (1995) model are assumed to measure "value creation", which brings us to the question of dividend distribution quite conveniently. Ohlson's assumption on the irrelevancy of dividends follow Modigliani and Miller's (MM) theory: a firm's dividend policy is – assuming no taxes, bankruptcy costs agency costs and asymmetric information – irrelevant or it has no effect on the firm's value. In accordance with the assumption of CSR, paying dividends reduces the current book value but has no effect on current earnings. However, due to the time value of money, Lundholm (1995) points out that it certainly does matter *when* dividends are paid out. Additionally, as the MM assumptions have been taken away by researchers in finance one by one, Lo and Lys (2000) state that the Ohlson (1995) model should incorporate the same assumptions (taxes, bankruptcy costs, agency costs and asymmetric information) to the model.

Many authors in the field of accounting research have recognized the value of the Ohlson (1995) model, but several have pointed out the opportunities to test its empirical validity (e.g. Lo and Lys, 2000). Additionally, Myers (1999) seized on the common motivation to apply the Ohlson (1995) model as it provides a theoretical basis for specifying the relation

between equity values and accounting information and questions the empirical evidence from a purely pragmatic point of view: “Theory may be irrelevant and the proof of the model is how well it estimates abnormal stock market returns and approximates stock prices.”

Finally, it is noteworthy, that the RIV-approach measures firm value from an equity-holder’s perspective only, whereas the DCF-approach measures firm value from a combined equity-holder and lender perspective (Plenborg, 2002). The thesis has taken this into account in its analyses and applies the capital asset pricing model -based (hereinafter also referred as “CAPM”) discount rate instead of that based on the weighted average cost of capital (hereinafter also referred as “WACC”).

## **2.4 Analysing uncertainty**

First, the chapter introduces the basic concepts of different methods used in analysing uncertainty. The methods presented in the chapter are divided into two subcategories: the traditional methods or sensitivity and scenario analyses and the simulation method. Afterwards, the chapter examines the pros and cons of each method and elaborates how Monte Carlo as the chosen simulation method applies to the Ohlson (1995) model and firm valuation in general.

### **2.4.1 Sensitivity and scenario analysis**

Sensitivity analysis is the most commonly used method to analyse uncertainty in investment proposals (Wagle, 1967). It examines for example a project’s or a valuation model’s sensitivity for the changes in one key economic variable at a time (for example increase in revenue, decrease in costs or changes in book values). This makes the method cut out for identifying the most important or sensitive variables of a project (Savvides, 1994). Furthermore, it can be applied to a stock valuation model as well by studying for example how an increase in the model’s discount rate affects the model’s outcome. This is studied in the empirical part of the thesis in more detail. A particular case of sensitivity analysis is to calculate maximum (b), minimum (a) and mean (c) values of the key economic variable based on its optimistic, pessimistic and neutral estimates, which provides a solid yet limited range of possible results. However, the method suffers from the weakness that it does not provide any measure of the likelihood of obtaining any particular value (Wagle, 1967). Additionally, relying on single values as inputs implicitly assumes that the values applied for

example in a stock valuation model are certain (Savvides, 1994). Thus, the outcome is also presented as a certainty with no possible variance or margin of error associated with it.

In comparison with a sensitivity analysis, a scenario analysis entails changing several yet also limited combinations of key variables at the same time. A scenario analysis may focus on a macro-level examination (for example probability of recession or recovery along with normal conditions in an economy) rather than a *ceteris paribus* –type of an analysis, in which other key variables are held constant. In a scenario analysis, the typical output is three results (for example three expected stock prices) where all variables simultaneously take on one of the three hypothetical realizations (optimistic, pessimistic and neutral scenarios). However, neither tool – sensitivity or scenario analysis – alone produces probabilities of success or failure for the wanted outcome (Reed and Stephan, 2010). Regardless of the analyses' usefulness, both tests are static and rather arbitrary in their nature (Savvides, 1994).

#### **2.4.2 Simulation analysis**

Simulation models are increasingly being used in problem-solving and to aid in decision-making (Sargent, 1991). Simulation analysis allows for incorporating correlations between variables as well as several project perspectives and presents results as probability distributions. Monte Carlo as a simulation method overcomes the limitations of sensitivity and scenario analyses by examining the effects of all possible combinations of variables and their realizations (Reed and Stephan, 2010). In the empirical part of the thesis, Monte Carlo simulation is incorporated into the traditional methods in respect of the Ohlson (1995) model for the purpose of forecasting the up-coming closing stock price of KONE Corporation for the FY2015.

#### **2.4.3 Fundamentals of Monte Carlo simulation**

Monte Carlo simulation is a computer-based simulation of a stochastic model repeated numerous times so as to estimate the probability distribution of the outcome of the stochastic model (Pedersen, 2013). It requires the user to estimate a probability distribution to reflect the uncertainty for each random variable (Reed and Stephan, 2010). Essentially, Monte Carlo simulation involves the use of both probability distributions and random

numbers<sup>9</sup> to estimate, with the aid of a computer, a distribution of possible net present values (hereinafter also referred as “NPV”) rather than a single NPV (Smith, 1994). As regards to the simulation of the Ohlson (1995) model, instead of determining for example a single predetermined value for the expected growth in earnings, Monte Carlo simulation applies the expected growth’s mean, standard deviation and predetermined – and worth mentioning, assumed – distribution, based on which it returns a distribution of the possible outcomes. Thus, each probability distribution used will reflect the uncertainty associated with the factors concerned (Smith, 1994), which in the thesis are the key variables – earnings and book value of equity – of the Ohlson (1995) model. Thus, Monte Carlo simulation is cut out for analysing the so-called *what-if* questions and taking into account the incorporation of uncertainty in an analytical manner. The methodology of the simulated Ohlson (1995) model is discussed in more detail in the third chapter and its results in the empirical part.

Although Monte Carlo simulation provides only an approximation of both the probability distribution and the corresponding parameters of the profitability criterion functions such as the NPV and IRR<sup>10</sup> (Wagle, 1967), it can be a useful tool for visualizing risk for the decision-maker and detecting the inherent optimistic bias of project originators (Reed and Stephan, 2010). The issue of inherent bias is complemented by Savvides (1994), who states that Monte Carlo simulation helps to reduce evaluation bias by eliminating the need to resort to conservative estimates as means. In practice, this can be conducted by providing the decision-maker with a wider picture of the uncertainty involved. For acquiring the wider understanding of the uncertainty involved, one significant feature of Monte Carlo simulation is that it enables the modelling of very rare events as it allows for arbitrary probability distributions (Pedersen, 2013). Referring to the very rare events, Wagle (1967) however states that “as far as extreme points of the distribution are concerned, the sampling approach is worthless” because “one may not be interested in the extreme values”. However, in this connection it is reasonable to emphasize that uncertainty and risk are not the same thing (Gonzalo and Olmo, 2004; Granger, 2002). Uncertainty of an event per se can be assessed by the variance in the event’s probability distribution and is, as a concept, more objective than risk. Risk on the other hand is produced by this uncertainty and its level depends on the decision-maker’s interpretation. Thus, Wagle’s (1967) statement on the relevance of

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<sup>9</sup> For example in Microsoft Excel, the function =RAND() generates a uniformly distributed *random* number  $U \sim u[0,1)$ .

<sup>10</sup> Internal rate of return



extreme values or rare events does not apply to risk, which is always in the eyes of the investor (Granger, 2002). Two decision-makers may well react differently to the same extreme values in a distribution. This highlights yet another significant advantage of Monte Carlo simulation: it allows the decision-maker easily change its estimate on a scenario (Reed and Stephan, 2010).

For illustrative purposes, the thesis presents an example on the matter discussed above on the right in Figure 1. Referring to the case company KONE Corporation, an investor may have a strong initial belief based on his/her intuition or something he/she heard on

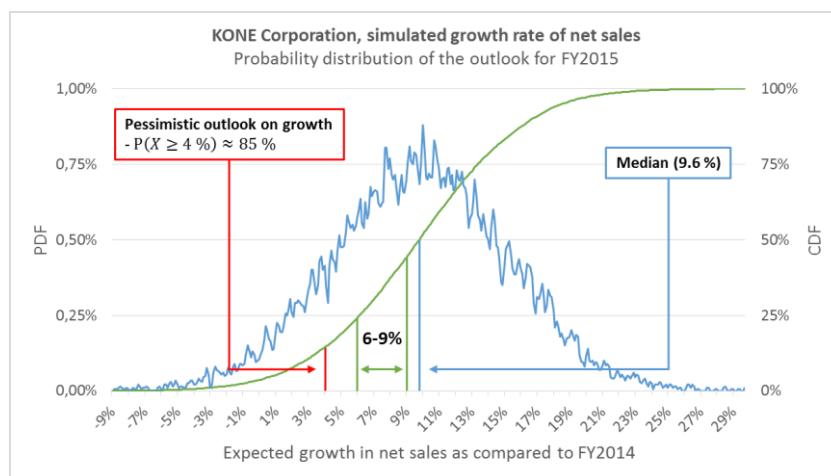


Figure 1 Simulation of the expected growth in net sales for FY2015

the news that the net sales do not have the actual potential to grow by 6-9 % (at comparable exchange rates as compared to 2014) as stated in the *Business outlook 2015* in the Board of Director’s report (FY2014). Instead, the fictional investor with a pessimistic outlook on the company’s net sales estimates an increase of merely 4 %. As presented above, a quick Monte Carlo simulation based on the historic accounting numbers reveals that there is some additional information available on the matter the investor should take into account. The following assumptions were made regarding the simulation: the net sales is assumed to be normally distributed, a compounded annual growth rate (hereinafter also referred as “CAGR”) of 9.49 %<sup>11</sup> acts as the mean or the expected growth rate and the standard deviation of the annual growth is 5.46 %. Results of the simulation after 10,000 iterations are presented above.

According to the results of the simulation, the median value of the simulated expected growth rates (the vertical blue line) is higher than the optimistic estimate of 9 % (the upper bound of the Board’s official outlook). Based on the historical accounting numbers, even the upper bound of the Board’s official outlook sets lower than the median value. Furthermore, the illustration of the pessimistic estimate (the vertical red line) made by the fictional investor in comparison with the quick Monte Carlo simulation indicates that the probability

<sup>11</sup> Based on the historical accounting information on KONE Corporation’s financial statements (2005-2014).

that KONE Corporation records a growth greater than or equal to 4 % in its net sales in 2015 is approximately 85 %. Variance in the probability distribution illustrates the uncertainty involved in the expected growth, yet as mentioned above, the final assessment of the actual risk the uncertainty produces and the interpretation of the results comes down to the investor's own discretion. Next the thesis discusses the benefits of linking the Ohlson (1995) model with Monte Carlo simulation.

## **2.5 Linking the Ohlson (1995) model with Monte Carlo simulation**

Monte Carlo simulation is a widely applied method in capital budgeting analysis and investment appraisals (e.g. Smith, 1994; Reed and Stephan, 2010), yet less focus has been incorporated to stock valuation in the topic's academic research and literature.

According to Reed and Stephan (2010), Monte Carlo simulation allows a decision-maker to address which variables are the most important. As the key variables of the Ohlson (1995) model – earnings and book value of equity capital – have their own probability distributions, calculation of mean and standard deviation of the wanted outcome or the expected stock price may be difficult (Wagle, 1967) and thus advocates the use of Monte Carlo simulation. In respect of the Ohlson (1995) model, probability distribution and consistency of residual income ( $RI_t$ ) is rarely available in financial statements. However, the particular bottom-line items or the model's key variables that compose the residual income may well have plausible and reliable means and variances. Imitating Smith (1994), Monte Carlo simulation involves the replacement of linear estimates of residual income for each year with probability distributions for the variables affecting the residual income, which reflects the uncertainty associated with the variable concerned. The probability distribution is also useful when the average present value is misleading because it is unlikely to occur (Pedersen, 2013).

Pedersen (2013) also points out that Monte Carlo simulation is a useful tool when the probability distributions are not possible to derive analytically, either because it is too complex or because the stochastic variables of the model are not from simple, well-behave probability distributions. As regards to the simulated Ohlson (1995) model, the probability distributions of the expected growth of the key variables are assumed to be normally distributed and thus considered quite simple and well-behaved, but due to other assumptions such as the temporary nature of losses (Hayn, 1995) discussed in more detail in the following chapter advocates the usage of Monte Carlo simulation. Additionally, Hull

(2014) points out that Monte Carlo simulation tends to be numerically more efficient than other procedures when there are three or more stochastic variables. The conducted scenario analysis for the FY2015, which is based on the simulated Ohlson (1995) model as well, contains four different variables each of which has its own predetermined probability distribution. Additionally, according to Reed and Stephan (2010), simulation software permits the financial modeller to specify (positive or negative) correlations and quantify their effects on the probability of success or failure. The constructed simulation model does not contain specifications of correlations between the applied variables, but the practical functionality of the model was ensured for example by adding constraints so that the distribution of wealth cannot result in negative values.

In the following chapter, the thesis discusses the methodology of the conducted analyses in more detail.

### 3 Methodologies, hypotheses and the case company

This chapter introduces some of the key features and figures of the case company KONE Corporation and its position in the elevator and escalator industry. After the brief company presentation, the chapter states the three hypotheses of this thesis and discusses the empirical methodology conducted in the studies.

#### Case company: KONE Corporation

The crown jewel of the current Finnish business environment, KONE, was founded in 1910. During its 100 years as an industrial engineering company, KONE has been involved in businesses as different as textile manufacture, medical technology and the design of hydraulic piping systems. The company's main focus, however, has always been the elevator and escalator business. As for its core business activities, KONE Corporation currently manufactures, installs and services elevators, escalators and automatic building doors and integrated solutions in more than 1,000 regional offices in almost 60 countries worldwide whilst headquartered in Helsinki, Finland. It is now one of the global leaders in the elevator and escalator industry among its three main competitors Otis (part of the United Technologies group), Schindler Group and ThyssenKrupp elevator (part of the ThyssenKrupp group). On 1 June 2005, Kone Corporation demerged into two separately listed firms KONE Corporation and Cargotec Corporation.

On the right in Figure 2 is a summary of the historical stock prices of KONE Corporation's class B shares from 1.6.2005 to year-to-date (YTD). The class B shares are listed on the OMX Helsinki Stock Exchange. In respect of the stock prices, the

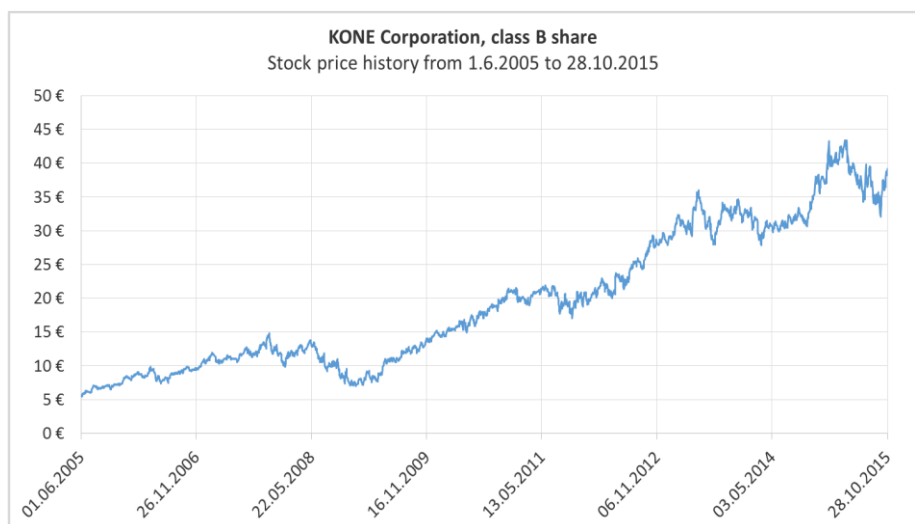


Figure 2 Historical stock prices of KONE Corporation (1.6.2005 – 28.10.2015)

company has shown steady growth since the demerger. According to Talouselämä 500, KONE Corporation was the 7<sup>th</sup> largest company in Finland in terms of net sales in 2014.

KONE Corporation is the largest family-owned business in Finland. The Chairman of the Board and the former CEO of the company is Mr. Antti Herlin, who owns 21.44 % of the company's shares and 61.76 % of the voting shares (FY2014). The current CEO of KONE Corporation is the company's former CFO Henrik Ehrnrooth. At the end of 2014, KONE Corporation employed more than 47,000 people of which 44 % were located in EMEA-region, 12 % in America and 44 % in APAC.

In the FY2014, new equipment or elevators and escalators accounted for 55 % of the total sales of €7,334.5 million. Maintenance (32 %) and modernization (13 %) accounted for the remaining part. In 2014, KONE's market share was estimated at 19 % measured by new elevators and escalators.

KONE Corporation's company performance and the key financial ratios are presented in the summary in figures below. The financials are from the period 2007-2014.

*Table 1 KONE Corporation 2007-2014 – summary in figures*

<b>Consolidated Statement of Income</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Sales, MEUR	4 079	4 603	4 744	4 987	5 225	6 277	6 933	7 334
Operating income, MEUR	321	558	567	696	725	791	953	1 036
- as percentage of sales, %	7,9	12,1	12,0	14,0	13,9	12,6	13,7	14,1
Net income, MEUR	180	418	466	536	644	611	713	774
<b>Consolidated Balance Sheet, MEUR</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Non-current assets	1 083	1 178	1 218	1 423	175	1 937	1 938	2 169
Current assets	1 277	1 478	1 634	2 725	2 977	3 197	3 405	4 191
Total equity	749	1 036	1 339	1 601	2 034	1 834	1 725	2 062
Non-current liabilities	334	328	180	203	208	302	262	321
Provisions	87	50	100	99	89	136	139	137
Current liabilities	1 191	1 243	1 232	2 245	2 397	2 862	3 217	3 839
Total assets	2 360	2 657	2 852	4 148	4 727	5 134	5 343	6 360
<b>Other Data</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Average number of employees	30 796	33 935	34 276	33 566	34 769	38 477	41 139	45 161
Number of employees at end of period	32 544	34 831	33 988	33 755	37 542	39 851	43 298	47 064
<b>Key Ratios</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>
Return on equity, %	24,9	46,8	39,3	36,5	35,5	32,1	40,1	40,9
Return on capital employed, %	18,6	35,9	34,0	34,8	34,3	29,4	36,4	37,7
Total equity/total assets, %	31,7	39,0	47,0	49,3	54,0	47,1	43,7	43,6
Gearing, %	12,2	-5,6	-37,7	-46,8	-40,8	-31,3	-36,1	-44,2

KONE Corporation was chosen as the case company for the thesis because the author considers its business-model both lucrative and sustainable, its corporate structure solid and financial position healthy and above all, its business easily understandable. Additionally, KONE Corporation is an attractive investment both in terms of growth in the share value and in terms of distribution of dividends.

### 3.1 Methodologies and hypotheses

This chapter discusses the methodologies applied in the empirical part and states the hypotheses of the thesis. The chapter is divided into three sub-sections which are to discuss the methodologies of each analysis in more detail.

First, in order to assess the general applicability of the Ohlson (1995) model, three multiple linear regression analyses for the periods 2000-2014, 2000-2006 and 2007-2014 are conducted. These regression analyses are conducted in order to determine whether the model's key variables – earnings and book value of equity – actually have statistically significant explanatory power to market values. Additionally, the potential effect of the Financial Crisis on the key variables' explanatory power is studied by comparing the two latter periods with each other. In the regression analyses, the key variables act as the independent explanatory variables and the market values act as the dependent variable. Thus, the first hypothesis of the thesis is as follows:

**H1:** *Earnings and book values have statistically significant explanatory power to market values at a 5 % significance level.*

Then, historical accounting numbers from KONE Corporation's financial statements (audited financial periods 1996-2014) are placed in the Ohlson (1995) model. Based on the historical accounting numbers, the Ohlson (1995) model's applicability is assessed by recalculating the stock prices<sup>12</sup> of KONE for 2007-2014 and then compared to the actual closing prices at the particular year's publishing date of the financial statement bulletin. The incorporation of uncertainty, which is conducted by including the probability distributions of the key variables with the help of Monte Carlo simulation is yet excluded in this part. The purpose of this initial assessment of the *original* Ohlson (1995) model is to set an initial framework for the further analysis, in which the Ohlson (1995) model's key variables are simulated and its outcomes visualized. Thus, the second hypothesis of the thesis is as follows:

**H2:** *The original Ohlson (1995) model is a plausible and applicable valuation method for a large enterprise and sets the recalculated stock prices within one standard deviation of the mean or the actual stock prices.*

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<sup>12</sup> The actual closing prices at the official publishing dates of the company's financial statements.

