D-CAF Working Paper Series

Disclosed Values of Option-Based Compensation – Incompetence, Deliberate Underreporting or the Use of Expected Time to Maturity?

Ken L. Bechmann and Toke L. Hjortshøj

D-CAF Working Paper No. 25 April 2007

Disclosed Values of Option-Based Compensation – Incompetence, Deliberate Underreporting or the Use of Expected Time to Maturity?

Ken L. Bechmann[a]

Department of Finance – Copenhagen Business School

Toke L. Hjortshøj[b]

School of Economics and Management – University of Aarhus

April 2, 2007

Key words: Option-based compensation; Option pricing; Expected time to maturity

JEL Classification: G30 (Corporate Finance and Governance); M41 (Accounting)

[a] Solbjerg Plads 3, DK-2000 Frederiksberg, Denmark

Phone: +45 38152953 Fax: +45 38153600 e-mail: kb.fi@cbs.dk

[b] University Park 323, DK-8000 Aarhus C, Denmark

Phone: +45 89422137 e-mail: thjortshoej@econ.au.dk

The authors wish to thank Trevor Buck, Peter Ove Christensen, Thomas Hemmer, Bjørn N. Jørgensen, Peter Løchte Jørgensen, David Yermack, and participants in the Workshop on Executive Compensation at Copenhagen Business School, the 2007 Loughborough University (ESRC) conference on Executive Pay in London, the 2006 meeting of the Danish Center for Accounting and Finance (D-CAF), the 2006 Skinance Conference, and participants in seminars at Copenhagen Business School, San Diego State University, and the University of Aarhus for many helpful comments. Excellent research assistance was provided by Simon Krantz Kristensen.

Disclosed Values of Option-Based Compensation – Incompetence, Deliberate Underreporting or the Use of Expected Time to Maturity?

JEL Classification: G30; M41

Key words: Option-based compensation; Option pricing; Expected time to maturity

Abstract

New accounting standards require firms to expense the costs of option-based compensation (OBC), but the associated valuations offer many challenges for firms. Earlier research has documented that firms in the U.S. generally underreport the values of OBC by manipulating the inputs used for valuation purposes. This paper examines the values of OBC disclosed by Danish firms. The results suggest that firms experience some difficulties in valuing OBC, but interestingly, there is no clear evidence of deliberate underreporting. For example, there is no evidence that firms use manipulated values for the Black-Scholes parameters in their valuations. Furthermore, firms determine the expected time to maturity in a way that is generally consistent with the guidelines provided by the new accounting standards.

The findings differ from those of the U.S., but is consistent with the more limited use of OBC and the lower level of attention paid to these values in Denmark. However, the differences can also be due to the fact that several Danish firms do not provide the information required regarding their OBC, which is clearly a very effective way of hiding the true values.

1 Introduction

The valuation of option-based compensation (OBC) offers many challenges to firms, especially given the fact that theoretically correct valuation approaches are considered impractical. Therefore, given the new accounting standards requiring firms to expense the costs of option-based compensation, it is interesting to examine how firms have overcome the challenges so far. The challenges include everything from the choice of valuation model to how the related parameters are determined.

Denmark is well-suited for such an examination because, since 2002, firms listed on the Copenhagen Stock Exchange have been required to disclose values of option-based compensation and explain how these values have been obtained. This information allows us to study how firms value option-based compensation in more depth than generally seen earlier in the literature. In particular, the information on how firms set the *expected* time to maturity and the distribution of options among different groups of recipients is quite detailed.

In addition to examining an interesting data-set, this paper contributes to the existing literature for three main reasons. First, according to our information, this paper is the first to study how non-U.S. firms value option-based compensation, which is a relevant issue given differences in the legal environment and in other corporate governance related aspects.

Second, compared to the U.S., option-based compensation used by Danish firms offers several interesting features, like time-varying exercise prices, knock-in features and different performance criteria. These features will generally allow firms more flexibility with respect to valuation models and the choice of input that can be used to minimize the value of the options. We therefore have a unique opportunity to study the extent to which firms take advantage of such exotic features.

The third and final contribution concerns the determination of *expected* time to maturity. We have exact information on this important aspect for a large fraction of our data-set, and hence do not have to rely on different approximations as is often the case in studies of valuations in the U.S. This is especially interesting since recent literature argues that this factor is important but also complicated to determine based on the guidelines in the new accounting standards (*International Financial Reporting Standards* 2 – Share-based Payment, IFRS 2).

The results generally suggest that Danish firms do not deliberately underreport the value of option-based compensation. In particular, there is very limited evidence that firms manipulate the inputs used for their valuations in order to obtain low option values. In fact, there is evidence that in some cases, due to "incompetence", firms actually use inputs that lead to option values

that are much too high. Therefore, if there is any underreporting, it is generally due to firms using an expected time to maturity that is too short. While it is difficult to judge if this is the case, our results show that firms adjust the expected time to maturity consistent with recommendations in the accounting standards and with empirical evidence on the early exercise behavior of option recipients. Thereby, our results may also help firms determining the expected time to maturity as the results shows how other firms have taken different characteristics of the option based compensation into account when setting time to maturity.

On the other hand, the results also show that relatively many Danish firms do not provide the information required for the valuation of their option-based compensation or do not disclose option values. This, of course, raises the question whether these firms are deliberately trying to hide the magnitude of their option-based compensation. Similarly, it would be interesting to know why it seems to have very few consequences if firms do not live up to information requirements and accounting standards.

The paper is organized as follows. Section 2 describes the rules requiring firms to value option-based compensation, including the new accounting standards, the IFRS 2, and accounting standards specific for Denmark. Furthermore, we discuss related literature as well as how the expected time to maturity of option-based compensation should be determined. Next, section 3 describes the data-set examined in this paper and provides some background information on the use of option-based compensation in Denmark. Section 4 contains the analysis of the values and input parameters used for the valuations as disclosed by the firms and, finally, section 5 offers concluding remarks.

2 Accounting for option-based compensation

2.1 Rules

The *International Accounting Standard Board* (IASB) outlines guidelines to estimate the fair value of option-based compensation in the *International Financial Reporting Standards* 2 (IFRS 2) – Share-based Payment, effective from January 1, 2005. In particular, the IFRS 2 lists which factors should be included in the option pricing model and how each input parameter should be estimated. The IFRS 2 allows for some flexibility in choosing the option pricing model as long as the model incorporates crucial input parameters such as current stock price, risk-free interest rate, dividend yield, exercise price, stock price volatility, and expected time to maturity. Examples

of option pricing models that fulfill the requirements are the Black-Scholes (Merton) model, the Binomial model, and the Monte-Carlo model. However, the IFRS 2 does not recommend one model more than others.

The IFRS 2 provides some guidelines on how input parameters should be estimated in order to reflect current market conditions, but in some cases the guidelines can still be considered vague. The guidelines are briefly described in the following.

To estimate the risk-free interest rate, the IFRS 2 suggests a zero-coupon government rate with maturity equal to the option's expected time to maturity. In cases where the recipient is not entitled to receive dividends and the options are not adjusted for dividends, dividend payments must be taken into account when calculating the fair option value. According to the IFRS 2, the dividend yield should be based on historical as well as future expected dividend payments. The dividend yield should, however, only be based on publicly available information and should not depend on inside information about future changes in the dividend policy. The stock price volatility should be expressed as the annualized standard deviation of stock returns and should take into account factors such as implied volatility from traded options, historical volatility, and mean reversion of the volatility.

With respect to the expected time to maturity, the IFRS 2 recognizes that recipients of option-based compensation tend to exercise their options earlier than what is optimal for freely traded and hedgeable options. To take this into account in the valuation of the options, the time to maturity should reflect the *expected* time maturity of the options. Some of the factors that should be considered when determining the expected time to maturity are the vesting period, the current stock price relative to the exercise price (moneyness of the options), the recipient's level within the organization, and the expected stock volatility. Furthermore, the historical exercise behavior should be considered when estimating the expected time to maturity. We will return to a discussion of these relations in section 2.3.

The IFRS 2 is in many ways comparable to the existing accounting regulations in the U.S. and Denmark. The Danish regulations will be discussed in much more detail in section 2.4 and the U.S. regulations, Statements of Financial Accounting Standards (SFAS) No. 123, are discussed in earlier studies, such as Huddart and Lang (1996); and Aboody, Barth, and Kasznik (2006).

2.2 Related literature

Even before SFAS No. 123 became effective in the U.S., Coller and Higgs (1997) showed that when firms follow the valuation recommendations, small changes in the input parameters can significantly influence the disclosed option values. These results lead the authors to note that, "As a result, financial statements of firms using the new standard [SFAS No. 123] should be interpreted with caution." Based on a sample of 182 CEO stock option grants in the 1992-93 and 1993-94 fiscal years, Yermack (1998) finds that firms underreport option values. In addition, the study finds the largest underreporting in cases where managers are paid excessively.

The various degrees of freedom in the choice of valuation method and parameter estimates (see e.g. Coller and Higgs (1997); and Yermack (1998)) were confirmed by Balsam, Mozes, and Newman (2003) in an examination of the firms' disclosed option values in the first fiscal year where SFAS No. 123 was in effect. Balsam, Mozes, and Newman (2003) find some evidence of firms exploiting these opportunities and disclose reduced option values. However, consistent with Yermack's (1998) results, higher performance-related compensation such as options and stocks cause greater underreporting.