After the general assessment of the original Ohlson (1995) model, probability distributions of the model's key variables among other assumptions discussed in more detail below are added to the model in order to construct the simulated valuation model. For the sake of consistency in the conducted analyses, the assumed variables (for example the discount rates, perpetual growth rates and linear growth rates of the key variables) remain the same in both cases. However, the simulated Ohlson (1995) model includes additional considerations and assumptions that are discussed in more detail in the sub-section on the analysis. The fundamental idea behind the analysis is to examine whether the simulated Ohlson (1995) model provides an investor with more detailed and accurate information on stock prices in comparison with the original Ohlson (1995) model. Thus, the third hypothesis of the thesis is as follows:

**H3:** *Applying Monte Carlo simulation to the Ohlson (1995) model provides investors with more detailed and accurate information on stock prices in comparison with the original Ohlson (1995) model by generating expected stock prices that are closer to the actual closing prices.*

Finally, the results of both the original and the simulated Ohlson (1995) model are compared with the actual closing stock prices.

## **3.2 Value relevance of the Ohlson (1995) model's key variables**

Before tackling the further analysis and practical applicability of the Ohlson (1995) model, the explanatory power or the value relevance of the model's key variables – earnings and book value of equity – on the market values is studied in this chapter in detail.

### **3.2.1 Acquisition of data**

The initial sample for the conducted regression analyses consisted of 1,875 observations for each variable from 125 Finnish publicly listed firms during the years 2000-2014 (15 years). The main variables gathered for the sample firms are market value of equity, book value of equity and net income. Additionally, information regarding the firm-specific sector and the corresponding financial year was gathered. The data was gathered from Thomson One – database.

The final sample consists of 1,151 observations for each variable. Firms or observations that had zero, negative, missing or inapplicable values for some of the variables were removed

from the sample. These observations could have skewed the results of the analysis and therefore were deleted from the sample. In addition to the analysis of the value relevance during 2000-2014, the initial period was split in two separate seven and eight year periods respectively: 2000-2006 (525 observations) and 2007-2014 (626 observations). The purpose of this is to study the potential effects of the Financial Crisis of 2007-2008 on the explanatory power of the key variables.

All of the 125 firms in the sample were assigned to a certain sector based on a hierarchical industry classification system called the Global Industry Classification Standard (GICS). The GICS consists of 10 sectors, 24 industry groups, 67 industries and 156 sub-industries<sup>13</sup>. Just like the financial year of a single observation, the observation's sector is also a so-called dummy variable and acts as a control variable in the analysis. Sector as a control variable gets the value of 0 or 1 to indicate whether or not an individual firm belongs to a certain sector. The same approach is applied with the financial period.

The GICS consists of the 10 following sectors based on which all of the firms are classified as: Energy (SEC1), Materials (SEC2), Industrials (SEC3), Consumer Discretionary (SEC4), Consumer Staples (SEC5), Health Care (SEC6), Financials (SEC7), Information Technology (SEC8), Telecommunication Services (SEC9) and Utilities (SEC10).

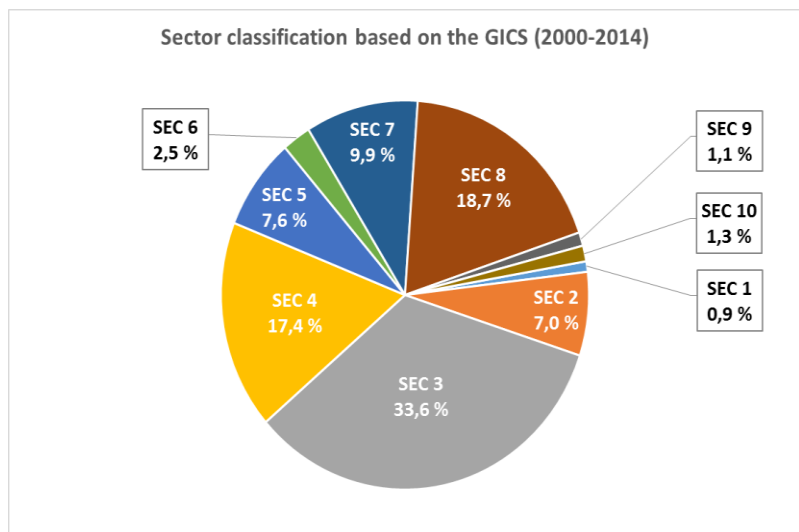


Figure 3 Sector classification of the sample firms

Distribution of the sectors in the sample is visualized above in Figure 3. Industrials sector (SEC3), in which the case company KONE Corporation is also classified to, holds the largest share (33.6 %) of the total distribution.

<sup>13</sup> Source: <https://www.msci.com/gics>, referred on 20 December 2015.



### 3.2.2 Regression models

Initially, the simplified regression model, variations of which appear in most “value relevance” studies (Lee, 1999), would be as follows:

$$MV_{jt} = \alpha_0 + \alpha_1 BV_{jt} + \alpha_2 NI_{jt} + e_{jt} \quad (11)$$

where  $MV_{jt}$  is the market value of a firm  $j$  at the time  $t$ .  $BV_{jt}$  and  $NI_{jt}$  are the book value of equity and the net income or earnings of a firm  $j$  at the time  $t$ .  $\alpha_0$  is the coefficient of the regression model’s intercept or constant and  $e_{jt}$  is the error or disturbance term of the model.

However, the regression model presented above in the equation (11) does not take into account the scale-related effects derived from the differences in firm sizes. These effects would result in biased estimates of the coefficients of the parameters and the constant and for example unrealistically high explanatory power or the R Square. Additionally, the model would exhibit heteroscedasticity or significant variance in its error terms due to the size differences. In order to alleviate the mentioned effects, the model is scaled by dividing the both sides of the equation by  $BV_{jt}$ . Additionally, as complemented by Dechow et al. (2014), earnings better explain firm value when the ratio of earnings to book value is high and firms are likely to remain in the same line of business. The scaling also acts as the reason why zero or negative values of the variables were deleted from the sample. Thus, the scaled yet interim regression model is presented below in the equation (12):

$$\frac{MV_{jt}}{BV_{jt}} = \alpha_1 + \alpha_0 \frac{1}{BV_{jt}} + \alpha_2 \frac{NI_{jt}}{BV_{jt}} + e_{jt} \quad (12)$$

Finally, in order to control the effects of corresponding sector and financial year, the dummy variables are included in the model as control variables. Additionally, by excluding the indicator variables for the first sector (SEC1) and the first year (Y2000), the model avoids the so-called dummy variable trap, which would introduce perfect collinearity (for example  $SEC1 + SEC2 + \dots + SEC10 = 1$ ) to the model. The effects of the excluded dummy variables or the so-called reference categories are included in the constant term or the intercept  $\alpha_1$  of the regression model.

Taking the aforementioned statistical issues into account, the final regression model for the period 2000-2014 is as follows:

$$\frac{MV_{jt}}{BV_{jt}} = \alpha_1 + \alpha_0 \frac{1}{BV_{jt}} + \alpha_2 \frac{NI_{jt}}{BV_{jt}} + \alpha_3 SEC2 + \alpha_4 SEC3 + \dots + \alpha_{11} SEC10 + \alpha_{12} Y2001 + \dots + \alpha_{25} Y2014 + e_{jt} \quad (13)$$

Furthermore, the regression models for the periods 2000-2006 (14) and 2007-2014 (15) are as follows:

$$\frac{MV_{jt}}{BV_{jt}} = \alpha_1 + \alpha_0 \frac{1}{BV_{jt}} + \alpha_2 \frac{NI_{jt}}{BV_{jt}} + \alpha_3 SEC2 + \alpha_4 SEC3 + \dots + \alpha_{11} SEC10 + \alpha_{12} Y2001 + \dots + \alpha_{17} Y2006 + e_{jt} \quad (14)$$

$$\frac{MV_{jt}}{BV_{jt}} = \alpha_1 + \alpha_0 \frac{1}{BV_{jt}} + \alpha_2 \frac{NI_{jt}}{BV_{jt}} + \alpha_3 SEC2 + \alpha_4 SEC3 + \dots + \alpha_{11} SEC10 + \alpha_{12} Y2008 + \dots + \alpha_{18} Y2014 + e_{jt} \quad (15)$$

Additionally, in order to study the linear relationships between the two key variables and the market values, the thesis conducted three correlation analyses for the periods. The following guidelines on strength of the relationships were applied:

- None or very weak: -0.1 to 0.1
- Weak: -0.3 to -0.1 or 0.1 to 0.3
- Moderate: -0.5 to -0.3 or 0.3 to 0.5
- Strong: -0.99 to -0.5 or 0.5 to 0.99
- Perfect: Exactly -1.00 or 1.00

Pearson's  $r$  and Spearman's  $\rho$  correlation coefficients were determined and they are discussed in more detail in the empirical part of the thesis.

### 3.3 The original Ohlson (1995) model

First, in order to set the initial framework for the further analysis, the Ohlson (1995) model's applicability is examined by recalculating the closing stock prices at the publishing dates of KONE's financial statements for the financial years 2007-2014. The analysis is conducted

by applying the manually gathered historical accounting numbers published in the audited financial statements from the financial periods 1998-2014. As for the upcoming<sup>14</sup> closing stock price at the publishing date of the financial statements for the FY2015, the thesis constructed a pro forma financial statements regarding the key variables and the parameters applied in the model. After the recalculations, the stock prices generated by the non-simulated or the original Ohlson (1995) model are compared with the actual closing prices at the publishing dates of KONE's financial statements.

### 3.3.1 Assumptions regarding the original and simulated Ohlson (1995) model

The Ohlson (1995) model applied in the analyses is presented in the equation (16) below. Its model-specific details and attributes are discussed in the second chapter in more detail.

$$MV_{t-1} = BV_{t-1} + \sum_{t=1}^n \frac{NI_t - r_E * BV_{t-1}}{(1 + r_E)^t} + \frac{T_n}{(1 + r_E)^n} \quad (16)$$

However, the case-specific assumptions that apply to both the original and the simulated Ohlson (1995) model are worth a closer examination. Therefore, the thesis discusses the assumptions regarding the valuation below.

#### CAPM and the related variables

The required rate of return for the case company's equity capital  $r_E$  is determined by the widely used capital asset pricing model or the CAPM [ $r_E = r_f + \beta_E(r_m - r_f)$ ] and acts as the model's discount rate<sup>15</sup>. It is used as the final discount rate for expected future abnormal earnings and it remains constant in forecasts (Lipe, 1986) for each particular valuation year. As for the FY2015, an average of the applied discount rates in 2007-2014 was applied (10.07 %). As regards to the other variables of the CAPM, the average annual yields on 10-year Finnish government bonds act as the risk-free rate  $r_f$ . The annual averages are determined based on the monthly averages. The average market return  $r_m$  is based on an average of the compounded annual growth rates (hereinafter also referred as the "CAGR") of OMX Helsinki (OMXHPI) from the beginning of 1987 until the particular year's closing rate. The historical beta coefficients of KONE Corporation were determined by benchmarking the variations in its stock price against the OMX Helsinki (OMXHPI) during each particular

<sup>14</sup> Written on 12 December 2015

<sup>15</sup> The thesis acknowledges that the problem of estimating a firm's cost of equity capital is perhaps the single most pressing research issue in corporate finance (Lee, 1999).

year. The average inflation rate within the Eurozone during each particular valuation year acts as the perpetual growth rate  $g$  applied in order to determine the terminal value. All the aforementioned data was gathered from DataStream-database.

### **Expected growth rates of the Ohlson (1995) model's key variables**

The expected growth rate for KONE Corporation's net income or earnings from the initial investment period  $t - 1$  or the decision point until the time  $t$  is determined as presented in equation (17) below:

$$E(NI_{growth\ rate, t}) = (NI_{t-1}/NI_{t-1-9})^{\frac{1}{9}} - 1 \quad (17)$$

Thus, the CAGR represents the linear growth of the item during the prior ten-year period and acts as the expected growth rate for the following five years. This approach is based on a principle, according to which the retrospective period applied as the basis of a forecast should be twice as long as the forecasting period. As stated in the second chapter, a forecasting period of five years is applied both to the original and the simulated Ohlson (1995) model. Information regarding the net income generated specifically by the business division KONE Elevators & Escalators was gathered manually from the consolidated financial statements of KONE during 1998-2005. After the demerger on 1 June 2005, this became the main business of KONE Corporation.

The expected growth rate for KONE Corporation's equity capital is determined as presented in equation (18):

$$E(BV_{growth\ rate, t}) = (BV_{t-1}/BV_{2005})^{1/(t-1-2005)} - 1 \quad (18)$$

Thus, the CAGR or the linear development of the case company's equity capital from the end of 2005 acts as the expected growth rate for this key variable. Due to the mentioned demerger, the closing balance of the equity capital of the FY2005 acts as the basis for the analyses.

### **Other considerations**

As the  $BV_{t+1} = BV_t + NI_{t+1} - D_{t+1}$ , the valuation models are constructed in a way that the distribution of wealth to the firm's shareholders cannot result in negative values yet the

this thesis acknowledges that a negative  $D_{t+1}$  may in real life indicate equity issuances as discussed in the previous chapter. However, this concerns more the simulated model than the original Ohlson (1995) model as the growth in the key variables are assumed to grow linearly and the deviations of the variables are yet excluded from the original model. Although KONE Corporation “has not defined a specific target for dividends or share buy-backs”<sup>16</sup>, the payout ratio for each particular year is calculated afterwards in order to ensure that the determined the growth rates for net income and equity capital ultimately result in values that correspond to reality and are legitimate and plausible assumptions in the analyses.

### 3.3.2 Structure of the original Ohlson (1995) model

Table 2 below presents an example how the valuation based on the original Ohlson (1995) model was conducted. The example concerns the FY2010.

Table 2 The original Ohlson (1995) model in practice – FY2010

(In thousands of euros)	2010	2011	2012	2013	2014	2015
(1) Recorded net income or NI (at time t = 0)	535 900 €					
(2) Expected NI		621 554 €	720 899 €	836 121 €	969 761 €	1 124 760 €
(3) Recorded book value of equity or BV (at time t = 0)	1 600 600 €					
(4) Expected BV		1 905 584 €	2 268 682 €	2 700 965 €	3 215 617 €	3 828 333 €
(5) Distribution of wealth		230 916 €	258 457 €	288 615 €	321 469 €	357 045 €
(6) Theoretical payout ratio		37,15 %	35,85 %	34,52 %	33,15 %	31,74 %
(7) Expected residual income or RI		461 879 €	530 799 €	609 799 €	700 314 €	803 972 €
(8) Expected terminal value or TV						9 762 682 €
(9) Discounted RI		419 982 €	438 869 €	458 452 €	478 743 €	499 750 €
(10) Discounted TV						6 068 493 €
<b>Applied parameters</b>						
Discount rate	9,98 %					
CAGR of BV	19,05 %					
CAGR of NI	15,98 %					
Perpetual growth rate	1,61 %					
Number of shares outstanding (class A + class B)	511 374 712					
Actual closing price (class B share) in 26.01.2011	19,87 €					
<b>Results</b>						
Recalculated market value	9 964 888 €					
Recalculated stock price	19,49 €					
				Difference from the actual (%)		-1,93 %

The calculations are conducted based on the applied Ohlson (1995) model presented and discussed in more detail in the previous chapter. On the grounds of the FY2010’s results, the

<sup>16</sup> Source: <http://www.kone.com/en/investors/share-information/dividend/>, referred on 8 February 2016.

original Ohlson (1995) model seems to work quite accurately. However, the overall results from the period 2007-2014 are presented and discussed in the fourth chapter in more detail.

### **3.4 The simulated Ohlson (1995) model**

In this chapter, the thesis discusses how the stock valuation model that applies Monte Carlo simulation to the Ohlson (1995) model is constructed and the following analyses conducted. The applied data consists of historical accounting numbers during the years 1998-2014 and was gathered manually from the audited financial statements of KONE Corporation. Before the demerger of Kone Corporation into two separately listed firms KONE Corporation and Cargotec Corporation on 1 June 2005, the financial statements naturally contained both the consolidated figures and the disaggregated numbers from the two main business divisions KONE Elevators & Escalators and Kone Cargotec. Since the scope of this thesis is to study the applicability of the simulated Ohlson (1995) model in the light of one firm and one particular sector, only the data regarding KONE Elevators & Escalators per se during 1998-2005 was applied in the analyses. The disaggregated data was found easily from the financial statements, which eased the process remarkably for the following analyses.

#### **3.4.1 Assumptions regarding the simulated Ohlson (1995) model**

KONE Corporation's net income or earning (hereinafter also referred as the "NI") and its book value of equity capital (hereinafter also referred as the "BV") at time zero or  $t - 1$  are the actual recorded values for the particular item extracted from each particular year's financial statements and act as the basis of the analysis. The expected growth rates for these key variables of the Ohlson (1995) model are assumed to be normally distributed as presented below in equations (19) and (20):

$$E(NI_{growth\ rate, t}) \sim N(X_{NI}, \sigma_{NI}^2), \quad (19)$$

where the sample mean  $X_{NI}$  is determined by the linear CAGR during the last ten-year period as presented in the equation (17). The growth rate's variance  $\sigma_{NI}^2$  is determined by calculating the standard deviation  $\sigma_{NI}$  of the annual growth rates from the same ten-year period. For example, the recalculated expected growth rate for  $NI_{2010}$  is 15.98 % (€85 million) and the standard deviation of the corresponding variable is 54.68 % (€293 million).

The assumption regarding the expected growth in  $BV$  is presented below in the equation (20).

$$E(BV_{growth\ rate,\ t}) \sim N(X_{BV}, \sigma_{BV}^2), \quad (20)$$

where the sample mean  $X_{BV}$  is determined by the linear compounded annual growth rate from the closing balance of the FY2005 until the particular year as presented in the equation (18). The growth rate's variance  $\sigma_{BV}^2$  is determined by calculating the standard deviation  $\sigma_{BV}$  of the annual growth rates from the same time period. For example, the calculated growth rate for the year's 2010 book value of equity is 19.05 % (€305 million) and the standard deviation of the corresponding variable is 14.37 % (€230 million).

Probability of each individual event, which is applied to the probability distribution of the model's particular key variable, follows a uniform distribution as follows:  $P \sim U[0,1)$ . This acts as the underlying idea of Monte Carlo simulation, according to which the outcome of an individual event is determined by a randomly generated number greater than or equal to zero and less than 1, each of which have the same probability<sup>17</sup>. The number of iterations ran in each simulation is 10,000 per valuation year.

The simulated Ohlson (1995) model is constructed so that each particular year's outcome is determined by the randomly generated number representing each particular event's probability, the mean or the expected value and the standard deviation of each key variable. As discussed above, residual income at time  $t$  ( $RI_t$ ) or the model's numerator  $NI_t - r_E * BV_{t-1}$  may well have a negative value. This may occur due to the following two reasons:

- (i) The simulation of net income generates a negative value or a loss; or
- (ii) The required return on equity capital (ROE) is higher than the net income.

Therefore, the simulated Ohlson (1995) model may generate a negative expected stock price as the fifth or the final forecasting period may result in a loss due to the nature of the simulation. However, the temporary nature of losses is discussed in more detail in the following chapter.

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<sup>17</sup> This is conducted in Microsoft Excel by applying the function =RAND(), which generates the random number representing a percentual probability.

### 3.4.2 Structure of the simulated Ohlson (1995) model

In figure 4 below, the thesis presents a process chart visualizing the construction process and the functionality of the simulated Ohlson (1995) model.

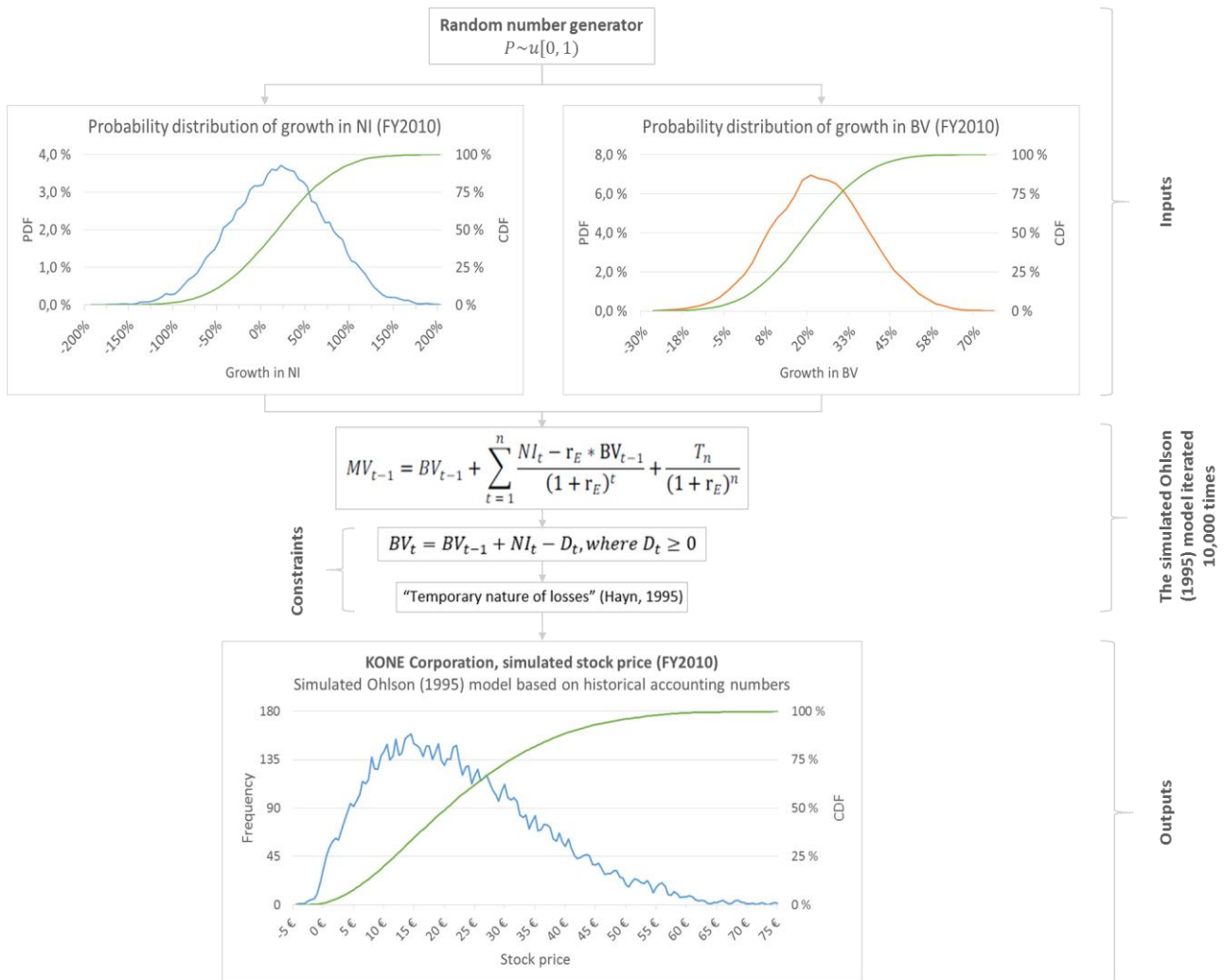


Figure 4 Process chart of the simulated Ohlson (1995) model

Apart from the random number generator, the inputs in the example presented in Figure 4 above are based on the analysis of the FY2010. The model is discussed in more detail below.

As for a single iteration, Table 3 below illustrates how the analysis was conducted in practice for the FY2010. For example, the simulated net income for the FY2011 or  $E(NI_{2011})$  for the amount of €351 million is based on the year's 2010 recorded net income or  $NI_{2010}$  (€536 million). Initially,  $E(NI_{2011})$  is determined as follows:  $E(NI_{2011}) = NI_{2010} * (1 + X_{NI})$ , where the sample mean or the expected growth rate  $X_{NI}$  (15.98 %) is determined as discussed above. In addition to the initial assumption, the standard deviation applied and included in the model is determined as follows:  $\sigma_{NI} * NI_{2010}$  or €535,900 \* 54.68 %, which results in a



numerical value for the amount of €293 million. The standard deviation remains constant in all the five forecasting periods whereas the expected growth in net income varies with its predetermined standard deviation applied to the simulation.

In order to apply Monte Carlo simulation to the Ohlson (1995) model with the help of Microsoft Excel,  $NI_{2011}$  or the first forecasting period is determined by the following function in Excel presented in equation (21):

$$NI_{2011} = NORM.INV[RAND(); NI_{2010} * (1 + X_{NI}); \sigma_{NI} * NI_{2010}] \quad (21)$$

Thus in addition to the applied mean or the expected growth rate, the simulation takes into account the variable's probability distribution including its standard deviation. After setting the bounds, the simulation generates a value within this distribution by applying the random number generator. The following forecasting periods are determined correspondingly yet with some noteworthy adjustments discussed in more detail below.

Table 3 The simulated Ohlson (1995) model in practice – FY2010

(In thousands of euros)	2010	2011	2012	2013	2014	2015
(1) Recorded net income or NI (at time t = 0)	535 900 €					
(2) Simulated NI (Monte Carlo)		351 213 €	229 609 €	70 837 € -	115 084 €	379 464 €
(3) Annual growth of the simulated NI		-34,46 %	-34,62 %	-69,15 %	-262,46 %	429,73 %
(4) Recorded BV (at time t = 0)	1 600 600 €					
(5) BV or (2) + (7)		1 932 905 €	1 890 341 €	1 906 051 €	1 790 967 €	2 170 431 €
(6) Simulated BV (Monte Carlo)		1 660 732 €	1 835 215 €	2 449 023 €	2 229 721 €	2 042 793 €
(7) Applied BV in the model or minimum at [(5),(6)]	1 600 600 €	1 660 732 €	1 835 215 €	1 906 051 €	1 790 967 €	2 042 793 €
(8) Annual growth of the applied BV		3,76 %	10,51 %	3,86 %	-6,04 %	14,06 %
(9) Distribution of wealth		291 081 €	55 126 €	- €	- €	127 638 €
(10) Theoretical payout ratio		82,88 %	24,01 %	0,00 %	0,00 %	33,64 %
(11) Simulated residual income or RI		191 539 €	63 935 € -	112 243 € -	305 230 €	200 798 €
(12) Simulated terminal value or TV						2 438 308 €
(13) Discounted RI		174 164 €	52 862 € -	84 385 € -	208 659 €	124 816 €
(14) Discounted TV						1 515 655 €
<b>Applied parameters</b>						
Discount rate		9,98 %				
Perpetual growth rate		1,61 %				
Number of shares outstanding (class A + class B)		511 374 712				
<b>Applied constant parameters in Monte Carlo simulation</b>						
CAGR of NI (expected growth or the mean)		15,98 %	85 654,12 €			
Standard deviation of growth in NI		54,68 %	293 053,35 €			
CAGR of BV (expected growth or the mean)		19,05 %	304 984,40 €			
Standard deviation of growth in BV		14,37 %	230 008,15 €			
<b>Results</b>						
Simulated market value		3 175 053 €				
Simulated stock price		6,21 €				

As stated by Hayn (1995): “Losses are likely to be considered temporary since shareholders can always liquidate the firm rather than suffer from indefinite losses.” This temporary

nature of losses is taken into account in the simulated Ohlson (1995) model. If the simulation of net income generates a negative value or a loss for the forecasting period (as in 2014 for example), the following year (2015) takes this into account and applies the highest value from the previous years including the initial recorded net income and applies that as the expected value or the mean. Thus, the model is constructed so that it avoids – at least to some extent – continuous streams of losses and practically unrealistic or negative terminal values that are derived from the final forecasting period's  $RI_t$ .

The avoidance of negative values or losses is conducted by adding an IF-function to the simulation model as follows (FY2015 as an example):

$$E(NI_{2015}) = NORM.INV[RAND(); IF(NI_{2014} < 0, then Max at NI_{2010-2013}) * (1 + X_{NI}); \sigma_{NI} * NI_{2010}] \quad (22)$$

It is noteworthy that the simulation model still generates losses as it obviously should, but the temporary nature is embedded into the model. Otherwise the model acts as presented previously.

Taking this into account as regards to the firm's equity capital, the simulated Ohlson (1995) model is constructed so that the final and applied value for the equity at time  $t$  ( $BV_t$ ) in the model is the lowest of the following:

- (i) Simulated  $NI_t + BV_{t-1}$ ; or
- (ii) Simulated  $BV_t$ .

As an example, the simulation generated a loss for the amount of €155 million in 2014, which means that applying the simulated equity for the amount of €2,228 million would be irrational and unrealistic. This is based on the constraint  $BV_t = BV_{t-1} + NI_t - D_t$ , where  $D_t \geq 0$ . In other words, the model assumes that the firm cannot distribute a negative amount of wealth in form of dividends. Noteworthy, the thesis acknowledges the fact that a negative  $D_t$  may in real life indicate equity issuances as discussed in the second chapter. However, taking into account the stability and solvency of the case company, this option is excluded from the model. The simulated  $BV_t$  is determined by following the same regularities as the simulated net income as follows:

$$BV_{2011} = NORM.INV[RAND(); BV_{2010} * (1 + X_{Equity}); \sigma_{Equity} * BV_{2010}] \quad (23)$$

One of the most prominent advantages of the simulated Ohlson (1995) model in comparison with the original model is that the simulation enables an analysis of a situation in which the key variables decrease. Thus, it corresponds to reality more comprehensively.

### 3.4.3 Example of results generated by the simulated Ohlson (1995) model

As Table 3 above presented an example of a single iteration, the following Table 4 presents the statistical results generated by the simulated Ohlson (1995) model for the FY2010 as a whole (after 10,000 iterations).

*Table 4 Statistical results generated by the simulated Ohlson (1995) model – FY2010*

<b>Results</b>	<b>2010</b>
Actual closing price at the publishing date of the financial statements	19,87 €
Simulated stock price (expected value)	22,92 €
Standard deviation or volatility of the simulated stock price	13,72 €
Relative standard deviation or RSD [or coefficient of variation (CV)]	59,85 %
Actual or observed volatility of the stock (12 months)	24,47 %
Standard error of the mean (SEM) based on the simulation	0,1372
Minimum	- 3,85 €
1st Quartile	11,68 €
Median	21,01 €
3rd Quartile	31,29 €
Maximum	94,98 €
Skewness	0,6511
Kurtosis	0,0949
Positive values generated by the simulated Ohlson (1995) model	99,41 %
P(Less than or equal to the actual)	47,67 %
P(Greater than the actual)	52,33 %

The expected stock price is the mean of all the 10,000 simulated stock prices and thus represents the recalculated stock price for the class B share at the publishing date of the financial statements for the FY2010. Additionally, the standard deviation or the volatility of the stock is based on the simulation. It is compared afterwards with the recalculated stock price, which results in the relative standard deviation or the RSD of the stock. In order to study the general applicability of the simulated Ohlson (1995) model, the RSD is compared with the actual or observed 12 month volatility of the stock. As one can see from the numerical results, the simulation's volatility is substantially higher than the actual volatility.

However, the overall results (2007-2014) of the simulation are discussed in the next chapter in more detail.

After 10,000 iterations, the simulated Ohlson (1995) model generates a distribution of all the possible outcomes as discussed in the second chapter in more detail. An illustrative example of the simulation's results from the FY2010 is presented on the right in Figure 5 and

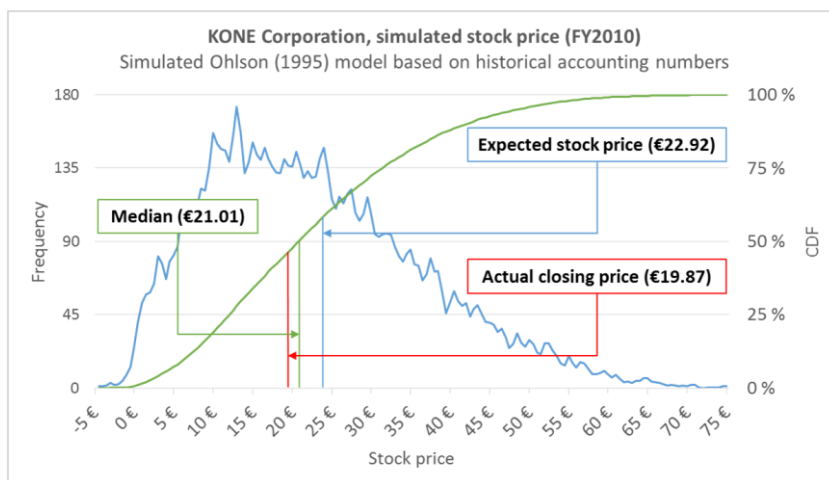


Figure 5 Probability distribution of the expected stock price generated by the simulated Ohlson (1995) model – FY2010

discussed in more detail in the next chapter. The blue line in Figure 4 denotes the expected stock price or the mean of the 10,000 iterations. The green line denotes the median value and the red line the actual stock price at the financial statements' publishing date. The y-axis on the left denotes the frequency distribution and the right y-axis its cumulative distribution function (hereinafter also referred as the "CDF"). The x-axis denotes the possible stock prices generated by the model.

As for the FY2010, the simulation generated a mean value of €22.92 for the closing stock price of KONE Corporation's class B share. In order to elaborate the functionality of the simulated Ohlson (1995) model, by running the simulation ten times, the expected stock price set between €22.33—€22.92. The actual closing price for the stock on 26 January 2011 was €19.87 (or €3.05 lower than the simulation's expected value), which, at least for the year 2010, indicates that the simulated Ohlson (1995) model works relatively well. In comparison, the original Ohlson (1995) model without applying Monte Carlo simulation, however, set the corresponding closing price at €19.49. Worth emphasizing, apart from adding the probability distributions to the model, all the other parameters and assumptions remained the same in both cases. Thus, adding the probability distributions to the Ohlson (1995) model seems to increase the expected stock price.

### 3.4.4 Stock price forecast for FY2015 based on the traditional methods

As mentioned in the previous chapters, KONE Corporation's financial statements for the FY2015 hasn't been published yet. Thus, a comparison between the actual or observed stock price and that based on the simulated Ohlson (1995) model cannot be conducted with the information currently available. However, the author simply couldn't resist the temptation to come up with an educated estimate of what the upcoming closing stock price could be.

Following the fundamentals of the traditional methods – scenario and sensitivity analysis – for analysing uncertainty in decision-making, the thesis formulated three different scenarios reflecting different outlooks on future economic conditions and company performance for the next five years: pessimistic, neutral and optimistic. These scenarios are incorporated into the simulated Ohlson (1995) model with a few minor adjustments discussed in more detail below.

#### Scenario analysis

As for the scenario analysis, uncertainty surrounding the stock price of KONE Corporation is analysed by simulating the following four variables: the expected discount rate  $E(r_E)$ , the expected perpetual growth rate  $E(g)$ ,  $E(NI_{growth})$  and  $E(BV_{growth})$ . In general terms, discount rate and perpetual growth rate act as indicators of future economic conditions. As the beta coefficient of KONE Corporation is currently close to one, the thesis assumes a strong correlation between the growth rates of the key variables of the Ohlson (1995) model and the two indicators. Therefore, if the outlook is considered pessimistic for the economy in general, it is considered pessimistic for the case company as well.

The most significant difference between the scenario analysis at hand and the previously applied simulated Ohlson (1995) model for the years 2007-2014 is that in the scenario analysis the probability distributions of the four variables are assumed to be triangularly distributed and thus having their own minimum (a), mean (c) and maximum (b) values in each particular scenario. Additionally, standard deviations (s) for  $E(NI_{growth})$  and  $E(BV_{growth})$  are determined by the following equation (24):

$$s = \sqrt{\frac{(a^2 + b^2 + c^2 - ab - ac - bc)}{18}} \quad (24)$$

Nevertheless, the mean (c) values of  $E(NI_{growth\ in\ 2016})$  and  $E(BV_{growth\ in\ 2016})$  in the neutral scenario are based on an assumption that both of the key variables of the Ohlson (1995) model grow linearly until the end of the FY2015 following the regularities presented above. Thus, the expected growth rates of the variables are the compounded annual growth rates based on the prior ten years.

Thus, the expected growth rates for the key variables from the beginning of the first forecasting period or the year 2016 are as presented in the equations (25) and (26):

$$E(NI_{growth\ in\ 2016}) = [E(NI_{2015})/NI_{2006}]^{1/9} - 1 = 16.99\ \% \quad (25)$$

$$E(BV_{growth\ in\ 2016}) = [E(BV_{2015})/BV_{2006}]^{1/9} - 1 = 14.36\ \% \quad (26)$$

In each scenario, as for the growth rates of the key variables of the Ohlson (1995) model, the minimum and maximum values are always 12 % away from the particular scenario's mean.

Probability distributions of the perpetual growth rate in each scenario are based on the most recent economic forecasts published and updated regularly in Talouselämä<sup>18</sup>. In each scenario, the minimum and maximum values of the perpetual growth rate's probability distribution are always 0.75 % from the particular scenario's mean. On the grounds of the previous analyses, the mean value of  $E(g)$  in the neutral scenario is 0.10 % (the current inflation rate).

The discount rate's mean in the neutral scenario is the average of the discount rates applied to the previous analyses for the years 2007-2014. In each scenario, the minimum and maximum values of the discount rate's probability distribution are always 2 % away from the particular scenario's mean.

Apart from  $E(r_E)$ , all the variables' mean values in the neutral scenario equal the maximum and minimum values of the pessimistic and optimistic scenarios, respectively. As for  $E(r_E)$ , the situation is the opposite. Theoretically speaking, all the probability distributions are symmetric around their means. In other words, the co-called best-case scenario for a pessimistic investor equals the worst-case scenario considered by an optimistic investor.

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<sup>18</sup> <http://www.talouselama.fi/suhdanne-ennuste/tuoreimmat-suhdanne-ennusteet-3419786>, referred on 5 January 2016.

For illustrative purposes, the triangular distributions of the key variables' expected growth rates are presented below in Figure 6.

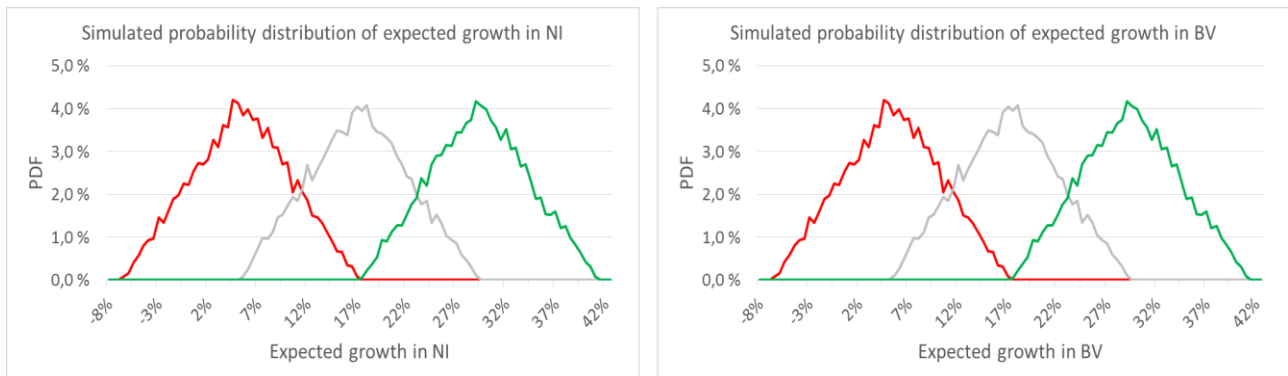


Figure 6 Triangular distributions of the key variables' growth rates

The red, grey and green triangles above denote pessimistic, neutral and optimistic scenarios, respectively.

A summary of the rates applied to each particular scenario in the analysis is presented below in Table 5.