In a recent study, Johnston (2006) finds the largest underreporting in cases where firms voluntarily expense the option values in the income statement compared to firms that still apply the footnote disclosures of option values. This suggests that the expense of option values provides firms with a stronger incentive to underreport the values.

In an attempt to analyze the underreporting of option-based compensation, prior research has examined the input parameters separately by comparing the disclosed values of input factors with values estimated following the recommendations in SFAS No. 123.

There is mixed evidence on whether firms manage the choice of interest rates. Hodder et al. (2006) find that reported interest rates are statistically lower than estimated rates. Neither Aboody, Barth, and Kasznik (2006) nor Johnston (2006), on the other hand, find that firms manage the choice of interest rate.

When studying the disclosed dividend yield, Aboody, Barth, and Kasznik (2006) find evidence that firms manage the value of the dividend yield. However, Hodder et al. (2006) and Johnston (2006) do not find similar evidence.

It is well known that option values are highly sensitive to changes in the stock return volatility, and therefore one effective way to reduce option values is by using a volatility that is too low. Aboody, Barth, and Kasznik (2006) show that especially firms with large compensation

schemes and excessively well-paid managers manage volatility, while Hodder et al. (2006) and Johnston (2006) find that firms disclose significantly lower volatilities compared to the historical volatilities. As mentioned in section 2.1, firms may account for expected changes in firm risk when setting the volatility. This leaves outsiders with an unobservable factor which could explain the underreported volatilities. Bartov, Mohanram, and Nissim (2007) examine whether forward-looking (implied) volatilities may explain the low reported volatilities. However, their results show that forward-looking volatility is primarily used when it is lower than the historical volatility.

Studies analyzing disclosed option values have found that firms manage the reported expected time to maturity (e.g. Yermack (1998); Aboody, Barth, and Kasznik (2006); and Hodder et al. (2006)). In particular, Aboody, Barth, and Kasznik (2006) find that firms with large compensation schemes and excessively well-paid managers use a shorter expected time to maturity to lower the disclosed values. However, this relation does not reflect the historically observed exercise behavior, where managers seem to hold the options longer (Bettis, Bizjak, and Lemmon (2005)).

The *expected* time to maturity is also discussed in Ikäheimo, Kuosa, and Puttonen (2006), who show that the market price of *traded* executive stock options, which can be observed in Finland, is significantly lower than the Black-Scholes value calculated based on the maximum time to maturity. Therefore, in order to obtain fair values of option-based compensation, it is important to determine the *expected* time to maturity. Some of the issues that should be taken into account when determining the expected time to maturity are described in the next section.

2.3 Determining expected time to maturity

According to the IFRS 2, there are five aspects a firm should take into account when determining the expected time to maturity of the option programs. They are the length of the vesting period, the price of the underlying stock (moneyness), the recipients' level within the organization, the expected volatility of the underlying stock, and the average length of time similar options have remained outstanding in the past.[1]

Usually, recipients are prohibited from exercising the options during a certain period denoted

[1]Ikäheimo, Kuosa, and Puttonen (2006) mention that the expected time to maturity should also take into account the possibility of changes in corporate structure. This is because in such cases, like a merger, the stock options in Finland will typically expire. IFRS 2 does not state anything about this issue. Furthermore, in Denmark, stock options will typically not expire in the case of mergers. Instead, option recipients have typically been offered a choice between keeping the options or selling the options at a price that includes a premium for the lost time value. Therefore, even though this issue is interesting, it will not be considered any further in this paper.

as the vesting period. Using data for 50,000 employees in eight firms in 1992, Huddart and Lang (1996) find a large exercise activity shortly after the end of the vesting period (see also, e.g., Heath, Huddart, and Lang (1999); and Huddart and Lang (2003)).

Theoretical work suggests that undiversified and risk-averse option recipients who hold vested (exercisable) in-the-money options will have an incentive to exercise their options early to rebalance their total wealth (e.g. Huddart (1994); Hall and Murphy (2002); and Brisley (2006)). Empirical work has shown that a positive relation exists between the intrinsic value (or moneyness) and exercise behavior. Huddart and Lang (1996) find increased exercise activity for high intrinsic values. Core and Guay (2001) document a positive relation between exercise decisions and the "fraction of Black-Scholes value realized", where the fraction is the ratio between the intrinsic value and the Black-Scholes value capturing the sacrificed time value when the recipients exercise their options. A positive relation therefore suggests that the more the options are in-the-money the more the option holders exercise their options (see also e.g. Heath, Huddart, and Lang (1999); Huddart and Lang (2003); and Bettis, Bizjak, and Lemmon (2005)).

According to the IFRS 2, the expected early exercise behavior will also depend on the recipient's level within the organization. Lambert, Larcker, and Verrecchia (1991) and Hall and Murphy (2002) show that the option holder's risk aversion and degree of diversification play a crucial role in determining exercise behavior. Bettis, Bizjak, and Lemmon (2005) find that executives hold their stock options longer than lower-level employees. Overall, there are reasons to expect that lower-level employees are more risk-averse and less diversified (more wealth constrained) than executives. However, there may be several other explanations for why executives seem to exercise their options later than lower-level employees. Bettis, Bizjak, and Lemmon (2005) argue that the longer holding period may be due to either political reasons or contractual requirements to maintain a certain level of firm-specific ownership. Another plausible reason could be that top-management uses private information and delays exercise until just before negative stock price returns (e.g. Huddart and Lang (2003) and Bartov and Mohanram (2004)).

Previous work has found a strong positive relation between exercise activity and volatility (e.g. Huddart and Lang (1996); Hemmer, Matsunaga, and Shevlin (1996); and Bettis, Bizjak, and Lemmon (2005)). The general explanation for the observed exercise behavior is that increased volatility triggers more exercises by risk-averse option holders.

The last factor outlined in the IFRS 2 is basically the observed historical exercise pattern for similar options and recipients. The data available do not allow us to include this factor in our

analysis, which is why we have to rely on the empirical results given in earlier studies evaluating exercise behavior. The additional factors suggested by these studies are "price run up" and "dividend yield". Several empirical studies have found that stock price run ups positively affect exercise decisions (see e.g. Huddart and Lang (1996); Heath, Huddart, and Lang (1999); Huddart and Lang (2003); and Bettis, Bizjak, and Lemmon (2005)). One explanation for early exercise after stock price run ups is that the risk-averse recipient wants to lock in the gain prior to a possible stock price decrease.

When examining early exercise behavior, Bettis, Bizjak, and Lemmon (2005) show that option holders in dividend paying firms exercise their options earlier. This is consistent with what should be expected based on the exercise pattern for standard, freely traded American options.

2.4 Danish regulations

Firms are required to provide detailed information to the stock market on option-based compensation. This follows from Danish legislation and the *Rules Governing Securities Listed on the Copenhagen Stock Exchange* (CSE). The Rules, which are updated frequently, have emphasized this since the version that became effective as of October 1, 1999. In particular, firms have been required to provide information on option type, number of options, date of issue, time to maturity, exercise price, and exercise provisions. Firms have also been required to disclose information on the distribution of the options among three recipient groups (directors, executives, and employees). An updated version of the Rules became effective as of January 1, 2002, which clarified and expanded some of the disclosure requirements. In particular, firms now have to disclose their own assessment of the value of the option-based compensation and explain how this value has been calculated.

With respect to the timing of the information disclosures, the Rules require that firms provide complete information as described above in the *accounting reports*. In addition, firms are required to disclose similar information immediately when new option-based compensation is granted, and this information is provided through *company announcements*.

The CSE has several possible sanctions if firms do not comply with the Rules. For the lightest sanction, firms receive a request asking them to comply with the Rules (the recipients of such a request remain anonymous). In more severe cases, the CSE can fine firms for up to DKK 1 million.[2] However, the CSE has often been criticized for being too soft on firms and rarely uses

[2]The current exchange rate is DKK 100 = EUR 13.40 = USD 16.99.

sanctions other than the lightest one.[3] Similarly, basically no tradition exists for shareholders filing lawsuits against firms that do not provide sufficient information in, for example, accounting reports. Thus, it is fair to say that it has limited direct consequences if a firm does not comply with CSE regulations.

All in all, the Danish regulations imply that firms have been required to provide information on the value of options-based compensation since January 1, 2002. However, as is also the case for the accounting standards, it is worth noting that the rules do not require any specific pricing model for the valuation, and actually, a very special valuation method has been used in Denmark. Following a specific request in 1995, the Danish tax authorities ruled that for valuation purposes, option-based compensation can be valued using a formula called *Ligningsraadets formula*, which is named after the tax authority that invented and approved the formula. Appendix A briefly describes the formula and shows that it does not take volatility into account in the valuation. Therefore, just like the intrinsic value, the formula does not comply with the requirements in the accounting standards, and hence the use of this formula as a valuation formula should no longer be expected.

3 Data collection and descriptive statistics

The following describes the data collection first and then provides descriptive statistics concerning the use of option-based compensation in Denmark as well as with respect to the data-set considered in this paper.