Table 5 Rates applied to the scenario analysis

<b>NI growth simulation</b>	<b>Pessimistic</b>	<b>Neutral</b>	<b>Optimistic</b>
Minimum (a)	-7,01 %	4,99 %	16,99 %
Mean (c)	4,99 %	16,99 %	28,99 %
Maximum (b)	16,99 %	28,99 %	40,99 %
Standard deviation (s)	4,90 %	4,90 %	4,90 %
Random number generator	0,8103	0,9929	0,7587
Simulated growth rate of NI based on triangular distribution	9,60 %	27,56 %	32,66 %
<b>BV growth simulation</b>	<b>Pessimistic</b>	<b>Neutral</b>	<b>Optimistic</b>
Minimum (a)	-9,64 %	2,36 %	14,36 %
Mean (c)	2,36 %	14,36 %	26,36 %
Maximum (b)	14,36 %	26,36 %	38,36 %
Standard deviation (s)	4,90 %	4,90 %	4,90 %
Random number generator	0,2883	0,3162	0,9432
Simulated growth rate of BV based on triangular distribution	-0,53 %	11,90 %	34,31 %
<b>Discount rate simulation</b>	<b>Pessimistic</b>	<b>Neutral</b>	<b>Optimistic</b>
Minimum (a)	10,07 %	8,07 %	6,07 %
Mean (c)	12,07 %	10,07 %	8,07 %
Maximum (b)	14,07 %	12,07 %	10,07 %
Standard deviation (s)	0,5000	0,5000	0,5000
Random number generator	0,0656	0,2289	0,7246
Simulated discount rate based on triangular distribution	10,79 %	9,42 %	8,59 %
<b>Perpetual growth rate simulation</b>	<b>Pessimistic</b>	<b>Neutral</b>	<b>Optimistic</b>
Minimum (a)	-1,40 %	-0,65 %	0,10 %
Mean (c)	-0,65 %	0,10 %	0,85 %
Maximum (b)	0,10 %	0,85 %	1,60 %
Standard deviation (s)	0,5000	0,5000	0,5000
Random number generator	0,3340	0,4201	0,2195
Simulated perpetual growth rate based on triangular distribution	-0,79 %	0,04 %	0,60 %

The simulated rates and the randomly generated numbers in Table 5 above (the last two rows in each rate) are results of a single iteration round. The cells are then linked to the same simulated Ohlson (1995) model that was applied to the financial years 2007-2014.

### **Sensitivity analysis on the four variables**

In addition to the scenario analysis discussed above, the thesis conducted a sensitivity analysis for the purpose of studying how the expected stock price generated by the simulated Ohlson (1995) model reacts when each of the four variables is changed holding the other variables constant. The three outlooks and the probability distributions are the same as in the scenario analysis discussed above.



## **4 Empirical results**

The fourth chapter presents, discusses and interprets the empirical results of the conducted analyses. Methodology of the analyses was discussed in more detail in the previous chapter.

First, the thesis presents the results of the conducted regression analyses, in which the market values of Finnish publicly listed firms were regressed on the key variables – earnings and book values of equity – of the Ohlson (1995) model. The initial purpose of the regression analysis is to examine the value relevance of the presented bottom-line items by studying whether their variations explain the variation in the market values. According to the results of the regression analysis conducted for the period 2007-2014, earnings and book values of equity show statistically significant explanatory power to the market values and therefore are considered value relevant components.

Secondly, the thesis discusses the general applicability of the original Ohlson (1995) model on the basis of the historical accounting numbers of KONE Corporation. Applied assumptions and the structure of the valuation model is presented and discussed in more detail in the methodology chapter. This analysis acts as an initial framework for the third analysis, in which the Ohlson (1995) model is combined with Monte Carlo simulation. According to the results, the original Ohlson (1995) model can be regarded as a plausible and applicable valuation method for a large enterprise but does not set the recalculated stock prices within one standard deviation of the mean without exceptions.

The third analysis combines the first two analyses and links the theoretical framework of the Ohlson (1995) model into practice via Monte Carlo simulation and real-life accounting numbers. The purpose of the simulated Ohlson (1995) model is to examine whether or not it provides an investor with more detailed and accurate information in comparison with the original Ohlson (1995) model. According to the results, the simulated Ohlson (1995) model does not generate more accurate results in comparison with the original Ohlson (1995) model but provides investors with additional and more detailed information on the stock prices.

Acknowledged restrictions, challenges, limitations and other considerations regarding the analyses as well as propositions for future academic research are discussed in more detail in the fifth chapter.

#### **4.1 Value relevance of earnings and book values to market values**

On grounds of the conducted regression analyses, only the earnings in relation to the book values of equity or the variable  $NI_{jt}/BV_{jt}$  showed clear statistically significant explanatory power to the market values consistently during all the three periods. However, during the period 2000-2014, the coefficient  $\alpha_0$  on  $1/BV_{jt}$  is considered statistically insignificant due to its high p-value (0.128). Therefore, the first hypothesis of the thesis as stated below is rejected.

**H1:** *Earnings and book values have statistically significant explanatory power to market values at a 5 % significance level.*

Nevertheless, the thesis would like to emphasize that although the first hypothesis of the thesis is rejected based on the results from the period 2000-2014, the key variables of the Ohlson (1995) model have statistically significant explanatory power to the market values of the sample firms during 2007-2014. Therefore, the further examination of the key variables' effect on the stock prices of the case company KONE Corporation in 2007-2014 is statistically reasonable and justifiable.

Results of the regression analyses concerning the scaled key variables' coefficients, the corresponding p-values and the explanatory powers (R Square) of the three models are summarized below. Additionally, the coefficients of the control variables or the sector and financial year are included in the summary and interpreted below.

Table 6 Summary of the regression analyses' results

	2000-2014		2000-2006		2007-2014	
	Coefficient $\alpha$	P-value ( $\alpha$ )	Coefficient $\alpha$	P-value ( $\alpha$ )	Coefficient $\alpha$	P-value ( $\alpha$ )
Constant	1,356	<b>0,028</b>	0,385	0,817	1,016	<b>0,027</b>
1/BV	-1,463	0,128	-5,798	<b>0,001</b>	2,459	<b>0,006</b>
NI/BV	7,364	<b>0,000</b>	9,637	<b>0,000</b>	5,803	<b>0,000</b>
Sector and year indicators (control variables)	Included		Included		Included	
R Square	0,257		0,277		0,333	
Adjusted R Square	0,240		0,252		0,313	
Sample size	1151		525		626	

SEC2	-0,178	0,769	0,388	0,814	-0,073	0,878
SEC3	0,240	0,678	0,740	0,647	0,385	0,386
SEC4	0,348	0,553	0,851	0,600	0,448	0,321
SEC5	-0,375	0,534	0,170	0,918	-0,285	0,544
SEC6	-0,233	0,726	0,542	0,764	-0,180	0,725
SEC7	-0,257	0,666	0,563	0,732	-0,472	0,307
SEC8	1,376	<b>0,019</b>	2,877	0,077	0,586	0,197
SEC9	1,099	0,148	1,992	0,296	1,170	0,058
SEC10	-0,211	0,775	0,275	0,880	0,004	0,994
2001	-0,929	<b>0,002</b>	-0,895	<b>0,018</b>	-	-
2002	-1,050	<b>0,001</b>	-0,893	<b>0,021</b>	-	-
2003	-0,474	0,118	-0,356	0,349	-	-
2004	-0,653	<b>0,024</b>	-0,634	0,080	-	-
2005	-0,490	0,090	-0,525	0,146	-	-
2006	-0,438	0,125	-0,513	0,151	-	-
2007	-0,611	<b>0,032</b>	-	-	-	-
2008	-1,525	<b>0,000</b>	-	-	-0,933	<b>0,000</b>
2009	-0,305	0,335	-	-	0,168	0,423
2010	-0,444	0,128	-	-	0,082	0,671
2011	-1,045	<b>0,000</b>	-	-	-0,499	<b>0,010</b>
2012	-0,848	<b>0,004</b>	-	-	-0,295	0,129
2013	-0,380	0,196	-	-	0,181	0,351
2014	-0,517	0,069	-	-	0,008	0,968

The results of each particular period are discussed in more detail in the following chapters below.

#### 4.1.1 Value relevance of the key variables during 2000-2014

As for the period 2000-2014, the regression model's R Square is 0.257 (the adjusted R Square is 0.240), indicating that 25.7 % of the variation in the market values of the sample firms can be explained by the variation in the independent variables. Additionally, the F

statistic that describes the statistical significance of the model as a whole is 15.562 (p-value 0.000), which indicates quite evidently that the model itself is plausible.

The coefficient of the intercept or the constant is 1.356 (p-value 0.028) and statistically significant at a 5 % significance level. The coefficient of the constant indicates that if all the independent variables including the model's control variables get the value zero, the dependent variable  $MV_{jt}/BV_{jt}$  (hereinafter also referred as the "P/B-ratio") would be 1.356. In other words, the initial P/B-ratio of the reference category or the Energy sector (SEC1) in 2000 was 1.356 given that all the other variables get the value zero. However, the scenario in which the scaled key variables would get zero values is more or less theoretical due to the existence of equity capital. Additionally, it is noteworthy that the average P/B-ratio in the sample is 2.0855, which indicates that during the years 2000-2014, the market values of equity were – on average – approximately twice the corresponding book values of equity.

According to the model, the estimated coefficients  $\alpha_0$  on  $1/BV_{jt}$  and  $\alpha_2$  on  $NI_{jt}/BV_{jt}$  in the regression model are as follows: -1.463 (p-value 0.128) and 7.364 (p-value 0.000), respectively. The p-value of the coefficient  $NI_{jt}/BV_{jt}$  is clearly less than the significance level of 5 % (0.05) used in the analysis, which indicates its clear statistical significance and therefore value relevance to the market values. As stated above,  $NI_{jt}/BV_{jt}$  is considered statistically significant or value relevant based on all the calculation periods. However, the coefficient of  $1/BV_{jt}$  cannot be deemed as statistically significant due to the high p-value and thus does not differ significantly from zero. The sample mean of the explanatory variable  $1/BV_{jt}$  is 0.0271.

As for the coefficients of the control variables, the regression analysis uncovers some interesting findings. As for the sectors, the coefficient of SEC8 (Information Technology) is 1.376 and its p-value is 0.019. Therefore it is the only sector with statistically significant coefficient at a 5 % significance level during the period. As for the financial years, seven out of the fifteen years are statistically significant at the applied significance level and all of the coefficients were negative. In order to elaborate the matter in more detail, adding up for example the coefficient of SEC8 with the coefficient of the FY2004 (-0.653, p-value 0.024), the regression analysis shows that the sector's P/B-ratios in 2004 were initially 53.3 % higher than those of the reference category. Therefore it is important not to run into hasty conclusions merely based on the negative coefficients.

As a theoretical example, consider a firm in SEC8 (Information Technology) that manages to increase its annual net income in 2002 by 10 % from €10 million and then distributes the earned wealth for the amount of one million dollars in a form of dividends to the firm's shareholders during the same year. The firm's  $BV_{jt}$  for the theoretical amount of €100 million remains unchanged due to the distribution of wealth, yet the  $NI_{jt}/BV_{jt}$  increased by 10 %. Let's assume that the initial P/B-ratio in 2002 of the particular firm is 2.418 (the firm records an annual net income of €10 million and its book value of equity is €100 million). In this particular case, the final P/B-ratio increases to 2.492 due to the 10 % increase in the net income, which increases the firm's market value by 3.04 %. According to the model and this particular example, doubling its net income the firm is able to increase its market capitalization by 30.45 %. Additionally, the sample mean of  $NI_{jt}/BV_{jt}$  is 0.1464 (14.64 %), which represents the average ratio of the sample firms' net income to their book values of equity during the years 2000-2014. If the firm's initial  $NI_{jt}/BV_{jt}$  were 0.1464 instead of the previous ratio 0.10, the comparable increase of 10 % in the variable would result in a 3.91 % increase in the P/B-ratio and therefore in the market value as well. What does this actually tell us? According to the model, the higher the initial  $NI_{jt}/BV_{jt}$  is the greater the increase in the market value is (assuming a constant 10 % increase in net income and instant distribution of wealth). However, if the firm decides to retain all of its annual earnings for the amount of €11 million instead of distributing the wealth to shareowners and therefore increase its book value of equity to €111 million, its P/B-ratio drops to 2.412. According to the model, this results in a theoretical increase of 7.42 % in the firm's market value (SEC8 and 2002). Thus, quite interestingly, retaining the earnings lowers the P/B-ratio yet increases the corresponding market value.

According to the correlation analysis for the period 2000-2014 (more detailed information in Appendix B), correlation between the P/B-ratios or  $MV_{jt}/BV_{jt}$  and  $1/BV_{jt}$  shows statistical significance and its strength varies from very weak to weak depending on the examined correlation coefficient<sup>19</sup>. The linear relationship between  $MV_{jt}/BV_{jt}$  and the scaled earnings or  $NI_{jt}/BV_{jt}$  is significantly higher than the correlation between  $MV_{jt}/BV_{jt}$  and  $1/BV_{jt}$  as it varies from moderate to strong (statistically significant as well). The linear relationship between  $NI_{jt}/BV_{jt}$  and  $1/BV_{jt}$  is considered very weak or weak.

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<sup>19</sup> Pearson's  $r$  and Spearman's  $\rho$

#### 4.1.2 Value relevance of the key variables during 2000-2006

As for the period 2000-2006, the regression model's R Square is 0.277 (the adjusted R Square is 0.252), indicating that 27.7 % of the variation in the market values of the sample firms can be explained by the variation in the independent variables. In comparison with the previously discussed period, the explanatory power is 2.0 percentage points higher. Additionally, the F statistic that describes the statistical significance of the model as a whole is 11.401 (p-value 0.000), which indicates quite evidently that also the regression model for the period 2000-2006 is statistically plausible.

The coefficient of the intercept or the constant is 0.385 (p-value 0.817) and statistically insignificant at a 5 % significance level. Although this indicates that the constant term is not significantly different from zero, it should not be removed from the equation. Due to its statistical insignificance, theoretically the P/B-ratio of a firm gets the value zero if all the other variables are zero.

During the period, the estimated coefficients  $\alpha_0$  on  $1/BV_{jt}$  and  $\alpha_2$  on  $NI_{jt}/BV_{jt}$  in the regression model are as follows: -5.798 (p-value 0.001) and 9.637 (p-value 0.000), respectively. Due to the statistically significant and similar coefficient  $\alpha_2$  on  $NI_{jt}/BV_{jt}$ , the interpretation and its theoretical application are as discussed in the previous chapter. Although it is noteworthy that the coefficient's value is higher, the overall effect does not differ substantially from that of the previous model. However, the statistically significant coefficient  $\alpha_0$  on  $1/BV_{jt}$  is worth further examination. Its mathematical form and relatively low – in comparison with that of the previous model – and negative coefficient -5.798 imply initially that an increase in book values actually has a positive effect on the P/B-ratios as for the variable per se. Mathematically a higher  $BV_{jt}$  results in a lower negative effect on the P/B-ratio. In other words, the results of the regression model imply that retaining earnings or not distributing them to the shareholders of a firm actually has a positive effect on the firm's P/B-ratio. However, this is not how the model works as a whole. By taking the other variables into account as well, the model actually shows that it is the other way around. As a theoretical example, consider a firm that manages to record a solid €20 million net income in 2002. The firm's  $BV_{jt}$  is €100 million. According to the model, instead of distributing the well-earned wealth to the shareholders and deciding to retain the earnings for future investments, the initial effect on the firm's P/B-ratio is -0.312 (-31.91 %). In terms of the

firm's market value, it drops 18.29 %. This is contradictory to the irrelevancy of dividend distribution (Ohlson, 1995) discussed in the second chapter.

None of the sectors' coefficients including the constant term of the model showed statistical significance. Furthermore, only the coefficients for the years 2001 and 2002 are considered statistically significant due to their lower than 0.05 p-values. What does this tell us? According to the model, the effect on the P/B-ratios caused by variation in the independent variables  $1/BV_{jt}$  and/or  $NI_{jt}/BV_{jt}$  is the same regardless of sector. For example, if two separate firms from the sectors SEC2 and SEC9 record an equivalent increase in their  $NI_{jt}/BV_{jt}$ -ratios, the final effect on the P/B-ratios is the same for the both firms. The same goes with the variable  $1/BV_{jt}$ .

As regards to the correlation analysis for the period 2000-2006, the results show a moderate or strong, statistically significant correlation between  $NI_{jt}/BV_{jt}$  and the corresponding P/B-ratios. As for the relationship between the P/B-ratios and  $1/BV_{jt}$ , the results are consistent with the results based on the previous period.

#### **4.1.3 Value relevance of the key variables during 2007-2014**

As for the period 2007-2014, the regression model's R Square is 0.333 (the adjusted R Square is 0.313), indicating that 33.3 % of the variation in the market values of the sample firms can be explained by the variation in the independent variables. In comparison with the previously discussed periods 2000-2014 and 2000-2006, the explanatory power of the model is 7.6 and 5.6 percentage points higher, respectively. Additionally, the F statistic that describes the statistical significance of the model as a whole is 16.816 (p-value 0.000) and the highest of the three models, which indicates quite clearly that the regression model for the period 2007-20014 is plausible as well.

It is noteworthy that in comparison with the previous regression models, the coefficients of the model's constant and scaled key variables are all statistically significant (p-values less than 0.05) at a 5 % significance level. During the period, the estimated coefficients  $\alpha_1$  on the constant,  $\alpha_0$  on  $1/BV_{jt}$  and  $\alpha_2$  on  $NI_{jt}/BV_{jt}$  in the regression model are as follows: 1.016, 2.459 and 5.803, respectively. The interpretation of the coefficients of the constant and the  $NI_{jt}/BV_{jt}$  does not differ from those discussed in more detail in the previous chapters, but that of the variable  $1/BV_{jt}$  does. Its positive (N.B. negative in 2000-2006) coefficient implies

that an accumulation of earnings actually decreases the P/B-ratio yet increases the market value. As a theoretical example, consider a firm that manages to increase its  $BV_{jt}$  by 10 % from €100 million. This is achieved by recording an annual net income for the amount of €10 million and investing the earnings back into the firm's equity for future investments. The coefficient's value drops from 0.0100 to 0.0091 or -9.09 %, which causes an equivalent decrease in the P/B-ratio. Although the P/B-ratio drops, it is caused by the increase in  $BV_{jt}$ . Holding other factors constant, the aforementioned actually increases the firm's market value by 6.27 %. Thus, the period's results are comparable to those of 2000-2014 by interpretation.

None of the sectors' coefficients excluding the constant term of the model showed statistical significance. Furthermore, only the coefficients for the years 2008 and 2011 are statistically significant. The correlation analysis' results for the period are consistent with the previous periods' results. The relationship between the P/B-ratios and  $NI_{jt}/BV_{jt}$  are considered moderate or strong and statistically significant.

Finally, the thesis would like to emphasize the following. Although the first hypothesis of the thesis is rejected based on the results from the period 2000-2014, the key variables of the Ohlson (1995) model have statistically significant explanatory power to the market values of the sample firms during 2007-2014. Therefore, the further examination of the variables' effect on the stock prices in 2007-2014 is statistically plausible.

#### **4.1.4 Value relevance of the key variables within the Industrials sector (SEC3) in 2008**

This chapter links the conducted regression analyses to the case company KONE Corporation and the Industrials sector (SEC3<sup>20</sup>) it represents. The chapter discusses and interprets the results of the regression analyses and focuses especially on the FY2008. Furthermore, as the simulated Ohlson (1995) model generated the most substantial spread between the actual stock prices and the recalculated stock prices based on the simulation model particularly in 2008 (discussed in more detail in the following chapters later in the

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<sup>20</sup> The Global Industry Classification Standard (GICS) categorises KONE Corporation as a firm in the Industrials sector (SEC3). Other firms in the sector among others are: Cargotec Oyj, Cramo Oyj, Glaston Oyj ABP, Konecranes Oyj, Lemminkäinen Oyj, Wärtsilä Oyj and YIT Oyj.



thesis), the thesis focuses on the potential effect of the Financial Crisis on the Industrials sector (SEC3).

According to the results of the conducted regressions analyses, the coefficient of SEC3 (Industrials) is considered statistically insignificant due to its high p-values during all the three periods. Statistically speaking, this indicates that the sector's coefficient is not significantly different from zero. However, the analyses for the periods 2000-2014 and 2007-2014 revealed some extremely important findings regarding the FY2008 in particular.

As for the period 2000-2014, the coefficient of the FY2008 is -1.525 (p-value 0.000) or substantially lower than that of any other sector considered in the analysis. According to the model, this indicates that the recorded P/B-ratios in 2008 were the lowest during the period 2000-2014 regardless of the sector. Additionally, the coefficient is lower than that of any other financial year, which indicates the potential effect of the Financial Crisis on the P/B-ratios of the sample firms. In order to emphasize the effect of the coefficient, even the P/B-ratios within the strong Information Technology sector were lower than that of the reference category in 2008. As for the SEC3 (Industrials), the whole industry witnessed a substantial drop (equivalent to the coefficient -1.525) in the corresponding P/B-ratios in 2008. Based on the regression model, the P/B-ratios within the sector were 112.5 % lower than those of the reference category. As for the SEC3 per se, the average  $MV_{jt}/BV_{jt}$ -ratio was 1.5206 in 2000 (26 firms). In comparison with 2008, the ratio was 1.1757 (29 firms).

The same conclusion can be drawn from the results of the period 2007-2014: the coefficient of the FY2008 is -0.933 (p-value 0.000) or significantly lower than that of any considered sector apart from the SEC9 (Telecommunication Services). However, it is noteworthy that the sector in the sample includes only one firm (a Finnish telecommunication company Elisa Oyj). Additionally, the sector's coefficient is not statistically significant. The coefficient of the FY2008 is also substantially lower than in comparison with the other years. The reference category's (SEC1 or the Energy sector in 2007) coefficient is 1.016 and considered statistically significant due to its p-value of 0.027. Holding other factors constant, the regression model indicates that the P/B-ratios of SEC3 in 2008 were initially 91.8 % lower than those of the reference category. As regards to the SEC3 per se, the average P/B-ratio was 2.5140 in 2007 (32 firms), which indicates a strong belief in the positive development of the sector during the time. However, the ratio dropped quite drastically to 1.1757 (-53.2

%) the next year. In order to elaborate the matter, the average equity capital within the sample firms in SEC3 was €310 million in 2007 and €302 million in 2008. Thus, the minor drop in the corresponding book values of equity capital does not explain the fall of P/B-ratios.

## **4.2 Applicability of the original Ohlson (1995) model**

Although the first hypothesis of the thesis is rejected, the conducted regression analysis for the period 2007-2014 showed a clear statistical significance of the key variables – earnings and book values of equity – on the market values within the sample firms. Therefore, the further examination of the Ohlson (1995) model's key variables is statistically reasonable during this period.

The purpose of the analysis is to assess the general applicability of the Ohlson (1995) model. Thus, the second hypothesis of the thesis is the following:

**H2:** *The original Ohlson (1995) model is a plausible and applicable valuation method for a large enterprise and sets the recalculated stock prices within one standard deviation of the mean or the actual stock prices.*

As presented below in Table 7, two out of the eight recalculated stock prices did not set within one standard deviation of the mean (the financial years 2007 and 2008). Thus, the second hypothesis is rejected as it is.

### **4.2.1 Empirical results based on the original Ohlson (1995) model**

A summary of the results is presented below in Table 7. KONE Corporation's financial statements for the FY2015 hasn't been published yet<sup>21</sup>, which is why the thesis cannot analyse the original Ohlson (1995) model's applicability in the light of the particular year.

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<sup>21</sup> Written on 12 December 2015.

Table 7 Results concerning the 2<sup>nd</sup> hypothesis

Results	2007	2008	2009	2010	2011	2012	2013	2014
Actual closing price at the publishing date of the financial statements	11,25 €	7,70 €	14,28 €	19,87 €	21,09 €	29,25 €	31,83 €	40,35 €
Actual closing price + one standard deviation	15,11 €	11,28 €	19,35 €	24,73 €	27,29 €	36,49 €	39,54 €	48,75 €
Actual closing price - one standard deviation	7,39 €	4,12 €	9,21 €	15,01 €	14,88 €	22,01 €	24,12 €	31,95 €
Recalculated stock price based on the original Ohlson (1995) model	7,38 €	22,66 €	17,55 €	19,49 €	25,06 €	30,56 €	29,80 €	39,77 €
Recalculated stock price sets within one standard deviation of the mean	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Accept or reject the second hypothesis (H2)	Reject	Reject	Accept	Accept	Accept	Accept	Accept	Accept

The recalculated stock prices for the financial years 2009-2014 set within one standard deviation of the mean. Additionally, four out of the eight recalculated market prices for KONE Corporation's class B share during the years 2007-2014 set higher than the actual closing prices at the publishing dates of the financial statements. In terms of differences between the actual stock prices and the recalculated prices based on the original Ohlson (1995) model, the smallest spread was in 2014 (1.44 % lower than the actual; the least biased year) and the largest in 2008 (194.25 % higher than the actual; the most biased year). The differences between the prices for the period 2007-2014 are visualized below in Figure 7.

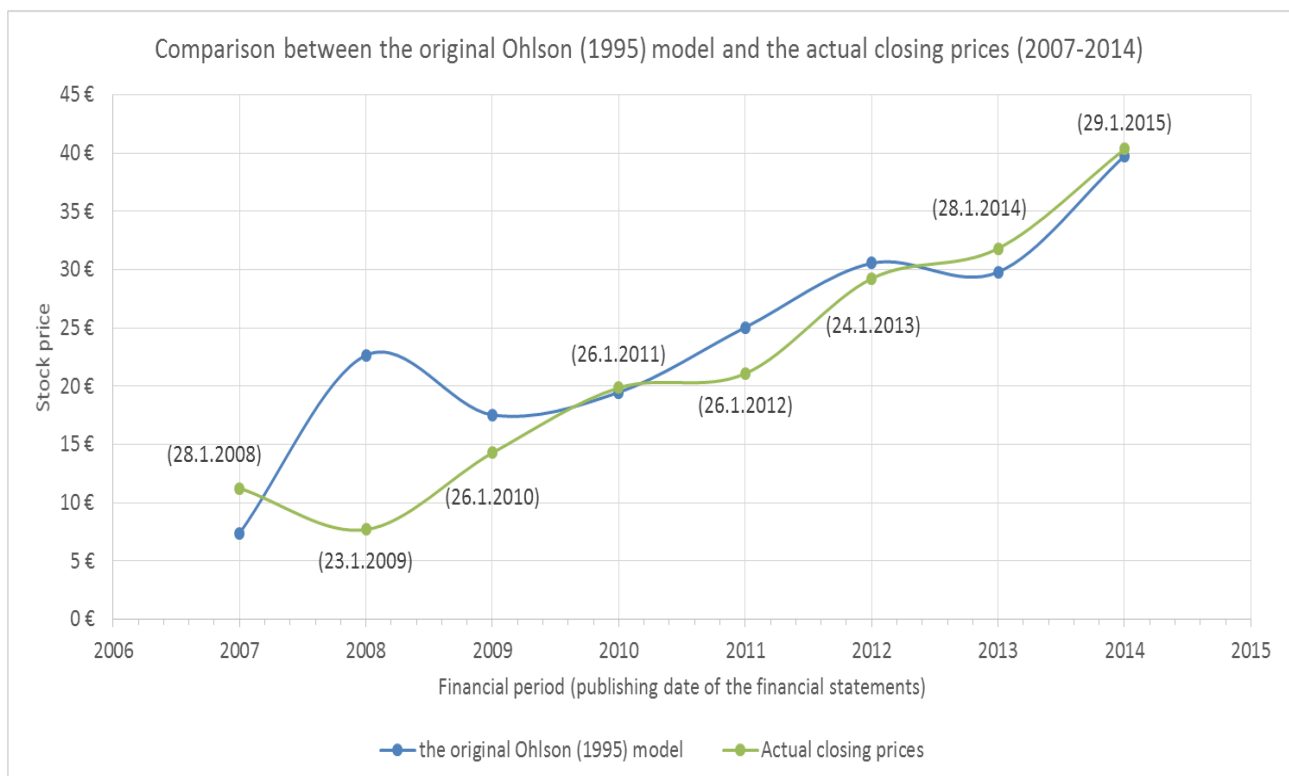


Figure 7 Comparison between the original Ohlson (1995) model and the actual closing prices

Although the original Ohlson (1995) model generally generated quite accurate stock prices in comparison with the actual closing prices, it did not apply flawlessly to the case company

KONE Corporation. Especially the large spread in 2008 is worth closer examination. The FY2008 and the potential effect of the Financial Crisis on the stock prices within the whole sector (SEC3 or the Industrials) is also discussed in the previous chapter in more detail.

#### 4.2.2 Remarks concerning FY2008

As mentioned above, the largest spread between the stock prices occurred in 2008. In statistical terms, the results generated by the simulated Ohlson (1995) model for the FY2008 were very biased. Rates applied to the original and the simulated Ohlson (1995) model for the years 2007-2014 are presented below in Table 8.

Table 8 Summary of the rates applied to the original and the simulated Ohlson (1995) model

	2007	2008	2009	2010	2011	2012	2013	2014
Discount rate	11,25 %	11,24 %	9,73 %	9,98 %	10,29 %	8,58 %	9,86 %	9,64 %
Perpetual growth rate	2,13 %	3,28 %	0,30 %	1,61 %	2,70 %	2,50 %	1,34 %	0,44 %
CAGR of NI (expected growth)	19,43 %	24,64 %	17,89 %	15,98 %	16,98 %	15,83 %	17,74 %	24,36 %
CAGR of BV (expected growth)	5,81 %	15,68 %	18,94 %	19,05 %	20,36 %	16,12 %	12,56 %	13,32 %

First of all, there were no significant changes in the applied perpetual growth rates ( $g$ ) or the discount rates ( $r_E$ ) during the period. As addressed above, the applied expected growth rates of the key variables  $NI_t$  and  $BV_t$  in both the original and the simulated Ohlson (1995) model witnessed quite substantial increases from those made for the FY2007. However, the applied expected growth rate of  $NI_t$  increased from 2013 to 2014 more than at the verge of the Financial Crisis, yet the model did not generate comparable differences in the stock prices. As discussed in the third chapter in more detail, the applied rates were based on the same assumptions and regularities consequently year after year.

Comparing the expected and the actual recorded net income, equity and residual income in 2008, one can observe that KONE Corporation outperformed its expectations set in 2007 for the FY2008 quite substantially, which – based on the constructed valuation model – caused the rapid increase in the expected growth rates. For example, the residual income in 2008 was 164.66 % higher than what could have been expected based on the Ohlson (1995) model's expected growth rates and other assumptions, which were based on the same regularities and historical accounting numbers than in the model otherwise.

Apart from the FY2008, applying the CAGR-based assumptions seems as a plausible alternative to determine the expected growth rates. This is illustrated below in Figure 8.

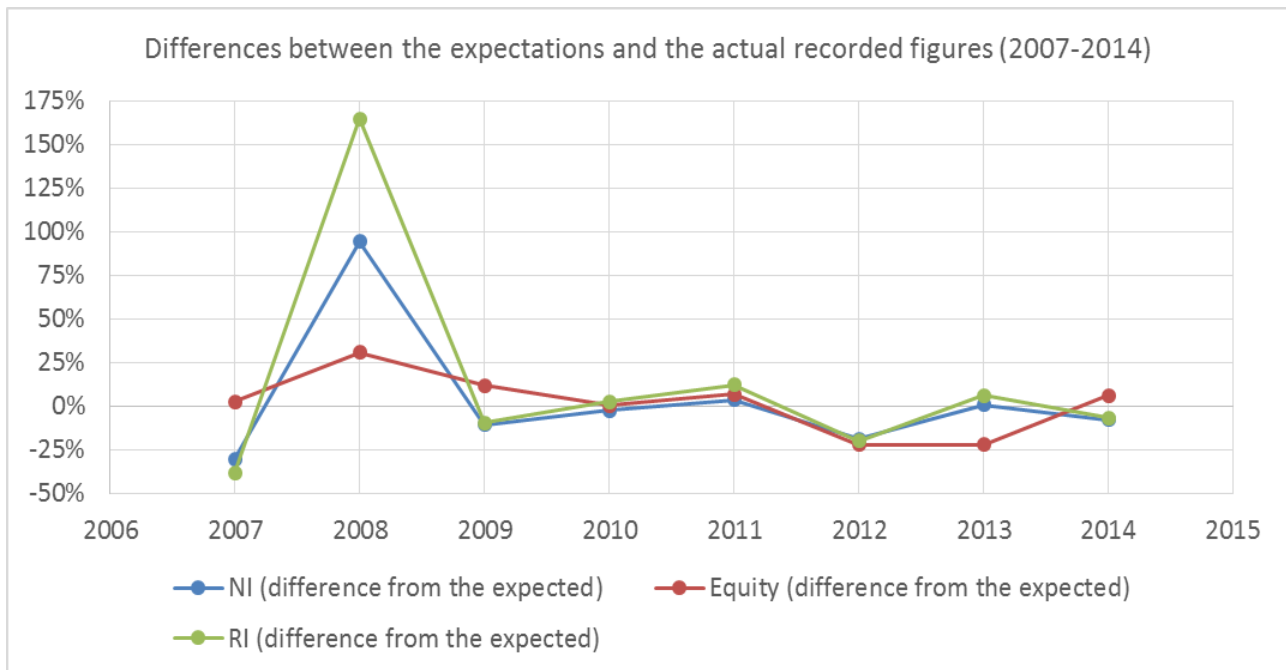


Figure 8 Differences from the CAGR-based expectations

As regards to KONE Corporation's net income and equity in 2008, the actual recorded figures in this respect were 94.16 % and 30.68 % higher than what could have been expected based on the constructed Ohlson (1995) model's assumptions made in 2007 for the FY2008. By taking a closer look at the differences between the expectations and the actual recorded figures, the final difference seems to have a tendency towards zero, which indicates stabilization between the Ohlson (1995) model and KONE Corporation's actual business after the FY2008. However, in 2012 and 2013 the book values of equity set approximately 22 % lower than expected. Nevertheless, this did not seem to have comparable effect to the recalculated stock prices, which were lower (2012) and higher (2013) than could have been assumed based on the model. Interestingly, regardless of the higher than expected company performance in 2008, the market price closed at €7.70 at the publishing date of financial statements (23 January 2009) whereas a year before the corresponding price was €11.25. As discussed in the previous chapter that covers the conducted regression analyses, the whole Industrials sector (SEC3) witnessed a quite significant drop in their P/B-ratios in 2008. The previous chapter also states that the drop was not due to the minor decrease in the sample firms' book values of equity but the corresponding market values.

#### 4.2.3 Final interpretation of the original Ohlson (1995) model's applicability

Taking into account the matters discussed above, the model does not work flawlessly without any additional analysis, which leaves room for ad hoc adjustments to analysts' forecasts and

investor discretion. Additionally, as stated by Dechow et al. (2014), growing research offers evidence that is inconsistent with the efficient market hypothesis. In other words, the evidence suggests that prices are surprisingly inefficient with respect to accounting information and prices take several months to fully reflect the information in earnings surprises (Dechow et al., 2014), which seems to be the exact case also in the conducted analysis as regards to the FY2008. The substantially higher than expected results were applied immediately to the Ohlson (1995) model, but not recognized correspondingly by equity markets. Thus, the model does not generate expected stock prices that reflect their true value (assuming that the market price is equal to the fundamental value of firm).

Nevertheless, after the large spread in 2008 the difference starts to narrow incrementally. Additionally, the recalculated stock prices for the years 2009-2014 set within one standard deviation (the actual volatility of the stock) of the actual closing price. Thus, the original Ohlson (1995) model can be considered suggestive by nature.

### **4.3 Accuracy of the simulated Ohlson (1995) model**

The fundamental purpose of applying Monte Carlo simulation to the Ohlson (1995) model is to assess whether it provides investors with more detailed and accurate information on stock prices in comparison with the original Ohlson (1995) model and in relation to the actual closing prices. In the analysis, KONE Corporation's closing stock prices at the publishing dates of the financial statements for the years 2007-2014 were recalculated. As for the FY2015, the expected stock price was ultimately determined based on both the simulated Ohlson (1995) model and the conducted scenario analyses, structures and assumptions of which are discussed in more detail in the previous chapter. Based on the following results, one can draw conclusions whether the simulation is worth the shot or should it be considered a mere Excel-exercise. Before tackling the topic more closely, the author can assure the reader that it is at least the latter.

#### **4.3.1 Empirical results of the simulation**

First, a comparison between the two valuation methods' results and the actual closing prices of KONE Corporation's class B share for the financial years 2007-2014 at the publishing dates of financial statements is visualized below in Figure 9 as follows:

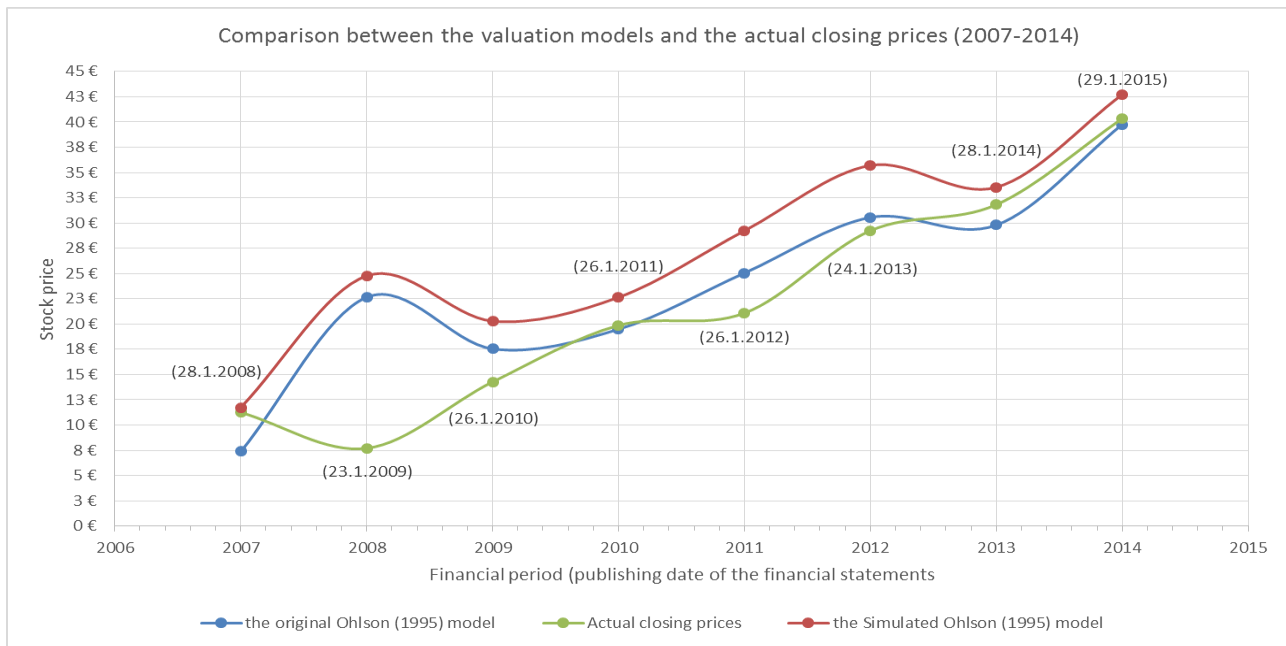


Figure 9 Comparison between the two models' results and the actual market prices

As expected, the original Ohlson (1995) model and the simulated version of it seem to follow each other quite consistently. However, it is noteworthy that the simulated Ohlson (1995) model denoted by the red or the upper line generated higher expected stock prices than the original model denoted by the blue or the middle line in all cases (approximately €3.6 on average). Additionally, the expected stock prices generated by the simulation were higher than the actual closing prices denoted by the green or the lower line every year. Thus, the simulated Ohlson (1995) model seems to have a prominent tendency to overprice the stock in comparison with the original model and the actual market prices.

In comparison with the original Ohlson (1995) model, the recalculated stock prices based on the simulated Ohlson (1995) model were closer to the actual stock prices merely in two out of the eight times. Additionally, three out the eight recalculated stock prices based on the simulation model did not set within one standard deviation (the actual 12 months volatility of the stock) of the actual closing price, whereas the corresponding ratio based on the original model was better (two out of the eight recalculations).

Therefore, the third hypothesis of the thesis is rejected as it was originally stated:

**H3:** *Applying Monte Carlo simulation to the Ohlson (1995) model provides investors with more detailed and accurate information on stock prices in comparison with the original Ohlson (1995) model by generating expected stock prices that are closer to the actual closing prices.*

Results concerning the third hypothesis are summarized below in Table 9.