3.1 Data collection

Our data is a unique data-set on option-based compensation by Danish companies listed on the Copenhagen Stock Exchange. The data is based on a hand-collected database by Bechmann and Jørgensen (2004) and Hjortshøj (2006) and contains all publicly available information about the characteristics of options granted by Danish companies.[4] To make the empirical analysis in this paper, we extend the database by hand collecting disclosures of option values in the 2002 to 2005 accounting reports and company announcements. We include both sources of information since regulations, as mentioned, require firms to disclose option values in both. This permits more

[3] This critique is voiced in several articles in the financial press. The CSE's passive role in connection with the lack of information on option-based compensation is also discussed, for example, in Bechmann and Jørgensen (2002).

[4] The database starts in 1995 so detailed information on programs issued earlier than 2002 is also available, which makes it possible to include these programs in the study when values are provided by the firms.

observations on the firms' valuations of the options and it allows us to study whether the two types of valuations are different.

The fact that the time period is from 2002 to 2005 is also interesting in relation to the IFRS 2 since the new accounting standards became effective for accounting reports starting on or after January 1, 2005. For most of the firms this meant complying with the IFRS 2 for one year, allowing us to examine if this has implications for the quality of the information or the valuations.

In order to examine the disclosed values of option-based compensation, we need to be able to identify all relevant option characteristics. This, however, can be somewhat complicated since firms often have granted options several times in the past, which results in a portfolio of outstanding tranches with very different characteristics. However, our unique database allows us to extract full information about individual option tranches, permitting us to calculate accurate option values and then compare them with the disclosed values.[5]

As discussed in connection with the related literature in section 2.2, the detailed information is an important advantage of our data-set compared to the data-sets used in many earlier studies. The vast majority of studies based on U.S. data extracts information on the executives' option holdings from the Execucomp database, where information about a firm's five highest paid executives is provided as average numbers and rely on the approximation algorithm suggested by Core and Guay (2002) to compute the aggregated portfolio value. Finally, U.S. firms with multiple grants within a given financial year may disclose ranges of crucial input parameters, which means that the only possibility left to researchers is to use the mid-point of the range as their choice of input parameters (e.g. Aboody, Barth, and Kasznik (2004); Bartov, Mohanram, and Nissim (2007); and Aboody, Barth, and Kasznik (2006)).

From each accounting report and company announcement, we collect the options outstanding for each tranche, the option characteristics, the disclosed value of the options, the valuation model, and the input parameters for the valuation model. We only include observations for which we can identify all relevant option characteristics and where the value of the options is disclosed.[6] Equity data and interest rates are obtained from Datastream.

[5]Ideally, we would also have liked to have values for all the individual tranches. Even though quite many firms disclose these values, the regulations do not require them.

[6]To ensure high quality data, we have been in contact with the firms in cases where information was lacking or where we were unsure as to how the information should be read. In many cases, this helped us to correct mistakes due to, for example, typos, etc. However, we also encountered firms that were not very helpful in clarifying information on their OBC and hence, we had to exclude these firms from the analysis.

3.2 Descriptive statistics

Table 1 describes the data-set and various aspects of the quality of the information provided by the firms. First, Panel A shows that the final sample consists of 66 firms with 1,068 observations of option values. The observations come from 172 accounting reports and 82 company announcements.

Table 1 also shows that this sample of firms is not equal to the whole sample of Danish firms using options-based compensation. For example, in 2005 there were 63 firms that used option-based compensation but only 48 firms are included in this study. This is because there are eight firms that do not provide sufficient information on the options and seven firms that do not disclose option values, which means there are 15 firms that cannot be included in this study. As a result, only 71% of firms using option-based compensation in 2005 are included. We consider this a relatively low fraction, but it is still an improvement from 2002, where only 41% could be included.

We have examined some of the differences between the firms that are included and firms that are excluded from the analysis. It turns out that *included* firms especially are larger and heavier users of option-based compensation. For example, the average (median) market value of included firms is DKK 13 (4) billion, which should be compared to DKK 1 (0.6) billion for the excluded firms. Similarly, the option overhang, defined as the number of options issued divided by the total number of shares outstanding, is also larger for included firms than for excluded firms.

The lack of information or values for option-based compensation does not seem to have any consequences for the firms. As mentioned in section 2.4, the Copenhagen Stock Exchange can punish firms in various ways, but very few cases exist in which a firm has been required to provide more information, and in these cases no fine was given and the name of the firm was not made public.[7]

Table 1, Panel B, provides an overview of the different valuation methods used by the firms to calculate the fair value of the options. The panel shows that the vast majority of firms use the Black-Scholes pricing model to value options. In a few cases, the Binomial model (the Cox, Ross, and Rubinstein (1979) model) is used. In addition to the more common option pricing models, we have a few examples of firms using the intrinsic value and the *Ligningsraadets formula* to value the options. This was from 2002-2003 and, consistent with the discussion in section 2.4, it therefore seems like these valuation methods are no longer used.

[7]For the period 2002-2005, we have only been able to identify two cases in which the stock exchange required more information on a stock option program and in both regards it was in connection with the announcement of a grant for a new program.

Table 1: The data-set. Panel A shows the number of firms and individual option tranches across the different years, which come from accounting reports and individual company announcements. Panel B shows the valuation method used in the announcements (accounting reports and company announcements). Panel C shows the fraction of firms that report the input used in the valuation.

Panel A: Number of firms and observations	2002	2003	2004	2005	All
No. of firms with option-based compensation	94	85	76	63	101
No. of firms included in the analysis	40	53	48	48	66
Included in percent	42%	62%	63%	71%	55%
No. of observations (individual option tranches)	204	282	317	265	1068
No. of accounting reports	35	48	47	42	172
No. of company announcements	19	24	15	24	82
Panel B: Valuation model (in number of announcements)	**2002**	**2003**	**2004**	**2005**	**ALL**
Black-Scholes (Merton)	51	70	61	64	246
Binomial	1	1	1	2	5
Intrinsic value	1	1	0	0	2
Ligningsraadet	1	0	0	0	1
Panel C: Disclosed information (relative to announcements)	**2002**	**2003**	**2004**	**2005**	**ALL**
Interest rate	69%	75%	79%	76%	74%
Dividend yield	54%	54%	68%	73%	62%
Volatility	74%	85%	89%	93%	85%
Time to maturity – used	43%	44%	47%	63%	49%
All of the above	26%	27%	36%	41%	33%

Following the results on the valuation method, it should be emphasized that when we consider valuations in the rest of the paper, we will only be looking at firms using the Black-Scholes model. In this way, we can be sure that we examine the observations in a consistent way.

Panel C of Table 1 shows to what extent firms follow the *Rules Governing Securities Listed on the Copenhagen Stock Exchange* and the IFRS 2 in 2005 and disclose the input parameters used in the firms' calculations of option values. This panel shows that firms have become better at reporting input parameters over time. This is especially clear in 2005, when nearly every firm in our sample disclosed volatility. Similarly, the fraction of firms providing information on the dividend yield has increased from 54% to 73%. On the other hand, the exact time to maturity used for the calculations is still often missing even though the fraction improved to 63% in 2005.

All in all, firms have an overall disclosure rate close to slightly more than 40% in 2005. Thereby, Panel C adds to the evidence discussed above suggesting that Danish listed firms generally do not comply very well with the regulations. Even though they have been required to explain how disclosed values are calculated since 2002, complete information is only provided by four out of every ten firms in 2005 – the year when IFRS 2 repeated that this information is required. However, the fact that more than 90% actually report volatility, which is quite important for valuations, suggests that the lack of compliance may be because firms take the requirements too lightly rather than it being a reflection of bad will.

3.3 Option-based compensation in Denmark

In order to put some of the following results into perspective, this section briefly describes the use of option-based compensation in Denmark (for a detailed discussion see Bechmann and Jørgensen (2004)). It was not until 1995 that listed firms started using option-based compensation, the use of which increased rapidly in the following years such that around half of all 200 firms listed in Denmark had introduced option-based compensation by the year 2000. In the subsequent bear-market period, the use of option-based compensation stagnated in the sense that only a few new firms started using option-based compensation, while some firms stopped doing so. All in all, only around 50-60 Danish listed firms can be deemed frequent users of option-based compensation in the 2002 to 2005 period. In order briefly to describe the design and magnitude of the option programs that we look at, Table 2 presents some descriptive statistics.

The table shows that there is a relatively large variation in the moneyness at issuance in Denmark, at least compared to the U.S., where nearly all options are issued at-the-money.[8] Similarly, the programs have shorter time-to-maturity, with a mean and median of approximately five years. Furthermore, the use of option-based compensation is not as pronounced as in the U.S. This follows from the fact that the mean (median) option overhang is a modest 3.4% (2.5%). Similarly and probably quite importantly, option-based compensation is a much smaller fraction of cash remuneration to executives since the value of options received by executives is on average less than 28% of the fixed remuneration. Finally, only a few firms grant options to the board of directors.[9]

[8]The information provided here on the use of OBC in the U.S. primarily comes from Murphy (1999). However, further information can also be found in various remuneration reports like the Towers Perrin Worldwide Total Remuneration Report.