Table 9 Results concerning the 3rd hypothesis

Results	2007	2008	2009	2010	2011	2012	2013	2014
Actual closing price at the publishing date of the financial statements	11,25 €	7,70 €	14,28 €	19,87 €	21,09 €	29,25 €	31,83 €	40,35 €
Recalculated stock price based on the original Ohlson (1995) model	7,38 €	22,66 €	17,55 €	19,49 €	25,06 €	30,56 €	29,80 €	39,77 €
Recalculated stock price based on the simulated Ohlson (1995) model	11,80 €	24,78 €	20,17 €	22,76 €	29,19 €	35,77 €	33,35 €	42,68 €
Simulated stock price sets closer to the actual value than that of the original model	Yes	No	No	No	No	No	Yes	No
Accept or reject the third hypothesis (H3)	Accept	Reject	Reject	Reject	Reject	Reject	Accept	Reject

A summary of the statistical results of the conducted simulations for the financial years 2007-2014 is presented below in Table 10. Furthermore, the probability distributions of all the possible outcomes for the years are summarized and visualized in Appendix A.

Table 10 Statistical results generated by the simulated Ohlson (1995) model

Results	2007	2008	2009	2010	2011	2012	2013	2014
Actual closing price at the publishing date of the financial statements	11,25 €	7,70 €	14,28 €	19,87 €	21,09 €	29,25 €	31,83 €	40,35 €
Simulated stock price (expected value)	11,87 €	24,72 €	20,24 €	22,72 €	29,08 €	35,60 €	33,47 €	42,75 €
Standard deviation or volatility of the simulated stock price	8,38 €	14,55 €	12,07 €	13,70 €	18,37 €	21,74 €	19,26 €	23,85 €
Relative standard deviation or RSD [or coefficient of variation (CV)]	70,62 %	58,85 %	59,64 %	60,29 %	63,19 %	61,06 %	57,55 %	55,78 %
Actual or observed volatility of the stock (12 months)	34,33 %	46,48 %	35,49 %	24,47 %	29,41 %	24,75 %	24,24 %	20,83 %
Standard error of the mean (SEM) based on the simulation	0,0839	0,1455	0,1207	0,1370	0,1838	0,2174	0,1926	0,2385
Minimum	- 5,09 €	- 3,22 €	- 8,87 €	- 5,57 €	- 7,69 €	- 7,72 €	- 10,02 €	- 8,20 €
1st Quartile	5,56 €	13,27 €	10,82 €	12,17 €	14,97 €	18,68 €	18,50 €	23,92 €
Median	10,34 €	23,12 €	18,61 €	20,77 €	26,54 €	32,54 €	31,34 €	40,02 €
3rd Quartile	16,86 €	34,59 €	28,07 €	31,58 €	40,76 €	49,52 €	45,75 €	59,12 €
Maximum	49,48 €	93,06 €	74,39 €	84,89 €	101,73 €	120,05 €	126,92 €	149,11 €
Skewness	0,8764	0,5460	0,6448	0,6801	0,6466	0,6589	0,5972	0,5368
Kurtosis	0,6480	-0,1214	0,0756	0,2082	0,0471	0,0875	0,0709	-0,0951
Positive values generated by the simulated Ohlson (1995) model	97,32 %	99,64 %	99,69 %	99,45 %	99,01 %	99,16 %	99,67 %	99,90 %
P(Less than or equal to the actual)	54,29 %	11,60 %	36,77 %	47,56 %	38,70 %	44,47 %	50,97 %	50,57 %
P(Greater than the actual)	45,71 %	88,40 %	63,23 %	52,44 %	61,30 %	55,53 %	49,03 %	49,43 %

Imitating Smith's (1994) remark, the dispersion or spread of the stock price distribution would reflect the level of uncertainty surrounding the key variables – earnings and book value of equity – of the Ohlson (1995) model. This leads us quite conveniently to the next topic, in which the dispersions of the stock price distributions during 2007-2014 are discussed in more detail. A compilation of the annual dispersions of the stock price distributions are presented in Figure 10 below in order to illustrate the aforementioned reflection of uncertainty.



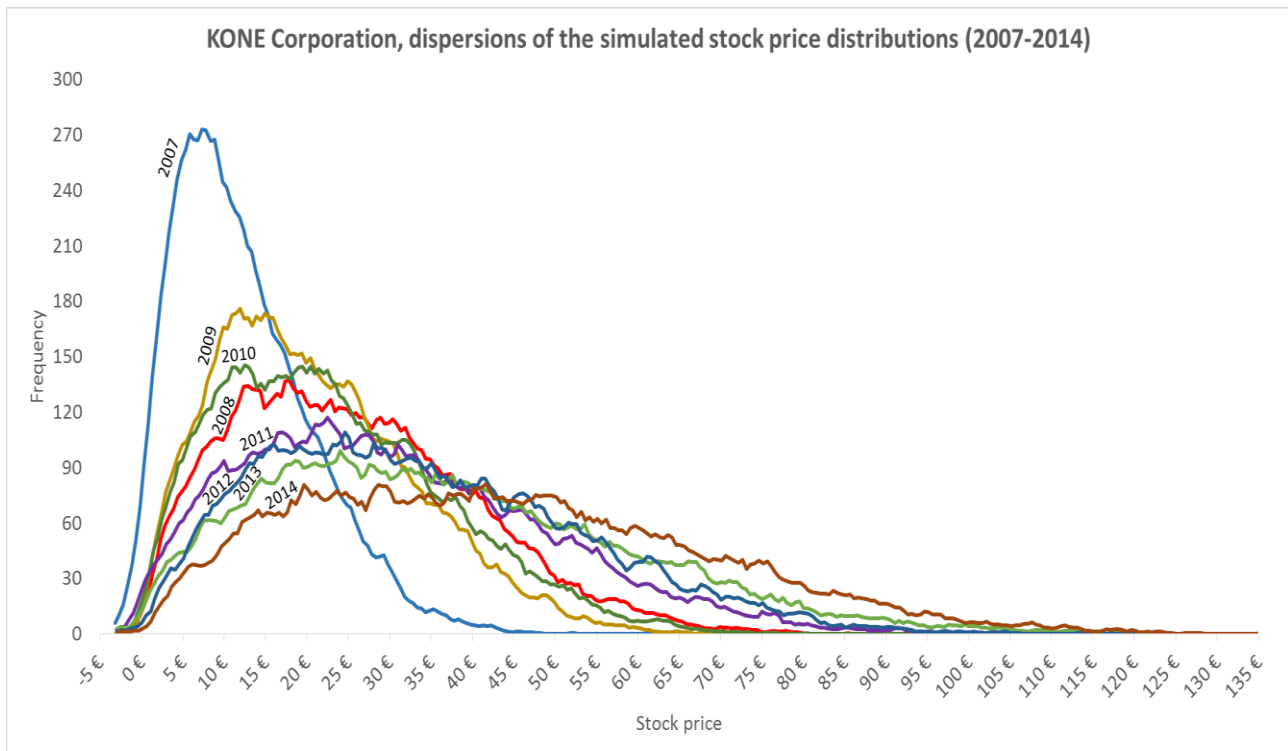


Figure 10 Illustration of the probability distributions' dispersions

As regards to the monetary values, the variances in the expected stock prices seem to expand quite clearly during 2007-2014, indicating the growing uncertainty. In statistical terms, however, apart from the year 2007 the relative standard deviation (hereinafter also referred as the “RSD”) seems to remain approximately at 60 %. The RSDs are also significantly higher than the actual or observed 12 months volatilities of the stock, which indicates that the equity market considers the stock less risky and biased than what could be expected on the grounds of historical accounting numbers. Thus, the findings support the statement of Richardson et al. (2014) on insufficiency of historical accounting numbers used in “a fundamental analysis exercise”. Additionally, apart from the FY2007 there are no significant variation in the corresponding skewness (measure for a distribution’s asymmetry) nor in kurtosis (measure for a distribution’s “peakedness” or flatness).

The figure above is constructed so that the ranges of the both axes remain unchanged during the period (frequencies on the y-axis: 0–300; stock prices on the x-axis: -€5–€135). The smallest dispersion in monetary values occurred during the FY2007, when all the observations set approximately between -€4 and €57. In comparison, the largest dispersion was during the FY2014, when the corresponding gap between the minimum and the maximum was €165. Noteworthy, neither the FY2007 nor FY2014 witnessed a substantial difference between the actual stock price and that of the simulated Ohlson (1995) model.

As the sample means or the expected stock prices differ from each other quite clearly (the range is approximately from €12 to €43), the standard error of the mean<sup>22</sup> (hereinafter also referred as “SEM”) is calculated in order to examine the differences in uncertainty during the period. As expected, the smallest SEM was in 2007 and the highest in 2014 (0.0840 and 0.2356, respectively). In statistical terms, the simulated Ohlson (1995) model can be considered a quite inefficient estimator of the expected stock prices due to the large variances. However, taking into account that the model is essentially based on the balance sheets of KONE Corporation, the results are in practical terms very plausible.

Probability distributions of the simulated stock prices (see Appendix A) are all positively skewed or right skewed distributions (skewness >0). Thus, the median value is always lower than the expected stock price or the mean value in each distribution. In practical terms, the probability that the stock price sets below the mean is always greater than the corresponding probability that the price sets above the mean.

Additionally, the simulation model has a minor tendency towards zero values. As discussed in the third chapter in more detail, the model is constructed in a way that it should avoid or minimize the values less than zero as in practice negative stock values do not reflect reality. However, the simulated Ohlson (1995) model generated an insignificant amount of negative values for every year during 2007-2014, which indicates and can be interpreted as the general functionality of the model. The probability that the model generates values greater than or equal to zero is very high: during 2007-2014, the probabilities’ range set at approximately 97.2 % - 99.9 %, the average being approximately 99.2 %.

Next the thesis discusses the practical advantages of Monte Carlo simulation in relation to the results for the FY2008 and FY2009.

#### **4.3.2 Additional information provided through visualization**

Although the third hypothesis of the thesis is rejected, the author claims that the simulated Ohlson (1995) model provides investors with valuable additional information. One of the most prominent advantages of the simulation is the visualization of all the possible outcomes as probability distributions. As stated in the literature view of the thesis, this helps an investor to detect the possible inherent biases and reassess his or her estimates.

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<sup>22</sup>  $SE_{\bar{x}} = \sigma/\sqrt{n}$

Probability distribution of all the possible outcomes concerning the expected stock price for the FY2008 is visualized in Figure 11 as follows:

The red line on the left denotes the actual closing stock price at the publishing date of financial statements of 2008. The blue line is the expected stock price or the mean generated by the simulation model and the green line is the median value. As the

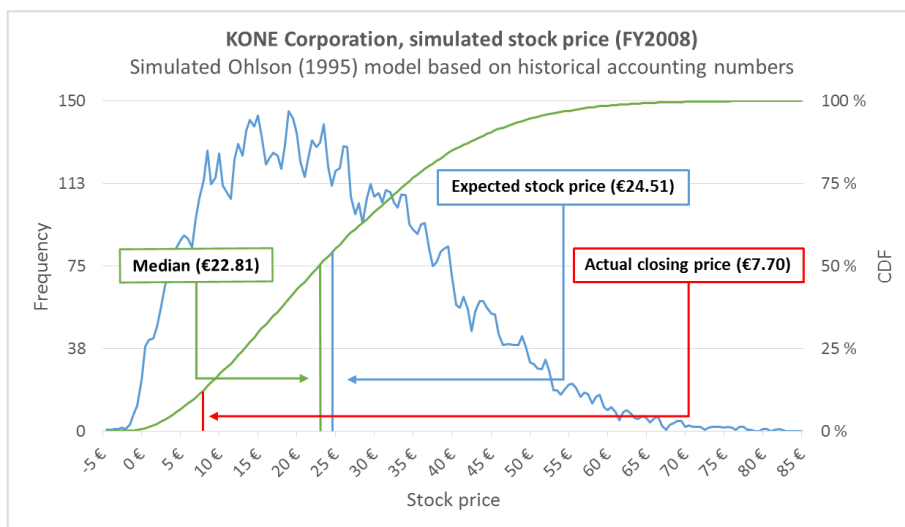


Figure 11 Probability distribution of the expected stock price generated by the simulated Ohlson (1995) model – FY2008

blue line can be also regarded – on the grounds of the simulated Ohlson (1995) model – as the target price of the stock, one could have drawn a conclusion at that time to buy the stock as it was significantly undervalued by the equity market. Worth emphasizing, this requires a strong faith in the model and its fundamentals as the model is statistically speaking very biased.

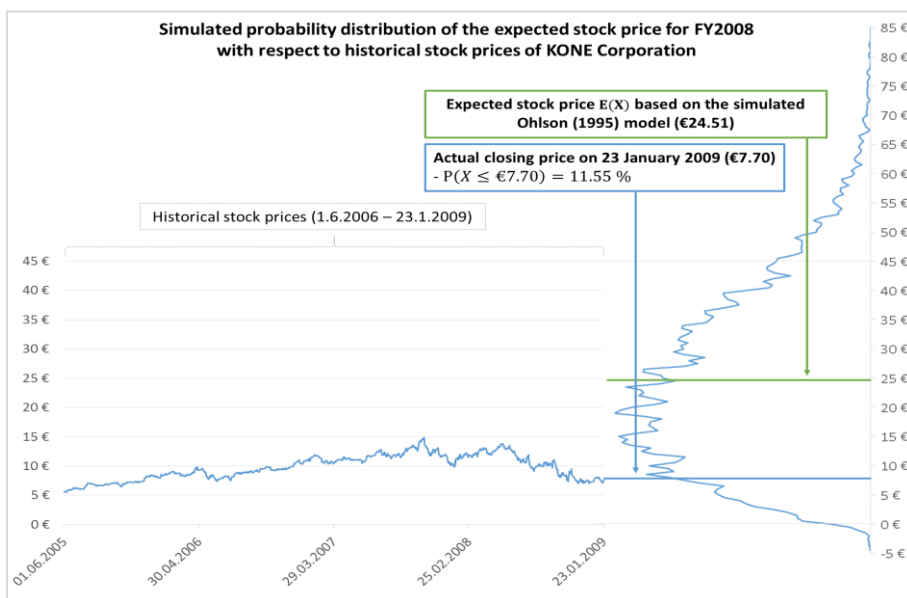


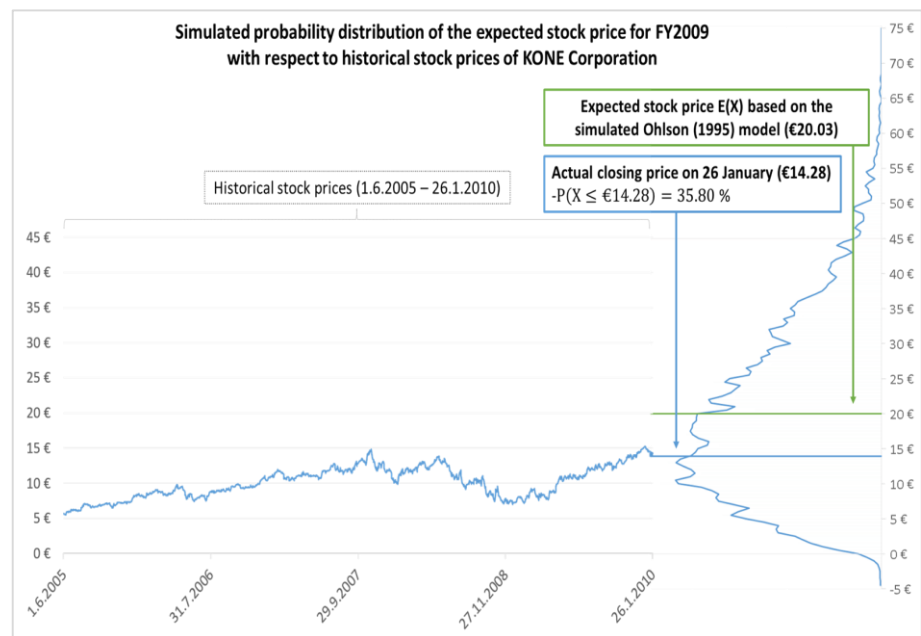
Figure 12 Simulated stock price for FY2008 with respect to historical stock prices

In order to elaborate the practicality of the simulated Ohlson (1995) model and the additional value it provides, the illustration on the left in Figure 12 of the closing price on 23 January 2009 for the FY2008 with respect to the simulation model should provide investors

with additional information on the stock price. As the purpose of this thesis is to assess the general applicability of the simulated Ohlson (1995) model by benchmarking the observed

market prices of KONE Corporation's class B share against the prices generated by the simulation model, the model does not – at least based on the FY2008 – result in accurate values. Statistically speaking, the estimator or the expected stock price is very biased and thus cannot be considered accurate. Therefore, from that perspective, the simulation model did not work well as for the FY2008. However, if an investor placed trust in the model and the assumptions behind it, there would have been a strong incentive to buy the stock as it was highly undervalued by the equity market. In order to imitate the famous Warren Buffet's quote stated at the beginning of the thesis, the price set by the equity markets is substantially lower than the fundamental or true value of the stock. Additionally, the stock price went up and a year later was valued at €14.28. As shown below, the spread starts to narrow significantly after the clear impact of the Financial Crisis.

The same analysis was conducted for the FY2009. In comparison with the prior year's outcome, the FY2009 (illustrated on the right in Figure 13) results in similar interpretations: the expected stock price generated by the simulated Ohlson (1995) set higher than the



actual closing price, the *Figure 13 Simulated stock price for FY2009 with respect to historical stock prices* distribution of all the possible outcomes is similar and the same initial recommendations can be made (a strong recommendation to buy). Although the model did not generate an accurate stock price in comparison with the actual stock price, one should take into account that if an investor followed the interpretations and recommendations made in 2008, the investor would have gained substantially from the transaction. The same recommendation to buy the stock would have resulted in substantial profits also in 2009.

As the assumptions behind the simulated Ohlson (1995) model are based on raw historical accounting numbers extracted from the audited financial statements of KONE Corporation,

the results presented above are in a way neutral and free from investor-specific biases. The historical discount rates and perpetual growth rates are also based on raw market data and not for example on the author's personal perceptions.

Interim reports, recent news about a positive company performance in China or the worldwide chaos caused by the Financial Crisis are not incorporated into the model. This brings us to the obvious advantages and disadvantages of the model. The simulated Ohlson (1995) model is an excellent valuation tool for those who are fully confident about the future company performance regardless of what may happen around the firm. The value relevance of the model's variables seem to ensure that the model is built upon a solid premise. This, however, is at the same time a clear disadvantage of the model. Taking the model on trust is not recommended because it would have required for example ignoring the Financial Crisis.

Next the thesis discusses the results of the conducted scenario and sensitivity analyses which ought to provide some answers to how the expected stock price generated by the simulated Ohlson (1995) model reacts to the different scenarios of uncertainty and changes in the four variables.

### 4.3.3 Scenario analysis

As discussed in the methodology chapter in more detail, the scenario analysis was conducted for the purpose of assessing how different outlooks on economic conditions and company performance affect the stock price of KONE Corporation in respect of the simulated Ohlson (1995) model. The results presented below in Figure 14 and Table 11 concern the expected stock price for the FY2015.

Results of the scenario analysis are presented as probability distributions of all the possible outcomes in each scenario on the right in Figure 14. The red, grey and green lines denote pessimistic, neutral and optimistic scenarios, respectively. According to the

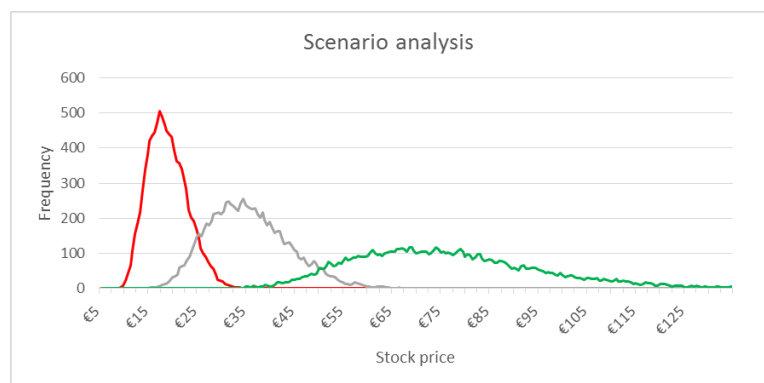


Figure 14 Results of the scenario analysis

illustration, an investor with a pessimistic outlook on the company performance as well as

on economic conditions in general seems to take pleasure in lower uncertainty in terms of the stock price per se. Respectively, an investor with an optimistic outlook on the matters has to acknowledge that high returns go hand in hand with high risk.