[9] This is probably a consequence of suggestions in various recommendations for good corporate governance. These reports recommend against options for the board of directors, arguing that they could undermine the controlling role of the board towards the executives (see the so-called Nørby-report, www.corporategovernance.dk).

Table 2: The design and use of option-based compensation (OBC) in Denmark. The information is based on the 2002-2005 period. Moneyness is the stock price divided by the exercise price; option overhang is the number of options issued divided by the total number of shares outstanding.

	Mean	Stdev	Max	Q3	Median	Q1	Min
Option characteristics at issuance:							
Moneyness	1.1	0.6	8.9	1.1	1.0	0.8	0.1
Time to maturity	5.6	3.1	20.3	6.2	5.0	3.8	0.8
Option characteristics in our sample:							
Moneyness	1.4	1.2	11.3	1.6	1.1	0.7	0.0
Time to maturity	3.5	2.3	11.0	4.7	3.1	1.7	0.1
Distribution of OBC:							
- Directors	3.9%	14.5%	100.0%	0.0%	0.0%	0.0%	0.0%
- Executives	36.8%	30.6%	100.0%	50.8%	30.4%	13.5%	0.0%
- Employees	59.3%	31.8%	100.0%	83.2%	67.9%	44.9%	0.0%
Option overhang	3.4%	3.0%	13.7%	4.9%	2.5%	1.2%	0.1%
Value of OBC / cash remuneration:							
- Directors	15.1%	61.6%	508.3%	0.0%	0.0%	0.0%	0.0%
- Executives	27.6%	31.9%	218.4%	40.4%	19.0%	8.3%	0.0%

It is difficult to judge whether Danish listed firms all in all have smaller or larger incentives to underreport the values of option-based compensation compared to, for example, U.S. firms. The fact that the level of option-based compensation is much smaller suggests that firms have fewer incentives to underreport values. Denmark, however, has a tradition for relatively small variations in salaries even between ordinary workers and top executives.[10] Furthermore, examples of extraordinarily large salaries or large option programs are generally criticized in the financial press as well as by politicians and different groups of shareholders.

4 Analysis

This section will start by documenting relatively large differences between the values disclosed by the firms and the market values calculated by using the Black-Scholes (Merton) formula with

[10]For example, the ratio of remuneration for top executives relative to the remuneration for ordinary workers is around 10 to 20 in Denmark. These numbers are much smaller than similar numbers discussed in the U.S.

a time to maturity equal to the options' time to maturity. In order to examine the cause of these differences, we then turn our attention to the parameters used to calculate the value of option-based compensation. First, we briefly consider the stock price and the interest rate. Then, we consider the dividend yield, the exercise price, the volatility, and the time to maturity, where especially the time to maturity is studied in detail in order to examine if this factor is determined in accordance with the IFRS 2 guidelines.

4.1 Disclosed values versus market values

We start the analysis by comparing the values disclosed by firms with what could be argued to be the market value of the options, i.e. the value of the options obtained by using the Black-Scholes formula with the maximum time to maturity. In appendix B, we briefly introduce the formula for valuation purposes in our case, and perhaps more importantly, we describe how we obtain the relevant parameters.

Table 3 compares the values disclosed by firms with the market values calculated using the Black-Scholes formula. In order to make this comparison across different values, the disclosed value is divided by the value calculated. A number less than one thus implies that the disclosed value is less than our calculated market value. In calculating the market values in Table 3, the values of the interest rate, volatility, and dividend yield used are estimated as explained in appendix B. As time to maturity, the maximum time to maturity is used.

Table 3 shows that the mean of the disclosed value relative to the market value is 0.83 across all 578 individual observations, which is a ratio significantly less than one based on a standard t-test as well as a Wilcoxon signed rank-test. Valuations at the portfolio level provide similar results. There is a minor tendency for the disclosed values to approach the market values over time, but interestingly, the ratio of disclosed value to market value dropped from 2004 to 2005 at the firm level. This is discussed later in connection with the results on the use of expected time to maturity by the firms.

This table also shows that there are large deviations in both directions between the disclosed values and the values calculated. For example, there are firms that disclose values that are more than two times larger than the values we have calculated. Similarly, the minimum ratio corresponds to cases where the firm discloses a value of zero for their option-based compensation. However, this is often due to the rounding of numbers in the accounting report. Therefore, it is relevant to note that the first quartile corresponds to cases where the firm underreports the values by around 30-40%.

Table 3: Disclosed values of option-based compensation relative to market values calculated by Black-Scholes using maximum time to maturity. The left-hand side of the table examines valuations at the firm level, i.e. valuations of complete programs. The right-hand side examines valuations of individual tranches. Z_{wilcox} is a standard Wilcoxon signed rank-test; T_{mean} (T_{median}) is a standard t-test for whether the mean (median) is different from 1. The two-tailed 1%, 5%, and 10% critical values for the three tests are ±2.58, ±1.96, and ±1.64, respectively.

	Portfolio values					Individual observations				
	2002	2003	2004	2005	All	2002	2003	2004	2005	All
N	51	70	61	64	246	104	141	166	167	578
Mean	0.81	0.89	1.00	0.92	0.91	0.78	0.73	0.78	1.01	0.83
Stdev	0.37	0.37	0.31	0.37	0.36	0.50	0.48	0.51	0.43	0.49
Maximum	2.01	1.74	1.83	2.05	2.05	2.01	1.81	2.32	2.57	2.57
Q3	1.02	1.02	1.13	1.06	1.07	1.11	1.00	1.06	1.12	1.07
Median	0.78	0.88	1.01	0.96	0.93	0.79	0.83	0.94	1.00	0.95
Q1	0.60	0.72	0.88	0.70	0.71	0.46	0.42	0.53	0.82	0.61
Minimum	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Fraction<1	0.73	0.70	0.48	0.63	0.63	0.65	0.72	0.66	0.51	0.63
Z_{wilcox}	−3.62	−3.07	0.04	−2.03	−4.63	−3.88	−6.13	−4.95	−0.14	−7.68
T_{mean}	−3.71	−2.50	−0.07	−1.68	−4.02	−4.55	−6.61	−5.54	0.36	−8.05
T_{median}	−4.26	−2.66	0.17	−0.81	−3.05	−4.37	−4.21	−1.41	−0.08	−2.68

In relation to these results, it is also interesting to examine if there are any differences between the values disclosed in accounting reports and the values disclosed in company announcements. One reason to believe that this is the case is that the valuations in company announcements are values of new option grants and hence, directly related to what, for example, executives are paid at the cost of shareholders, whereas the accounting reports simply disclose the value of all outstanding options.

The evidence, available upon request, does not suggest this to be the case, i.e. there are no significant differences between valuations disclosed in company announcements and valuations disclosed in accounting reports.

In summary, these first results suggest that the values disclosed by firms are consistently lower than the market values calculated using the Black-Scholes formula with the maximum time to maturity of the options. We examine the different inputs in order to see if the selection of these parameters by the firms can explain the low disclosed values.

4.2 Stock price

All firms in the sample are listed firms that trade reasonably often, implying that it is straightforward to obtain a stock price for the valuation date. Around a third of the firms explicitly state the stock price used for their valuation. These prices are generally equal to the firm's stock price on the valuation date.

The fact that firms seem to use the correct stock price is consistent with how easily accessible and verifiable the stock price is. Therefore, we will not discuss the stock price in further detail, but instead turn our attention to other factors that potentially are more complicated to estimate.

4.3 Interest rate

In studying the determination of the interest rate, we first consider how the interest rate is determined by firms since the type of interest rate that should be used it is not precisely defined.

As seen in Table 1, we have information on the interest rate used for 74% of the announcements. However, for most of these observations the firms just state the value of the interest rate and do not explain how the value has been obtained. In fact, only one out of every five firms explains how the interest rate is determined, and these firms are equally split between firms using treasury rates and firms using swap rates. Very rarely do the firms report the maturity of the interest rate, but in a few cases it is stated that the maturity is chosen to match the maturity of the options.

We have complete information on the value used for the interest rate and the time to maturity of the options for 425 observations. This allows us to compare the interest rate used with an estimated interest rate based on a maturity equal to the options' maturity.[11]

Table 4, Panel A, which presents results for the ratio of the reported interest rate to our estimated interest rate, shows that the reported interest rate is significantly higher than our estimated interest rate with a mean (median) ratio of 1.36 (1.41).

These results suggest that firms generally use interest rates *higher* than our estimated rates, which actually means that option values disclosed by the firms tend to be *higher* than our option values. In order to examine this in further detail, we have made a comparison as in Table 4, Panel A, but where reported interest rates are compared to the interest rates estimated based on a five-year time to maturity for all options. The five-year time to maturity is chosen to match the average time to maturity of options at *issuance*, as seen in Table 2. In this comparison, the

[11] Details on the estimation of the interest rates (and the following parameters) are provided in appendix B.

Table 4: The reported interest rate relative to our estimated interest rate (Panel A) and the reported dividend yield to our calculated dividend yield (Panel B). Z_{wilcox} is a standard Wilcoxon signed rank-test, T_{mean} (T_{median}) is a standard t-test for whether the mean (median) is different from 1. The two-tailed 1%, 5%, and 10% critical values for the three tests are ±2.58, ±1.96, and ±1.64, respectively.