Table 11 below presents the results of the same analysis in a statistical manner.

*Table 11 Statistical results of the scenario analysis*

	<b>Pessimistic</b>	<b>Neutral</b>	<b>Optimistic</b>
Simulated stock price (expected value)	18,56 €	35,19 €	75,49 €
Standard deviation or volatility of the simulated stock price	4,14 €	8,33 €	18,79 €
Relative standard deviation or RSD [or coefficient of variation (CV)]	0,2228	0,2367	0,2490
Standard error of the mean (SEM) based on the simulation	0,0004	0,0008	0,0019
Minimum	7,20 €	15,18 €	30,54 €
1st Quartile	15,48 €	29,06 €	61,85 €
Median	18,12 €	34,44 €	73,19 €
3rd Quartile	21,22 €	40,66 €	87,46 €
Maximum	37,47 €	69,16 €	158,07 €
Skewness	0,4749	0,4574	0,6001
Kurtosis	-0,0344	-0,0205	0,3786

Statistically speaking, however, the differences are not that significant. The differences in the RSDs and SEMs for example are quite small between the three scenarios. However, the probability distribution of the optimistic scenario seems to be a bit more (positively) skewed than those of the other two moderately skewed scenarios. Additionally, the optimistic scenario's kurtosis, which measures the height and sharpness of the peak relative to the rest of the data, is higher than those of the other two scenarios. Nevertheless, the kurtosis values are not considered statistically relevant which means that the variability in the distributions is not due to extreme differences from the means.

In terms of statistical reliability, the pessimistic scenario's results can be regarded as the most reliable due to the smallest variance among the three scenarios.

#### **4.3.4 Sensitivity analysis**

Results of the performed sensitivity analyses on the four variables  $E(NI_{growth})$ ,  $E(BV_{growth})$ ,  $E(r_E)$  and  $E(g)$  conducted based on the simulated Ohlson (1995) model are presented below. The results denote the probability distributions of the expected stock prices for the FY2015. Methodology of the analysis is discussed in the third chapter in more detail.

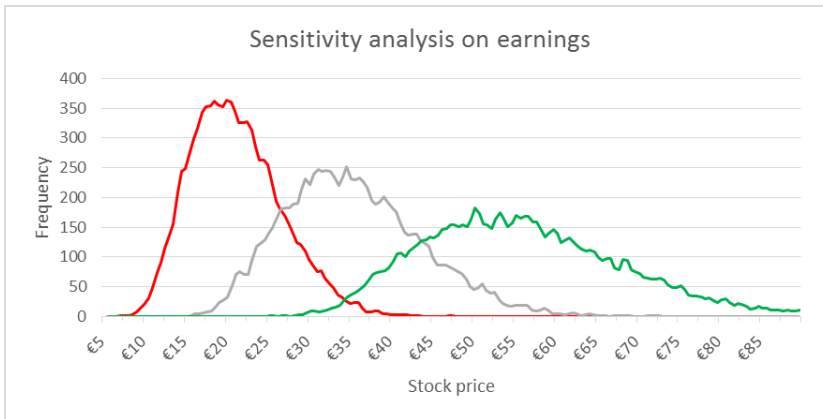


Figure 15 Sensitivity analysis on earnings

Results of the sensitivity analysis performed on annual earnings of KONE Corporation is presented on the left in Figure 15. Red, grey and green lines denote the probability distributions of the possible outcomes in each scenario. In comparison with the other three variables, earnings was by far the most sensitive variable in terms of the variation in the expected stock price. Depending on the particular scenario, the expected stock prices generated by the simulation model were approximately 40 % lower (pessimistic) and 58 % higher (optimistic) in comparison with the so-called reference value based on the neutral scenario.

As for the other key variable of the Ohlson (1995) model, the sensitivity of book value of equity is quite different from that of earnings as presented on the right in Figure 16. According to the model, an optimistic outlook on growth

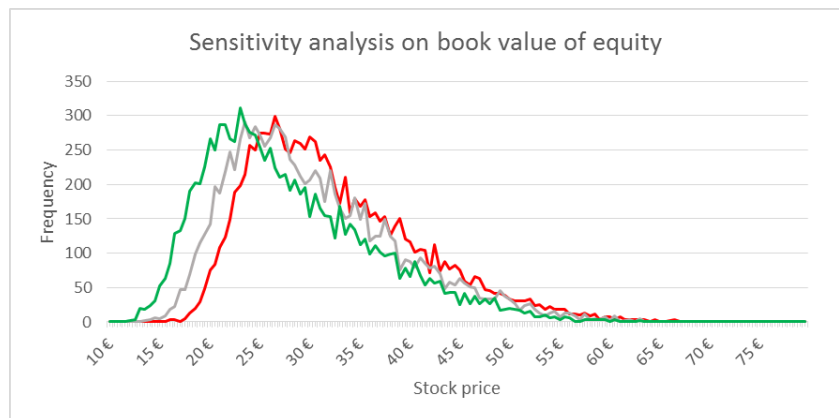


Figure 16 Sensitivity analysis on book value of equity

in the company's equity seems to have a decreasing effect on the expected stock price. Noteworthy, in the optimistic scenario of the sensitivity analysis the expected growth in book value of equity is on average 9.37 % higher than that of earnings. This indicates an accumulation of earnings in a long run, which in accordance with the simulated Ohlson (1995) model results in lower expected stock prices. In other words, on the grounds of the conducted sensitivity analyses on earnings and book values, distribution of earnings is considered more valuable than accumulation of earnings. Depending on the particular scenario, the expected stock prices generated by the simulation model were approximately 7 % higher (pessimistic) and 8 %

lower (optimistic) in comparison with the so-called reference value based on the neutral scenario.

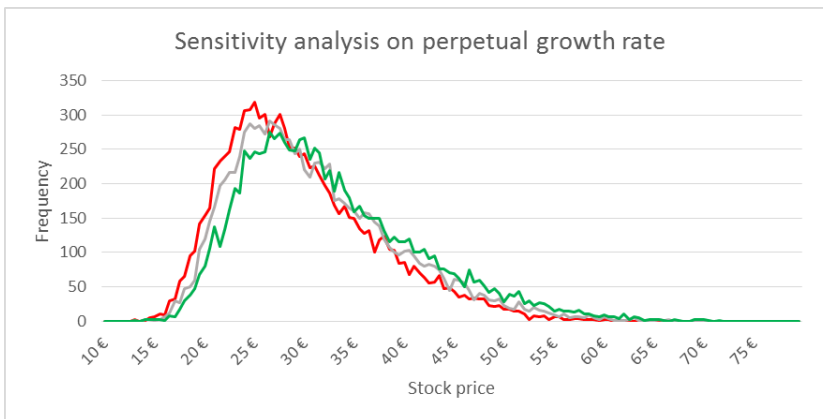


Figure 17 Sensitivity analysis on the perpetual growth rate

Based on the conducted sensitivity analysis on the perpetual growth or inflation rate, variation in the variable does not cause the stock price to change significantly. The variable's sensitivity on the stock price is presented on the left in Figure 17. Depending on

the particular scenario, the differences in the stock prices generated by the model are approximately  $\pm 5\%$  from the reference value. Thus, the variable cannot be deemed as highly sensitive in respect of the simulated Ohlson (1995) model.

For the purpose of assessing the effect of required rate of return on equity on the stock price, the final sensitivity analysis was conducted on the discount rate. Results of the analysis are presented on the right in Figure 18. According

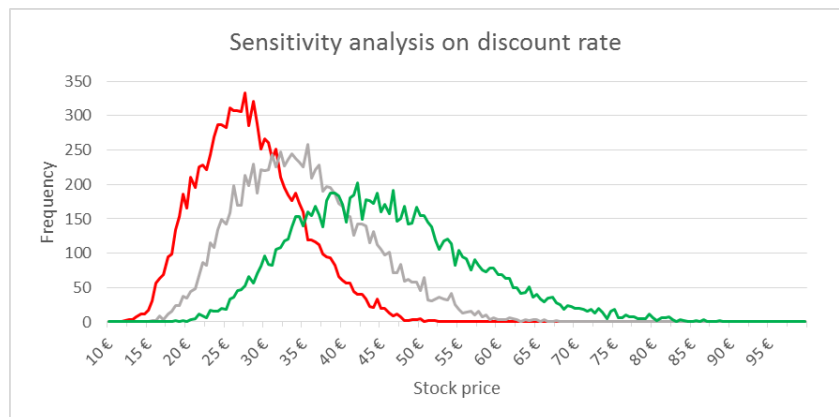


Figure 18 Sensitivity analysis on discount rate

to the results, the required rate of return on equity by an investor has a substantial effect on the stock price as expected. Differences between the generated stock prices in the pessimistic and optimistic scenarios in comparison with the reference value were approximately 20 % lower and 30 % higher, respectively. Thus, regardless of the actual company performance and economic conditions, investors' personal considerations about the true value of the stock are very significant in respect of the simulated Ohlson (1995) model.

To conclude, the sensitivity analysis' results are in line with the results of the conducted regression and correlation analyses. Based on the regression analysis, earnings to book value



of equity or the independent variable  $NI_{jt}/BV_{jt}$  was considered statistically significant (p-values 0.000) in every period with relatively high coefficient in comparison with those of the other variables. Additionally, the correlation analysis revealed the same results. The correlation between  $NI_{jt}/BV_{jt}$  and  $MV_{jt}/BV_{jt}$  was considered moderate or strong and statistically significant in all cases. Furthermore, the estimators of the expected stock price based on the sensitivity analysis in statistical terms are much more efficient than those based on the historical accounting numbers due to the smaller variances of the expected stock prices.

Results of the conducted sensitivity analysis are summarized below in Table 12 (a single iteration round).

Table 12 Summary of the sensitivity analysis

Expected stock price / difference from the neutral scenario								
Scenario	Earnings		Book value of equity		Discount rate		Perpetual growth rate	
Pessimistic	20,55 €	-40,22 %	32,09 €	6,66 %	27,79 €	-19,32 %	29,01 €	-4,44 %
Neutral	34,37 €	-	30,09 €	-	34,44 €	-	30,36 €	-
Optimistic	54,36 €	58,17 %	27,54 €	-8,47 %	44,68 €	29,73 %	31,96 €	5,27 %

#### 4.3.5 Forecasted stock price for FY2015

Next the thesis benchmarks the results of the conducted scenario and sensitivity analyses against the results generated by the same simulated Ohlson (1995) model that was applied to the years 2007-2014. At this time, the expected stock price was calculated for the FY2015.

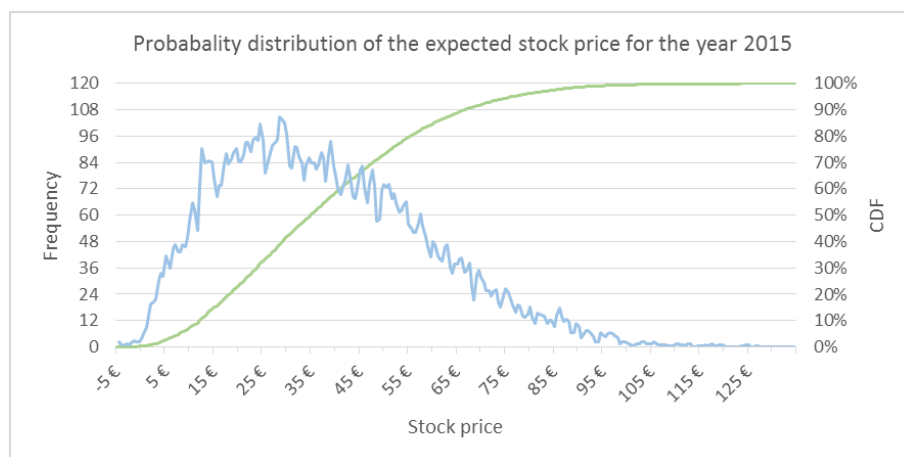


Figure 19 Probability distribution of the expected stock price generated by the simulated Ohlson (1995) model – FY2015

In comparison with the results of the scenario and sensitivity analyses, the probability distribution of the expected stock price for the FY2015 based on the simulated Ohlson (1995) model and historical accounting numbers

(presented above in Figure 19) is significantly more dispersed in terms of the stock price.

Additionally, the expected stock price is slightly higher than those based on the scenario and sensitivity analyses. Statistical results of the same analysis are presented below in Table 13.

*Table 13 Statistical results generated by the simulated Ohlson (1995) model – FY2015*

	<b>2015</b>
Simulated stock price (expected value)	37,80 €
Standard deviation or volatility of the simulated stock price	21,10 €
Relative standard deviation or RSD [or coefficient of variation (CV)]	0,5582
Standard error of the mean (SEM) based on the simulation	0,21
Minimum	- 4,48 €
1st Quartile	21,31 €
Median	35,24 €
3rd Quartile	51,91 €
Maximum	123,75 €
Skewness	0,5449
Kurtosis	-0,1131

As disclosed in the statistical tables, the RSDs generated by the scenario and sensitivity analyses are substantially lower than that of the simulation model based on historical accounting numbers. As far as the valuation models are concerned, there are less uncertainty in the expected stock prices generated by the scenario and sensitivity analyses in comparison with the analysis based on the historical accounting numbers alone. In statistical terms, the estimators are more efficient. This is of course due to the minimum (a) and maximum (b) values assigned to the probability distributions of the four variables in the scenario and sensitivity analyses. Additionally, standard deviations of the triangularly distributed expected growth rates are substantially lower than those based on the historical accounting numbers extracted from KONE Corporation's financial statements.

As a conclusion, the simulated Ohlson (1995) model based on historical accounting numbers can be deemed as a firm valuation model that generates plausible and feasible market value estimates for a firm's equity capital.

Finally, what is the expected stock price for the FY2015? On the grounds of the conducted analyses, including both the simulated Ohlson (1995) model based on the historical accounting numbers and those based on the different scenarios, the optimistic author of the thesis predicts that the closing price of KONE Corporation's class B share at the publishing date of financial statements for the FY2015 is going to set at least at €37.80. This is based

on the author's relatively optimistic assumption that the recorded net income and book value of equity for the FY2015 are going to be approximately €963 million and 2,337 million, based on which the expected annual growths in the bottom-line items for the following five years set at 16.99% and 14.36 %, respectively.

#### **4.4 Closing stock price for FY2015**

As discussed above, the thesis predicted that – based on the simulated Ohlson (1995) model – the closing stock price at the publishing date of the financial statements for the FY2015 is going to set at least at €37.80. The closing stock price on 28 January 2016 or the publishing date was €38.80. The day after the stock price increased to € 40.37 (4.05 %).

Interestingly, 2015 was the only financial year when the simulated Ohlson (1995) model generated an expected stock price lower than the actual closing price despite the fact that the assumptions behind the model followed the exact same regularities consistently. As addressed and discussed in more detail in the fourth chapter of the thesis, the expected stock prices generated by the simulation model were all slightly higher than the actual closing prices.

On the grounds of historical accounting numbers from the financial periods 2005-2014, the expected net income for the year 2015 was €963 million. Correspondingly, the book value of equity was expected to be €2,337 million at the end of the year. However, the actual recorded values of the key variables – earnings and book value of equity – of the Ohlson (1995) model at the end of the FY2015 were €1,053 million and €2,576 million, respectively. Therefore, KONE Corporation outperformed the optimistic expectations set and applied in the thesis substantially.

## **5 Discussion and conclusions**

In the final chapter the thesis summarizes the contributions of the simulated Ohlson (1995) model and the additional information it provides as well as presents the key findings of the study. Additionally, the chapter briefly covers the construction process of the simulation model and shares some of the experience acquired from it. Then the limitations, concerns and cautions about the simulation model and the empirical results are discussed and finally the research opportunities are presented.

### **5.1 Summary of results and key findings**

In reference to the first research question, did the simulated Ohlson (1995) model generate accurate and plausible expected stock prices in respect of the case company KONE Corporation? In terms of plausibility, yes. In terms of accuracy, not entirely. The simulation model generated expected stock prices for the financial years 2007-2015 that were in fact more or less within one standard deviation of the mean. However, the model cannot be considered accurate in statistical terms as it did not generate unbiased estimates or expected stock prices consistently during 2007-2015. Furthermore, the results or the probability distributions of the expected stock price generated by the model on the grounds of historical accounting numbers cannot be considered statistically efficient due to the large variances especially in comparison with the results generated by the traditional methods. Thus in conclusion, the results can be considered plausible yet should be deemed as suggestive. As regards to the accuracy of the recalculated stock prices, the simulation model did not capture the fundamental value of KONE Corporation entirely. Thus, some of the information was lost regardless of the value relevance of the Ohlson (1995) model's key variables.

As regards to the second research question, does the simulation model provide an investor with valuable additional information on the stock price of KONE Corporation? In terms of additional, most definitely. In terms of valuable, possibly. Monte Carlo simulation is an excellent tool for analysing uncertainty efficiently, but the value an investor gets from it depends on the investor. Regardless of the scalability and general functionality of the simulated Ohlson (1995) model, the model's most significant contributions rest on the illustration of uncertainty it provides. It definitely provides the broader picture in relation to the investor's own preliminary understanding on the matter and the biases concerning the valuation model's assumptions.

Although the first hypothesis was rejected and the value relevance of the key variables of the Ohlson (1995) model couldn't be verified entirely, the conducted regression analysis for the period 2007-2014 provided a solid ground for analysing the model and its variables in more detail. Moreover, the results of the regression analyses provided an additional explanation why the spread between the expected stock price generated by the simulation model and the actual closing price in FY2008 was so enormous.

The second hypothesis was rejected as well. As for the FY2008 and FY2009, the original Ohlson (1995) model generated stock prices that were not within one standard deviation of the mean. On the grounds of the results, however, the model can be regarded as a plausible and applicable firm valuation model.

As the simulated Ohlson (1995) model did not generate more accurate stock prices than the original model, the third hypothesis was rejected as well. In reference to the actual closing prices, the simulation model was closer than the original model only in two out of the eight years (FY2007 and FY2013). According to the results, the simulation model has a clear tendency to overprice the stock in comparison with the original model. Additionally, one of the key findings was that the RSD generated by the simulation model was significantly higher than the actual 12 months volatility of KONE Corporation's stock, which also supports the indication that the model does not capture all the information concerning the uncertainty surrounding the stock. Additionally, the higher variance in the expected stock prices indicate the statistical inefficiency of the valuation model yet makes the model more plausible in practical sense.

## **5.2 Construction process**

As regards to the actual construction work of the simulated Ohlson (1995) model from the very first thoughts until the final and crucial moment of choosing the colour for the probability distributions' trendlines, the author deems the whole process as an excellent and truly unique learning experience. Although Wagle (1967) pointed out that "the simulation necessities the use of a computer and this could lead to a lot of programming work", the hours spent on the task genuinely paid off.

### **5.3 Limitations, concerns and cautions**

Next the thesis discusses the limitations of the study as a whole. Additionally, concerns and cautions regarding the simulated Ohlson (1995) model are discussed as well.

#### **5.3.1 Limitations of the study**

The thesis studied the combination of Monte Carlo simulation and the Ohlson (1995) model in respect of one Finnish publicly listed firm in one particular industry during a specific period of time. Thus, the statistical results generated by the simulation model must be limited strictly to the case company. Additionally, the results of the conducted regression analysis concern only a small fraction of Finnish business life during a relatively short period of time.

#### **5.3.2 Concerns about the simplifying assumptions**

As stated by Pohjola (2010): “Model is a simplified representation of reality.” As for the conducted analyses, the thesis made simplifying assumptions regarding, among other things, the probability distributions of the applied variables. For example, the compounded annual growth rates of net income and book value of equity and their annual standard deviations were based on historical accounting numbers extracted from KONE Corporation’s financial statements and were assumed to be linear on an annual basis. The conduct is supported by Plenborg (2002) who states that “given the uncertainty surrounding firm valuation in practice, the use of simplifying assumptions may seem acceptable”. However, this has to be taken into account if the simulated Ohlson (1995) model is applied further. An investor may find it reasonable to contemplate the presented assumptions and reassess their legitimacy. In this respect, a financial year is also a relatively long period without the consideration of other value relevant information for example published in a firm’s interim reports and on the news. Furthermore, the analyses conducted with the simulated Ohlson (1995) model didn’t take into account the development of economic conditions (for example the Financial Crisis), results of which are discussed in the empirical part of the thesis in more detail.