	Panel A	Panel B
	Interest rate	Dividend yield
N	425	584
Mean	1.36	1.20
Stdev	0.26	0.93
Maximum	2.00	9.68
Q3	1.48	1.17
Median	1.41	1.00
Q1	1.20	1.00
Minimum	0.90	0.00
Fraction<1	0.12	0.24
Z_{wilcox}	17.21	7.43
T_{mean}	28.71	5.09
T_{median}	32.41	0.00

mean (median) ratio turns out to be 0.95 (0.95), so in this case there is no evidence that reported interest rates are higher than the estimated rates.

To conclude, there is some evidence that firms use interest rates that are somewhat higher than the market rates with a similar time to maturity. However, this clearly does not seem to be a deliberate attempt to underreport option values, but rather is a failure to adjust for the time to maturity. Finally, if the purpose was to obtain low values of the options, there are other parameters that are more effectively manipulated than the interest rate. These parameters are considered in the following.

4.4 Dividend yield

Dividends paid by firms will generally influence the value of options and should therefore be taken into account in valuations. The only exception is when firms have designed option programs such that the options are adjusted for dividends. A typical way of doing this is to adjust the exercise

price for dividends such that when a dividend payment is made, the exercise price is reduced by the same amount. Four of our 66 firms explicitly state that their programs are adjusted for dividends, which means they should not take dividends into account when valuing their options.

To the extent that the remaining firms do not adjust options for dividends, they need to take dividends into account when valuing options. Only a few firms describe in detail how this is done, but from the information provided, quite a large fraction of firms make an attempt to adjust the option values for dividends. In connection with the valuation, 584 observations provide some information on dividends, but only 42% of the firms provide information on the dividend yield (dividend rate) normally used when the adjusted Black-Scholes (the Merton) formula is used to price options taking dividends into account. The remaining 58% provide information on dividends in monetary terms per share, but how this is used in the valuation of the options is not explained.

Assuming that all firms providing information on dividends in monetary terms actually adjust this to a dividend yield as described in appendix B, we can compare our calculated dividend yields with the yields "reported" by the firms. Table 4, Panel B, presents results from this type of comparison, again based on the ratio between the reported dividend yield and our calculated value for the dividend yield.

The table shows that there is evidence that firms use, on average, a slightly higher dividend yield than the one we have calculated. An average ratio of 1.20 shows this, but it is interesting to note that the median is 1.00.

Therefore, with respect to the dividend yield, there is some indication of underreporting. However, the fact that some firms use a dividend yield higher than the one we obtain based on historical dividend information might also be consistent with the fact that Danish firms actually increased the dividend rate from 2002 to 2005 and that some firms maybe look forward when determining the dividend yield. This instead raises the question about whether these firms use information that is not publicly available when setting the dividend yield, which would be against the recommendations in the IFRS 2.

4.5 Exercise price

The exercise price is the fourth factor needed to obtain the value of option-based compensation. In general, there does not seem to be much to discuss since the exercise price is contractually specified for the options. However, as briefly mentioned in the introduction, time varying exercise

prices are used quite often in Denmark. It is therefore interesting to examine how the firms' valuation take this into account – both compared to the accounting standards and in connection with a discussion of the underreporting of values.[12]

As seen in Table 5, there are 113 observations in the sample where the exercise price increases over time based on a fixed rate per year. For these, appendix B explains that a fair and consistent valuation of the programs would require an adjustment of the exercise price such that it is consistent with the time to maturity used for the valuation. Table 5 describes the adjustment of the exercise price made by the firms for these 113 observations.

Table 5: Number of observations where the exercise price increases over time and the adjustment made by firms when calculating the value of these options.

	2002	2003	2004	2005	All
Increasing exercise price	18	33	27	35	113
No adjustment	67%	55%	52%	46%	53%
Adjustment to maximum time to maturity	33%	30%	30%	3%	22%
Other adjustments	0%	15%	18%	51%	25%

This table shows that firms often fail to adjust the exercise price to be consistent with the time to maturity as no adjustment at all is made in more than 50% of the cases. By not making this adjustment, the firms actually end up disclosing option values that are too high. A further look at these observations reveals that the annual adjustment rates vary from 3% to 12%. If the firms do not make the appropriate adjustment of the exercise price, the option values can be exaggerated by as much as 140%.

However, this table also suggests an improvement over time since the fraction with no adjustment decreased from 67% in 2002 to 46% in 2005. Similarly, the fraction with other adjustments has increased from 0% to 51%, but these firms generally do not report the expected time to maturity of the options, which prevents us from examining if the adjustment in the exercise price is consistent with the expected time to maturity used in pricing the options.

[12]There are also examples of firms that have used indexed options where the exercise price is adjusted for changes in different indices. However, as they do not provide any details on how this feature has been taken into account, we have left them out of our analysis. Similarly, there are cases with knock-in features, performance criteria and other quite exotic features, but interestingly the firms do not seem to try to take these features into account in their valuations. As a result, we have also decided to leave these options out of our analysis, but the conclusions remain unchanged even if they are included.

4.6 Volatility

Volatility is known to be one of the most important parameters when valuing options, but also as a parameter whose estimation always can be discussed. Similarly, there are, at least in theory, several different ways in which such estimates can be obtained.

As seen in Table 1, we have the precise value for the volatility used for 85% of the announcements. However, as was the case for the interest rate, most of firms just state the value of the volatility without explaining how it has been obtained. Actually, less than 10% of the observations include details on how the volatility is estimated, and in all cases, it is estimated as historical volatility.[13] Among firms mentioning the use of historical volatility, details on how it is obtained are even more limited. A few firms mention that the historical volatility is estimated based on daily or weekly stock returns going back one year or more.

We have information on the volatility used by firms for 867 observations, which allows us to compare the volatility used with estimated values for the volatility. Table 6 shows results for the ratio of disclosed values to our estimated volatility using estimation periods of approximately six months, a year, and two years. The reported volatility is, on average, consistent with our volatility, which is estimated based on a one-year period. However, it is also worth noting that the ratio of reported to estimated volatility varies from around 0.1 to 3.5. Therefore, there are examples where firms use volatilities that are either very large or very small compared to the historical volatilities. In one of the extreme cases, a firm used a volatility of 5% even though our estimated volatility was more than 35%. Such a low value decreases the option values substantially.

Again, some improvements are observed over time. In particular, unreported results show that the maximum and especially the minimum are much closer to one in 2005 than in the early years.

In summary, there is very little evidence that firms systematically use volatilities that are different from what can be estimated as historical volatilities based on the previous year's stock price data. Instead, there is some evidence that firms find it quite difficult to provide reasonable values for the volatility. This illustrates the importance of complying with the IFRS 2, which also requires firms to explain how the volatility is obtained.

[13]The fact that only historical volatility is used is consistent with the fact that the options market in Denmark is not very developed, generally preventing the calculation of usable implied volatilities.

Table 6: The reported volatility relative to our estimated volatility where different estimation periods have been used. Z_{wilcox} is a standard Wilcoxon signed rank-test; T_{mean} (T_{median}) is a standard t-test for whether the mean (median) is different from 1. The two-tailed 1%, 5%, and 10% critical values for the three tests are ±2.58, ±1.96, and ±1.64, respectively.

Estimation period (days):	125	250	500
N	867	867	855
Mean	1.09	1.02	0.91
Stdev	0.41	0.34	0.29
Maximum	3.31	3.49	3.29
Q3	1.28	1.12	1.02
Median	1.04	1.00	0.92
Q1	0.88	0.89	0.74
Minimum	0.09	0.10	0.10
Fraction<1	0.44	0.49	0.67
Z_{wilcox}	5.66	0.80	−11.98
T_{mean}	6.39	1.91	−8.72
T_{median}	2.56	0.11	−8.03

4.7 Expected time to maturity

We now turn to the last factor needed for valuation, which is the time to maturity. Given the regulations in the IFRS 2, this factor offers firms quite some flexibility for most of the options since they are of the American type where firms are allowed to use the *expected* time to maturity as explained in section 2.1. This flexibility is also the reason why we examine the firms' determination of expected time to maturity. More precisely, we describe the policies used by the firms in setting the expected time to maturity. Thereafter, we examine if the expected time to maturity seems to be reasonable in light of the existing accounting standards and existing empirical research.

4.7.1 Reported expected time to maturity

Panel A of Table 7 describes how the expected time to maturity is determined for the observations where it can be derived from the information provided. This table shows that in 8% of the 492 observations, the earliest possible date is used to obtain the expected time to maturity, whereas

the latest possible date is used in 46% of the cases. Halfway between the earliest and latest exercise date is used in 3% of the observations, whereas one year after the earliest date is used in another 20%. Finally, 22% explicitly mention the expected time to maturity, but these cases cannot be argued to be covered by the other policies described above. For firms which explicitly state the expected time to maturity, Panel B of Table 7 describes characteristics of the time to maturity.

Panel B shows that for firms using an explicit expected time to maturity, there is no clear evidence suggesting that this expected time to maturity is chosen very close to the minimum possible time to maturity. Actually, it shows the contrary, that the explicit expected time to maturity (mean 3.30) is generally closer to the maximum time to maturity (mean 4.24) than to the minimum time to maturity (mean 0.68).

All these results on the expected time to maturity show that only a few firms use the shortest possible expected time to maturity. Another way to examine the determination of the expected time to maturity is to examine where the expected time to maturity is chosen relative to the interval from the earliest time to maturity to latest time to maturity. Here, the average (median) across all observations is 68% (68%). The numbers should be compared to 0% (100%), which would correspond to an expected time to maturity equal to the earliest (latest) time to maturity. These numbers again suggest that even though the expected time to maturity is shorter than the maturity of the options, it is generally quite close to the maximum time to maturity.

Table 7 suggests that the use of maximum time to maturity (latest date) has decreased over time and that firms instead have started using some of the other policies, for example, halfway into the exercise period or the earliest date. These observations are confirmed by the relative location of the expected time to maturity as considered above. Here, the average has decreased from 71% in 2002 to 63% in 2005. It is difficult to judge whether this change is due to a deliberate attempt to lower the values now that the IFRS 2 requires these values to be expensed or because the IFRS 2 has increased the awareness of the possibility (or need) to take the expected time to maturity into account in the valuations. In any case, this change over time is probably the primary reason why the ratio decreased from 2004 to 2005 as reported in Table 3.

One natural question to ask following these results is if the expected time to maturity can be argued to be reasonable, for example, given option program characteristics, as discussed in section 2.1. However, before doing so, we will briefly examine if the average underreporting analyzed in section 4.1 primarily can be attributed to firms using an expected time to maturity,

Table 7: The reported expected time to maturity. Panel A describes the firms' policies for setting the expected time to maturity – if stated. Panel B describes the characteristics for the cases where firms state an explicit time to maturity that is not covered by any of the general policies in Panel A. TTM_{min} (TTM_{max}) is the minimum (maximum) time to maturity.

PANEL A	2002	2003	2004	2005	All
No. of obs.	62	102	165	163	492
No. of firms	18	23	22	26	45
Earliest date:					
No. of obs.	5%	12%	7%	9%	8%
No. of firms	11%	13%	9%	19%	13%
Latest date:					
No. of obs.	58%	58%	35%	45%	46%
No. of firms	50%	48%	41%	38%	40%
Halfway in exercise period:					
No. of obs.	0%	5%	2%	5%	3%
No. of firms	0%	4%	5%	12%	9%
One year after vested:					
No. of obs.	15%	8%	32%	18%	20%
No. of firms	17%	9%	18%	12%	13%
Explicit TTM:					
No. of obs.	23%	18%	24%	23%	22%
No. of firms	22%	26%	27%	19%	24%
PANEL B	2002	2003	2004	2005	All
No. of obs.	14	18	39	37	108
TTM_{min}					
Mean	1.36	1.31	0.44	0.37	0.68
Median	1.25	1.08	0.08	0.08	0.08
TTM_{max}					
Mean	4.66	5.23	3.99	3.86	4.24
Median	4.88	5.25	3.83	2.00	3.88
Explicit TTM					
Mean	3.34	3.59	3.34	3.11	3.30
Median	4.00	4.00	3.00	1.39	3.00

which is shorter than the maximum time to maturity of the options. This is done by making a table similar to Table 3, where instead of the maximum time to maturity, the expected time to maturity as reported by the firms is used. It follows from results available upon request that the average underreporting seen in Table 3 decreases over time and is generally insignificant in 2004-2005.

To conclude, these results and the results on the individual parameters show that if the deliberate underreporting of option values exists, it must be because firms use an unrealistically

short expected time to maturity. This is of course difficult to prove, but what we can examine, as is the case in the next section, is whether the expected time to maturity, for example, is related to program characteristics consistent with recommendations by the accounting standards and earlier research on exercise behavior.

4.7.2 Expected time to maturity and program characteristics

Given the recommendations in the accounting standards outlined in section 2.1 and the empirical work on exercise behavior as discussed in section 2.3, the obvious question is now whether the reported expected time to maturity reflects the characteristics of the options and the firms themselves. We will therefore investigate if the discussed factors are taken into account when firms determine the expected time to maturity ($ETTM$).

The IFRS 2 lists several factors that should be considered when setting the $ETTM$ and, as described in section 2.3, these factors are:

- If the options are vested: $VEST_{gt}$,
- Volatility of the underlying stock: $VOL1Y_{gt}$,
- The market price of the underlying stock relative to the exercise price: MTE_{gt},
- The proportion of a given trance granted to directors: DIR_{gt},
- The proportion of a given trance granted to executives: $EXEC_{gt}$,
- The proportion of a given trance granted to employees: EMP_{gt},
- The average length of time similar options have remained outstanding in the past,

where $VEST_{gt}$ is defined as an indicator variable equal to one if the option holder is allowed to exercise the stock options at date t for tranche g. $VOL1Y_{gt}$ is the annualized stock return volatility estimated in the 250 trading days prior to the valuation date. MTE_{gt} denotes the market-to-exercise price ratio (also known as moneyness) for tranche g at date t. To capture the differences in the exercise behavior among the recipient groups, we define DIR_{gt}, $EXEC_{gt}$ and EMP_{gt} as the proportions of tranche g at date t granted to directors, executives, and employees, respectively.

The last factor outlined in the IFRS 2 is basically the observed historical exercise pattern of similar options. We do not have information on this pattern, so we have to rely on empirical

results given in earlier studies evaluating exercise behavior. As described in section 2.3, this suggests that the following factors are relevant:

- Dividend yield: DIV_{gt},
- Price run ups: $RET6MO_{gt}$,

where DIV_{gt} denotes the annual dividend yield and $RET6MO_{gt}$ denotes the firm's return during the six months prior to the valuation date.

We include the log of total assets, $SIZE_{gt}$, to control for firm size. Furthermore, following Aboody, Barth, and Kasznik (2006), we use the value of all outstanding stock options scaled by the number of shares outstanding, $VALUE_{gt}$, as a proxy for the magnitude of the option-based compensation. We also include industry dummy variables for all two-digit Global Industry Classification Standard (GICS) industries to capture possible differences in the exercise behavior or underreporting incentives across industries. Finally, we include year indicator variables to account for year effects.

In all regressions we use $RATIO_{gt}$ as the dependent variable, which is defined as the number of years the $ETTM$ is in the exercise period (i.e. the difference between the expected exercise date and the earliest possible exercise date) divided by the length of the entire exercise period in years (i.e. the difference between the latest and the earliest possible exercise date).[14] In other words, the left-hand side variable captures where the $ETTM$ is relative to the exercise period, as is also discussed above. When $RATIO$ is close to zero, it means that the $ETTM$ is close to the first possible exercise time, whereas a $RATIO$ close to one corresponds to cases where the firm has chosen an $ETTM$ close to the latest possible exercise date.

By definition, our dependent variable is bounded between zero and one, which forces us to consider how we obtain valid regression coefficients and appropriate tests. In this setup, OLS may, however, predict left-hand side values outside the bounded range. Therefore, we instead use the Fractional Logit Regression (FLR) technique, which is described in more detail in Papke and Wooldridge (1996) and Wooldridge (2002). Here, we obtain robust estimates and FLR ensures that our model predicts left-hand side variables within the unit interval.[15]

We present our regression results in Table 8.[16] Model (1) to Model (3) in Table 8 analyze

[14] In cases where options are vested, we assume that the options can be exercised tomorrow.

[15] Even though OLS regressions are not appropriate in this case, we performed the same regressions using OLS with robust standard errors in order to check robustness. In results available upon request, we show that the conclusions are unchanged if OLS regressions are considered instead.

[16] In the regressions, the firms enter with a different numbers of observations, but we have checked that the findings are not in any way caused by the firms with relatively more observations.

the recommendations in the IFRS 2. We observe a significant positive relation between $RATIO$ and $VEST$, which as expected suggests that firms are more likely to disclose an $ETTM$ close to the vesting date for options that have not vested yet. Inconsistent with both the guideline in the IFRS 2 and prior empirical findings, we find weak evidence that more volatile firms tend to use a longer $ETTM$. On the other hand, this is consistent with what should be expected for the early exercise in the case of freely traded options.

[Table 8 about here.]

The results also show that moneyness and the option recipients' level in the organization are used in determining the $ETTM$. In particular, we find a strong and significantly negative association between moneyness and the $RATIO$, suggesting that for in-the-money (out-of-the-money) options, the firm uses a shorter (longer) $ETTM$. Furthermore, we observe that as the executives hold a greater proportion of a particular option tranche, the firm sets a longer $ETTM$. Especially the last finding is important since Aboody, Barth, and Kasznik (2006), who study values disclosed by U.S. firms, find the completely opposite relation to be true.

Somewhat interestingly, we find a negative relation between the proportion granted to directors and the size of the $ETTM$. In general, we would expect directors to have less human capital tied to firm performance, to be less risk averse, and to be more diversified than the average employee. This all implies that directors, similar to executives, would delay the exercise of their options. Given the data available, we have not been able to examine if the shorter $ETTM$ reflects actual exercise behavior among directors or, as mentioned in footnote 9, the fact that strong opinion makers have argued against options to directors, providing an incentive for firms with large programs for directors to disclose low values. Furthermore, as mentioned earlier, only a few firms actually issue stock options to directors.