Nonetheless, the impact of simplifying assumptions on firm value estimates may be significant (Plenborg, 2002), which in this study was illustrated on the grounds of the conducted scenario and sensitivity analyses. Accordingly, it is crucial that practitioners

introducing simplifying assumptions in their firm valuation are aware of the impact of these on firm value estimates (Plenborg, 2002). As regards to the simplified assumptions concerning the three different scenarios, another investor may simply disagree on the whole reasoning behind the setting and see the things in a totally different way.

Although the assumptions behind the simulated Ohlson (1995) model can be fairly regarded as simple and simplified, they are still a great improvement on valuation models that do not incorporate probability distributions into their structures. However, it is advisable to keep in mind the famous quote from George E. P. Box: “Essentially, all models are wrong, but some are useful.”

### **5.3.3 Cautions and validity of the model**

In reference to the simulation model and its assumptions, Olsson (1998) states that “one sometimes hears comments to the effect that it is not worth the extra effort to use correct and precise calculation techniques when valuing companies, since there is so much uncertainty anyhow in the data that must ultimately be fed into the model”. The author agrees with the objection stated by Olsson (1998) himself that it is not really much of an effort. Furthermore, the uncertainty surrounding the key variables is actually what makes the simulated Ohlson (1995) model generate the additional information.

As far as the author is concerned, the constructed simulation model is scalable to other firms as well. However, the assessment of the model’s validity must be left to future research. As stated by Sargent (1991), determining that a model is absolutely valid over the complete domain of its intended applicability is however often too costly and time consuming. He also adds that there are no set of specific tests that can be easily applied to determine the “correctness” of a simulation model. Thus, the final assessment of the simulated Ohlson (1995) model’s applicability comes down to the individual discretion of a decision-maker. As stated by Warren Buffet: “In the business world, the rear-view mirror is always clearer than the windshield.”

## **5.4 Opportunities for future research**

The thesis applied Monte Carlo simulation mainly to the key variables – earnings and book value of equity – of the Ohlson (1995) model. These so-called bottom-line items of an income statement and balance sheet are, however, results of quite a few items each of which has its

own plausible probability distribution. Therefore, a comparable analysis could be conducted by simulating for example the disaggregated items of an income statement and compare the results with the outcomes of the simulated Ohlson (1995) model of this thesis.

The results of the simulated Ohlson (1995) model indicate that the assumptions behind the valuation were clearly upward biased in comparison with the original Ohlson (1995) and the actual closing prices. Therefore, it would be interesting to study what assumptions, in respect of the simulation model, would have resulted in the exact or unbiased closing stock prices and how they evolve during a forecasting period.

Nevertheless, the simulated Ohlson (1995) model worked quite well within the determined scope regardless of the rejected hypotheses. Thus, it would be very interesting to study how the model applies to other sectors and unlisted companies. As regards to the future research opportunities in the light of unlisted firms, a study could be conducted for example on the relation between the fair value of a firm's stock assessed by the firm's annual general meeting with the estimated stock price generated by the model. A practical example of a research opportunity could be as follows: the AGM of PricewaterhouseCoopers Oy confirmed at the end of the FY2015 (30.6.2015) that the fair value of its stock is €440<sup>23</sup> (new subscriptions for new equity partners). This multiplied by the total number of the firm's stocks – 38,100 in total owned by 44 partners – results in the market value of the firm's shareholders' equity for the amount of €16.76 million. At the end the FY2015, the firm's recorded book value of equity was €19.29 million. Thus, the P/E-ratio of PricewaterhouseCoopers Oy at the end of the FY2015 was 0.84. Is this a typical P/E-ratio of the so-called Big 4—companies (PricewaterhouseCoopers, EY, Deloitte and KPMG)? What kind of differences, if any, the simulated Ohlson (1995) model would generate in regard to the stock price for new subscriptions? As regards to a new equity partner, what is the relationship between the paid subscription price and the fundamental, true value of the stock? How much the partner pays and how much he or she actually gets?

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<sup>23</sup> Source: PricewaterhouseCoopers Oy – Financial Report and Financial Statements for the FY2015, <http://www.pwc.fi/fi/julkaisut/vuosiraportit.html>, referred on 2 February 2016



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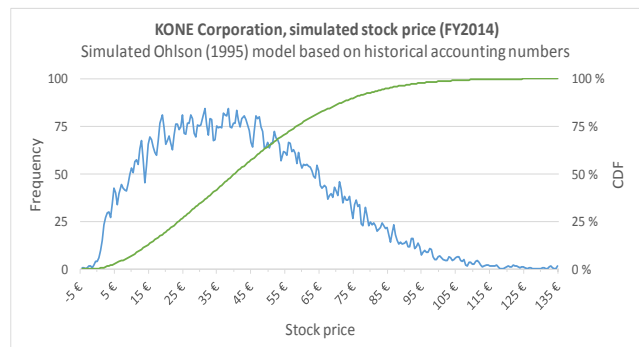
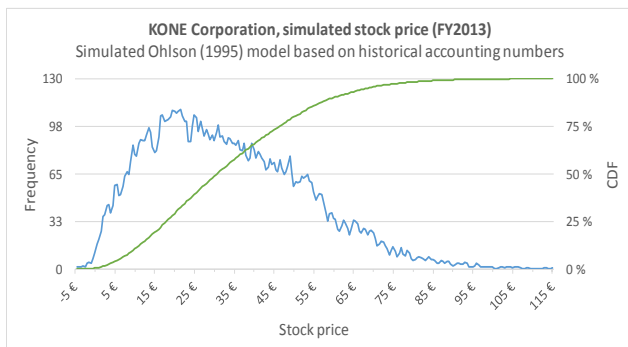
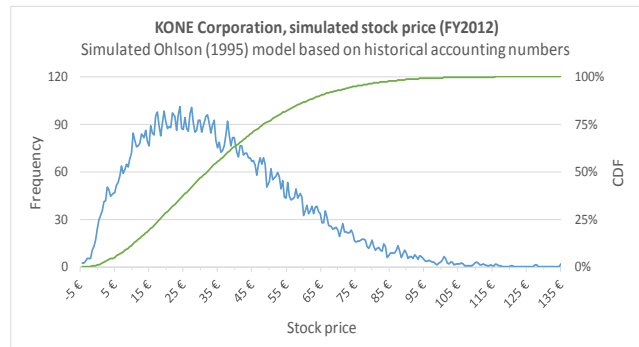
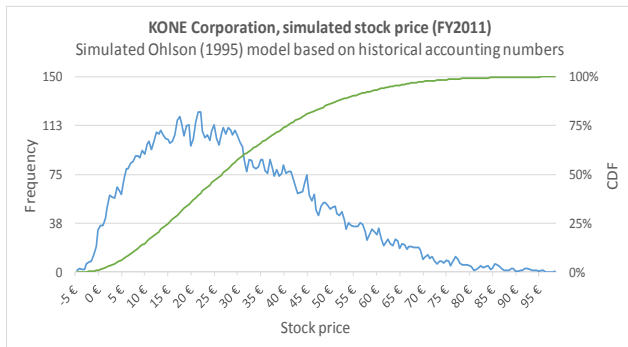
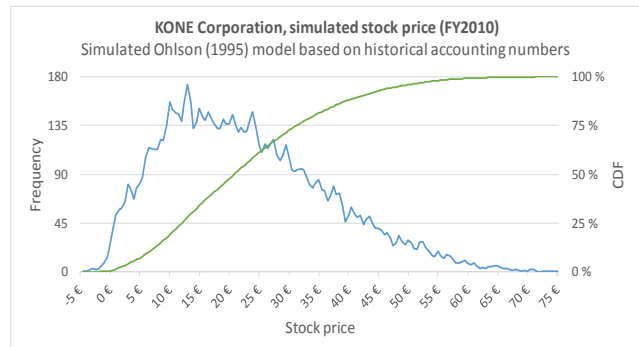
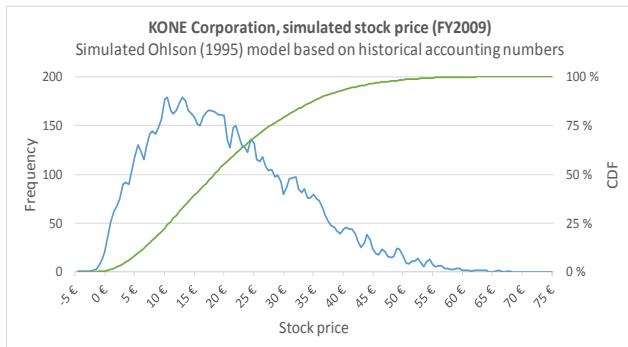
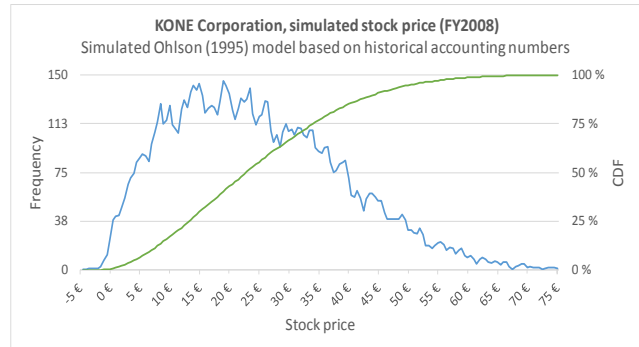
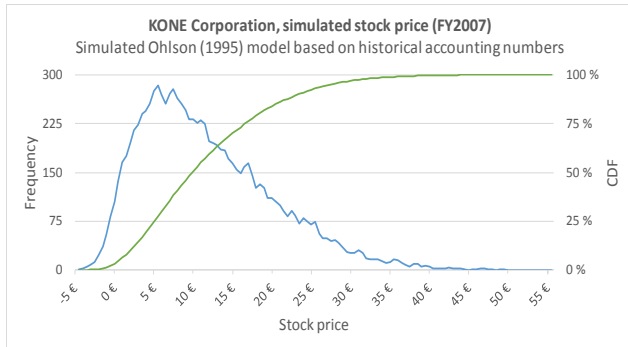
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# Appendices

## Appendix A: Outcomes of the simulated Ohlson (1995) model – 2007-2014

The probability distributions presented below are the final outcomes of the simulated Ohlson (1995) model for the financial years 2007-2014. Each of them represent the particular year's probability distribution of the simulated stock price of KONE Corporation's class B share based on historical accounting numbers.



## Appendix B: Results of the regression and correlation analyses

*Regression analysis for the period 2000-2014*

**Variables Entered/Removed<sup>a</sup>**

Model	Variables Entered	Variables Removed	Method
1	2014, SEC9, SEC10, SEC6, SEC5, 2012, SEC2, 2009, 2002, 2001, SEC7, 2003, 1/BV, 2011, 2013, 2010, 2008, SEC4, NI/BV, 2005, 2004, SEC8, 2006, 2007, SEC3 <sup>b</sup>		Enter

a. Dependent Variable: MV/BV

b. All requested variables entered.

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,507 <sup>a</sup>	,257	,240	1,8014758

a. Predictors: (Constant), 2014, SEC9, SEC10, SEC6, SEC5, 2012, SEC2, 2009, 2002, 2001, SEC7, 2003, 1/BV, 2011, 2013, 2010, 2008, SEC4, NI/BV, 2005, 2004, SEC8, 2006, 2007, SEC3

**ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1262,600	25	50,504	15,562	,000 <sup>b</sup>
	Residual	3650,979	1125	3,245		
	Total	4913,579	1150			

a. Dependent Variable: MV/BV

b. Predictors: (Constant), 2014, SEC9, SEC10, SEC6, SEC5, 2012, SEC2, 2009, 2002, 2001, SEC7, 2003, 1/BV, 2011, 2013, 2010, 2008, SEC4, NI/BV, 2005, 2004, SEC8, 2006, 2007, SEC3

Coefficients<sup>a</sup>

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			
1	(Constant)	1,356	,618		2,196	,028
	1/BV	-1,463	,960	-,043	-1,524	,128
	N/BV	7,364	,544	,374	13,535	,000
	SEC2	-,178	,607	-,022	-,293	,769
	SEC3	,240	,579	,055	,415	,678
	SEC4	,348	,585	,064	,594	,553
	SEC5	-,375	,604	-,048	-,621	,534
	SEC6	-,233	,663	-,018	-,351	,726
	SEC7	-,257	,596	-,037	-,431	,666
	SEC8	1,376	,587	,260	2,342	,019
	SEC9	1,099	,758	,056	1,448	,148
	SEC10	-,211	,736	-,012	-,286	,775
	2001	-,929	,303	-,106	-3,068	,002
	2002	-1,050	,309	-,116	-3,400	,001
	2003	-,474	,303	-,054	-1,566	,118
	2004	-,653	,290	-,081	-2,254	,024
	2005	-,490	,289	-,061	-1,697	,090
	2006	-,438	,285	-,056	-1,534	,125
	2007	-,611	,285	-,078	-2,141	,032
	2008	-1,525	,294	-,184	-5,182	,000
	2009	-,305	,316	-,033	-,964	,335
	2010	-,444	,292	-,055	-1,521	,128
	2011	-1,045	,293	-,127	-3,567	,000
	2012	-,848	,294	-,103	-2,887	,004
	2013	-,380	,294	-,046	-1,295	,196
	2014	-,517	,284	-,067	-1,818	,069

a. Dependent Variable: MV/BV

Regression analysis for the period 2000-2006

Variables Entered/Removed<sup>a</sup>

Model	Variables Entered	Variables Removed	Method
1	2006, SEC3, 1/BV, SEC9, SEC10, SEC6, 2002, 2001, SEC2, SEC5, 2003, SEC7, N1/BV, 2004, SEC4, 2005, SEC8 <sup>b</sup>		Enter

a. Dependent Variable: MV/BV

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,526 <sup>a</sup>	,277	,252	2,2428369

a. Predictors: (Constant), 2006, SEC3, 1/BV, SEC9, SEC10, SEC6, 2002, 2001, SEC2, SEC5, 2003, SEC7, N1/BV, 2004, SEC4, 2005, SEC8

ANOVA<sup>a</sup>

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	974,938	17	57,349	11,401	,000 <sup>b</sup>
	Residual	2550,371	507	5,030		
	Total	3525,309	524			

a. Dependent Variable: MV/BV

b. Predictors: (Constant), 2006, SEC3, 1/BV, SEC9, SEC10, SEC6, 2002, 2001, SEC2, SEC5, 2003, SEC7, N1/BV, 2004, SEC4, 2005, SEC8

Coefficients<sup>a</sup>

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,385	1,660		,232	,817
	1/BV	-5,798	1,781	-,134	-3,254	,001
	N1/BV	9,637	1,067	,375	9,036	,000
	SEC2	,388	1,653	,039	,235	,814
	SEC3	,740	1,614	,136	,458	,647
	SEC4	,851	1,622	,125	,525	,600
	SEC5	,170	1,652	,018	,103	,918
	SEC6	,542	1,807	,024	,300	,764
	SEC7	,563	1,639	,064	,343	,732
	SEC8	2,877	1,625	,429	1,771	,077
	SEC9	1,992	1,903	,075	1,047	,296
	SEC10	,275	1,819	,012	,151	,880
	2001	-,895	,378	-,116	-2,372	,018
	2002	-,893	,387	-,113	-2,307	,021
	2003	-,356	,379	-,046	-,938	,349
	2004	-,634	,361	-,088	-1,756	,080
2005	-,525	,361	-,074	-1,455	,146	
2006	-,513	,356	-,074	-1,440	,151	

a. Dependent Variable: MV/BV



*Regression analysis for the period 2007-2014*

**Variables Entered/Removed<sup>a</sup>**

Model	Variables Entered	Variables Removed	Method
1	2014, SEC7, SEC10, SEC9, 1/BV, SEC6, 2009, SEC5, SEC2, 2011, 2013, N1/BV, SEC4, 2008, 2012, SEC8, 2010, SEC3 <sup>b</sup>		Enter

a. Dependent Variable: MV/BV

b. All requested variables entered.

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,577 <sup>a</sup>	,333	,313	1,2280375

a. Predictors: (Constant), 2014, SEC7, SEC10, SEC9, 1/BV, SEC6, 2009, SEC5, SEC2, 2011, 2013, N1/BV, SEC4, 2008, 2012, SEC8, 2010, SEC3

**ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	456,485	18	25,360	16,816	,000 <sup>b</sup>
	Residual	915,402	607	1,508		
	Total	1371,887	625			

a. Dependent Variable: MV/BV

b. Predictors: (Constant), 2014, SEC7, SEC10, SEC9, 1/BV, SEC6, 2009, SEC5, SEC2, 2011, 2013, N1/BV, SEC4, 2008, 2012, SEC8, 2010, SEC3

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1,016	,457		2,223	,027
	1/BV	2,459	,892	,100	2,757	,006
	N1/BV	5,803	,489	,422	11,878	,000
	SEC2	-,073	,475	-,012	-,153	,878
	SEC3	,385	,443	,122	,868	,386
	SEC4	,448	,451	,114	,993	,321
	SEC5	-,285	,471	-,050	-,607	,544
	SEC6	-,180	,512	-,022	-,352	,725
	SEC7	-,472	,461	-,096	-1,023	,307
	SEC8	,586	,453	,155	1,293	,197
	SEC9	1,170	,617	,089	1,898	,058
	SEC10	,004	,615	,000	,007	,994
	2008	-,933	,193	-,207	-4,834	,000
	2009	,168	,210	,033	,801	,423
	2010	,082	,192	,018	,425	,671
	2011	-,499	,193	-,111	-2,591	,010
	2012	-,295	,194	-,066	-1,519	,129
	2013	,181	,194	,040	,933	,351
	2014	,008	,187	,002	,041	,968

a. Dependent Variable: MV/BV

*Correlation analysis for the three periods*

<b>Pearson correlation (2000-2014)</b>				
(n = 1151)		MV/BV	1/BV	NI/BV
MV/BV	Pearson Correlation Sig. (2-tailed)	1	,108** ,000	,399** ,000
1/BV	Pearson Correlation Sig. (2-tailed)	,108** ,000	1	,153** ,000
NI/BV	Pearson Correlation Sig. (2-tailed)	,399** ,000	,153** ,000	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

<b>Spearman's rho (2000-2014)</b>				
(n = 1151)		MV/BV	1/BV	NI/BV
MV/BV	Correlation Coefficient Sig. (2-tailed)	1	,083** ,005	,528** ,000
1/BV	Correlation Coefficient Sig. (2-tailed)	,083** ,005	1	,062* ,036
NI/BV	Correlation Coefficient Sig. (2-tailed)	,528** ,000	,062* ,036	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

<b>Pearson correlations (2000-2006)</b>				
(n = 525)		MV/BV	1/BV	NI/BV
MV/BV	Pearson Correlation Sig. (2-tailed)	1	0,061 ,163	,393** ,000
1/BV	Pearson Correlation Sig. (2-tailed)	0,061 ,163	1	,225** ,000
NI/BV	Pearson Correlation Sig. (2-tailed)	,393** ,000	,225** ,000	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

<b>Spearman's rho (2000-2006)</b>				
(n = 525)		MV/BV	1/BV	NI/BV
MV/BV	Correlation Coefficient Sig. (2-tailed)	1	,126** ,004	,537** ,000
1/BV	Correlation Coefficient Sig. (2-tailed)	,126** ,004	1	,104* ,017
NI/BV	Correlation Coefficient Sig. (2-tailed)	,537** ,000	,104* ,017	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

Pearson correlations (2007-2014)				
(n = 626)		MV/BV	1/BV	NI/BV
MV/BV	Pearson Correlation	1	,182**	,448**
	Sig. (2-tailed)		,000	,000
1/BV	Pearson Correlation	,182**	1	,092*
	Sig. (2-tailed)	,000		,021
NI/BV	Pearson Correlation	,448**	,092*	1
	Sig. (2-tailed)	,000	,021	

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

Spearman's rho (2007-2014)				
(n = 626)		MV/BV	1/BV	NI/BV
MV/BV	Correlation Coefficient	1	0,035	,518**
	Sig. (2-tailed)		,388	,000
1/BV	Correlation Coefficient	0,035	1	0,008
	Sig. (2-tailed)	,388		,842
NI/BV	Correlation Coefficient	,518**	0,008	1
	Sig. (2-tailed)	,000	,842	

\*\* . Correlation is significant at the 0.01 level (2-tailed).