When we turn our attention to Model (4) to Model (6) we observe that a higher dividend yield, as expected, leads firms to use a shorter $ETTM$, whereas the historical stock return leads to a positive but insignificant effect on the $ETTM$. Since the sign is the opposite of what we had expected, we have tried to include the historical stock return but only for the vested options. In this case, the sign becomes negative, as expected, but the relation is still not significant. This suggests that firms do not seem to pay that much attention to the historical stock return when setting the expected time to maturity.

Firm size and the magnitude of option-based compensation are not found to have any impact

on the disclosed $ETTM$.[17] This result is again interesting in light of the findings from the U.S., where larger programs generally lead to more underreporting obtained by using shorter expected time to maturity.

Finally, we control for year effects in Model (4) to Model (9) and industry effects in Model (7) to Model (9). The control variables come out insignificant and the main conclusions remain unchanged.[18]

To sum up, the results suggest that firms to a large extent follow the guideline in the IFRS 2, and contrary to the U.S., there is no evidence that firms manipulate the values in situations where they have the largest incentive to do so, i.e. in cases where executives receive large programs.[19] The only exception is that the firms seem to use a shorter time to maturity in cases where the directors receive a large fraction of the options.

5 Conclusion

Option-based compensation has attracted a lot of attention in recent years, which emphasizes the importance of having access to appropriate valuations of options. This issue has become even more important after the IFRS 2 began requiring firms to expense options. In particular, it is relevant to examine how firms actually value OBC, including how special OBC characteristics are accounted for. Similarly, given that the regulations are not strict on exactly how valuations should be done, it is interesting to see if firms use this flexibility to lower the disclosed values of the OBC.

This paper examines valuations of OBC by listed Danish firms in the period from 2002 to 2005. In contrast to results from the U.S., there is only weak evidence of deliberate underreporting, but quite some evidence that firms find it difficult to obtain appropriate values for important parameters like volatility and that firms have trouble taking into account complicated features like time varying exercise prices in their valuations. The *expected* time to maturity generally seems

[17] We have examined the robustness of this result by using several other measures for the magnitude of the option-based compensation. However, no evidence exists in any of the cases that shows that larger programs lead to more underreporting.

[18] As discussed in section 4.5, a significant fraction of the options have exercise prices that increase over time. IFRS 2 does not mention that $ETTM$ should be adjusted in such cases, but everything equal, an increasing exercise price should lead to earlier exercise and hence, a shorter $ETTM$ should be used. We have examined this issue in the regressions by including a dummy for programs with increasing exercise prices, and the dummy turns up negative but insignificant.

[19] We have also examined if the fraction received by executives and the magnitude of option-based compensation can explain the cross-sectional variation in the ratio of reported volatility to our estimated volatility. This is not the case. Firms with large programs, for example, are not the firms that use low volatilities.

to be determined in a way consistent with the recommendations in the IFRS 2. In particular, and again in contrast to findings from the U.S., there is no evidence that firms with large compensations for executives or large option-based compensation attempt to underreport the option values.

Over time, we see improvements in the precision of the valuations and the quality of the information on OBC. Especially the introduction of the IFRS 2 in 2005 seems to have led to improvements in these two aspects. However, it is still striking that in 2005 we can only include 71% of the firms due to the lack of different types of information. This is, of course, an important aspect given the lack of evidence for underreporting for listed Danish firms. In particular, even though the omitted firms are mostly small firms that may find it complicated to provide sufficient details on OBC, we cannot rule out that some firms provide insufficient information in order to hide the value of their OBC.

The fact that we, in contrast to the U.S. findings, find very little evidence of underreporting for the group of firms that we examine may be explained by some of the differences between the U.S. and the Danish stock market. First, the magnitude of option-based compensation is not as pronounced in Denmark as in the U.S. Second, many of the listed Danish firms are characterized by having some large and influential shareholders such as foundations and/or institutional investors such as public pension funds. These shareholders may become dissatisfied if the firms are discovered to have underreported the value of option-based compensation, possibly because this could lead to bad publicity – as has been seen in Denmark in cases where certain firms did not provide sufficient information about their option programs. These characteristics seem to be enough to make most firms provide sufficient information and appropriate values even though official enforcement of the regulations seems relatively weak.

Appendix

A Ligningsraadets formula

As mentioned, the Danish tax authorities (Ligningsraadet) ruled in 1995 that for valuation purposes, option-based compensation can be valued using a formula quite different from the Black-Scholes formula. If we let S denote the stock price, T the maturity of the options, X the exercise price and r the interest rate, according to the formula, the value c of the option is:

$$c = S \cdot \frac{S}{X} \cdot r \cdot T.$$

B The Black-Scholes-Merton formula and required information

This paper focuses on the valuation of options according to the recommendations by IASB outlined in the IFRS 2. Here, the options are expected to be valued using a market price model such as the Black-Scholes-Merton model, the Binomial model, or the Monte-Carlo model. Our focus will solely be on the Black-Scholes-Merton model since the majority of firms in our sample use this valuation model.

The Black-Scholes-Merton model is given as:

$$Value = S \cdot \exp(-DIV \cdot ETTM) \cdot \Phi(Z) - X \cdot \exp(-R \cdot ETTM) \cdot \Phi(Z - VOL \cdot \sqrt{ETTM}), \quad (1)$$

where

$$Z = \frac{\ln(\frac{S}{X}) + (R - DIV + \frac{VOL^2}{2}) \cdot ETTM}{VOL \cdot \sqrt{ETTM}}, \quad (2)$$

and S is the stock price, R is the continuous risk-free interest rate, DIV is the continuous expected dividend yield, X is the exercise price, VOL is the annualized expected stock return volatility, $ETTM$ is the expected time to maturity in years, and Φ is the standard normal distribution function.

In our analysis, we compare the values reported by the firms to our calculated option values using the Black-Scholes-Merton pricing formula. In order to calculate option values that are as accurate as possible, we follow the recommendations in the IFRS 2 in estimating the input parameters. In the following, we carefully explain how we obtain each input parameter:

Stock price: S

S is chosen to be the most recent closing price available before the disclosed reporting date.

Interest rate: R

We follow the recommendations in the IFRS 2 and estimate R from a term structure of zero coupon interest rates. In order to estimate R with a maturity identical to the expected option life, we interpolate R from zero coupon interest rates with a constant maturity of 1, 2, 3, 4, 5, and 6 months, and 1, 2, 5, and 10 years.

The interpolation is given as follows,

$$R = R_i + \frac{(R_j - R_i)}{(t_j - t_i)}(ETTM - t_i), \quad (3)$$

where R_i is the interest rate with a maturity, t_i, closest to but lower than or equal to the $ETTM$, and R_j is the interest rate with the maturity, t_j, closest to but higher than the $ETTM$.

We assume that R is the zero rate with maturity of one month if the $ETTM$ is less than one month. For options with an $ETTM$ longer than 10 years, we assume R to have a maturity of 10 years.

Dividend yield: DIV

DIV is the logarithm of the expected dividend rate, where the rate is calculated as the ratio of the last ordinary dividend payment to the current stock price (see, e.g. Hull (2006)).

Exercise price: X

X is the exercise price of the option. We use the exercise price reported in grant announcements if the option is granted with a fixed exercise price. In cases where firms issue options with time varying exercise prices, an adjustment of the exercise price is required in order to obtain a fair value of the options.[20] In these cases, we calculate the future exercise prices, X_{ETTM}, given the expected time to maturity,

$$X_{ETTM} = X_0 \cdot (1 + \rho)^{ETTM}, \tag{4}$$

Here, ρ is the annual adjustment rate, X_0 is the grant date exercise price, and $ETTM$ is the expected time to maturity.

It is important to note that our unique data-set and knowledge about the option grant date allow us to calculate X_{ETTM}.

Volatility: VOL

VOL is the annualized stock return volatility. Following the existing literature, VOL is estimated using the standard maximum likelihood approach by Campbell, Lo, and MacKinlay (1997) and Hull (2006) from historical total returns adjusted for dividend payments. Unless otherwise noted, we choose an estimation period of 250 trading days prior to the date of reporting. We do not follow the recommendations in the IFRS 2 on this point, since the IFRS 2 states that the historical volatility should be estimated based on a time period corresponding to the time of maturity of the options. We have chosen our approach because the firms clearly use the same volatility for all outstanding programs.

[20] While this is not explicitly mentioned, the IFRS 2 does state that "Other factors that knowledgeable, willing market participants would consider in setting the price shall also be taken into account..." (Section B7, IFRS 2). We assume that a time varying exercise price must be just such a "factor".

Expected Time to maturity: $ETTM$

$ETTM$ is the expected time to maturity. In our unique data-set we have exact information about the grant date, vesting period, and maximum time to maturity. This allows us to compare the reported expected time to maturity with the option's exercise period and to examine whether the disclosed $ETTM$ is related to factors outlined in the IFRS 2 as well as factors that in earlier empirical work explain the historical exercise behavior. These factors are discussed in section 2.3.

References

Aboody, D., M. E. Barth, and R. Kasznik (2004): "SFAS No. 123 Stock-Based Compensation Expense and Equity Market Values," *The Accounting Review*, 79(2):251–275.

——— (2006): "Do Firms Understate Stock Option-Based Compensation Expense Disclosed under SFAS 123?," *Review of Accounting Studies*, 11:429–461.

Balsam, S., H. A. Mozes, and H. A. Newman (2003): "Managing Pro Forma Stock Option Expense under SFAS No. 123," *Accounting Horizons*, 17(1):31–45.

Bartov, E. and P. Mohanram (2004): "Private Information, Earnings Manipulations, and Executive Stock-Option Exercises," *The Accounting Review*, 79(4):889–920.

Bartov, E., P. S. Mohanram, and D. Nissim (2007): "Managerial Discretion and the Economic Determinants of the Disclosed Volatility Parameter for Valuing ESOs," *Review of Accounting Studies, forthcoming.*

Bechmann, K. L. and P. L. Jørgensen (2002): "Incentive Schemes and Disclosure Rules (In Danish: Incitamentsprogrammer og Oplysningsforpligtelsen)," *Finans/Invest*, 1:4–11.

——— (2004): "The Value and Incentives of Option-Based Compensation in Danish Listed Companies," *Journal of Derivatives Accounting*, 1(1):91–109.

Bettis, J. C., J. M. Bizjak, and M. L. Lemmon (2005): "Exercise Behavior, Valuation, and the Incentive Effects of Employee Stock Options," *Journal of Financial Economics*, 76:445–470.

Brisley, N. (2006): "Executive Stock Options: Early Exercise Provisions and Risk-Taking Incentives," *Journal of Finance*, 61(5):2487–2509.

Campbell, J. Y., A. W. Lo, and A. C. MacKinlay (1997): *The Econometrics of Financial Markets,* Princeton University Press, Princeton, New Jersey.

Coller, M. and J. L. Higgs (1997): "Firm Valuation and Accounting for Employee Stock Options," *Financial Analysts Journal*, 53(1):26–34.

Core, J. and W. Guay (2001): "Stock Option Plans for Non-Executive Employees," *Journal of Financial Enonomics*, 61:253–287.

——— (2002): "Estimating the Value of Employee Stock Option Portfolios and Their Sensitivities to Price and Volatility," *Journal of Accounting Research*, 40(3):613–630.

Cox, J. C., S. A. Ross, and M. Rubinstein (1979): "Option Pricing: A Simplified Approach," *Journal of Financial Economics*, 7:229–264.

Hall, B. J. and K. J. Murphy (2002): "Stock Options for Undiversified Executives," *Journal of Accounting and Economics*, 33:3–42.

Heath, C., S. Huddart, and M. Lang (1999): "Psychological Factors and Stock Option Exercise," *The Quarterly Journal of Economics*, 114(2):601–627.

Hemmer, T., S. Matsunaga, and T. Shevlin (1996): "The Influence of Risk Diversification on the Early Exercise of Employee Stock Options by Executive Officers," *Journal of Accounting and Economics*, 21:45–68.

Hjortshøj, T. (2006): "Managerial Risk-Shifting Incentives of Option-Based Compensation: Firm Risk, Leverage, and Moneyness," *Working Paper, School of Economics and Management, University of Aarhus.*

Hodder, L., W. Mayew, M. L. McAnally, and C. D. Weaver (2006): "Employee Stock Option Fair-Value Estimates: Do Managerial Discretion and Incentives Explain Accuracy?," *Contemporary Accounting Research, forthcoming.*

Huddart, S. (1994): "Employee Stock Options," *Journal of Accounting and Economics*, 18:207–231.

Huddart, S. and M. Lang (1996): "Employee Stock Option Exercises An Empirical Analysis," *Journal of Accounting and Economics*, 21:5–43.

——————— (2003): "Information Distribution Within Firms: Evidence from Stock Option Exercises," *Journal of Accounting and Economics*, 34:3–31.

Hull, J. C. (2006): *Options, Futures, and Other Derivatives,* Pearson Prentice Hall, sixth edition.

Ikäheimo, S., N. Kuosa, and V. Puttonen (2006): "'The True and Fair View' of Executive Stock Option Valuation," *European Accounting Review*, 15(3):351–366.

Johnston, D. (2006): "Managing Stock Option Expense: The Manipulation of Option-Pricing Model Assumptions," *Contemporary Accounting Research*, 23(2):395–425.

Lambert, R. A., D. F. Larcker, and R. E. Verrecchia (1991): "Portfolio Considerations in Valuing Executive Compensation," *Journal of Accounting Research*, 29(1):129–149.

Murphy, K. J. (1999): *Executive Compensation. In Handbook of Labour Economics, O Ashenfelter and D. Card (Eds),* volume III. Amsterdam: North-Holland.

Papke, L. E. and J. M. Wooldridge (1996): "Econometric Methods for Fractional Response Variables with an Application to 401(K) Plan Participation Rates," *Journal of Applied Econometrics*, 11:619–632.

Wooldridge, J. M. (2002): *Econometric Analysis of Cross Section and Panal Data,* MIT Press.

Yermack, D. (1998): "Companies' Modest Claims About the Value of CEO Stock Option Awards," *Review of Quantitative Finance and Accounting*, 10:207–226.

Table 8: Fractional Logit Regression analysis of the expected time to maturity

Model	1	2	3	4	5	6	7	8	9
INTERCEPT	0.43*	0.26	0.52**	2.10	1.55	1.96	19.53***	18.36***	19.63***
	(1.95)	(1.12)	(2.00)	(1.25)	(0.91)	(1.15)	(9.34)	(8.48)	(9.30)
VEST	0.97***	0.92***	0.93***	0.98***	0.93***	0.95***	1.00***	0.94***	0.97***
	(6.01)	(5.70)	(5.73)	(5.71)	(5.43)	(5.48)	(5.48)	(5.20)	(5.26)
VOL1Y	1.12**	1.04*	0.95*	0.23	0.11	0.05	−1.06	−1.13	−1.24
	(2.01)	(1.91)	(1.74)	(0.26)	(0.12)	(0.05)	(−1.19)	(−1.24)	(−1.36)
MTE	−0.22***	−0.23***	−0.24***	−0.21***	−0.23***	−0.25***	−0.17**	−0.19**	−0.20***
	(−4.57)	(−4.58)	(−4.76)	(−2.72)	(−2.91)	(−3.12)	(−2.19)	(−2.39)	(−2.61)
DIR	−0.82***			−0.74**			−0.71**		
	(−2.73)			(−2.32)			(−2.20)		
EXEC		0.47**			0.48**			0.33	
		(2.36)			(2.27)			(1.43)	
EMP			−0.12			−0.16			−0.02
			(−0.63)			(−0.76)			(−0.07)
DIV				−14.56***	−16.40***	−16.30***	−18.81***	−21.22***	−20.58***
				(−2.79)	(−2.91)	(−2.92)	(−3.03)	(−3.05)	(−3.04)
RET6MO				0.31	0.27	0.32*	0.15	0.13	0.17
				(1.61)	(1.40)	(1.66)	(0.71)	(0.61)	(0.78)
SIZE				−0.07	−0.05	−0.05	−0.08	−0.06	−0.07
				(−0.96)	(−0.69)	(−0.75)	(−0.87)	(−0.66)	(−0.83)
VALUE				−0.0006	0.0012	0.0010	−0.0012	−0.0001	−0.0002
				(−0.21)	(0.43)	(0.36)	(−0.34)	(−0.04)	(−0.05)
Year dummies	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	No	No	No	Yes	Yes	Yes
Observations	492	492	492	492	492	492	492	492	492
Pseudo Log Likelihood	−247.57	−248.03	−249.47	−244.23	−244.26	−245.58	−222.66	−223.36	−223.98
R-squared	0.12	0.11	0.10	0.15	0.14	0.13	0.26	0.26	0.25

This table reports the Fractional Logit Regressions of the expected time to maturity. The dependent variable is the difference between the expected exercise date and the earliest possible exercise date divided by the entire exercise period in years ($RATIO_{gt}$). Independent variables include $VEST_{gt}$, which is defined as an indicator variable equal to one if the option holder may exercise the stock options at date t for tranche g. $VOL1Y_{gt}$ denotes the annualized stock return volatility estimated in the 250 trading days prior to the valuation date. MTE_{gt} denotes the market-to-exercise price ratio for tranche g at date t. DIR_{gt}, $EXEC_{gt}$ and EMP_{gt} are the proportions of trance g at date t granted to directors, executives, and employees, respectively. DIV_{gt} denotes the annual dividend yield and $RET6MO_{gt}$ denotes the firm's return during the six months prior to the valuation date. $SIZE_{gt}$ is the logarithm of the total assets and $VALUE_{gt}$ is the value of all outstanding stock options scaled by the number of shares outstanding. Finally, the two-digit Global Industry Classification Standard (GICS) is used to define indicator variables for industries. The t-statistics are reported in parentheses and are based on Papke and Wooldridge (1996) robust standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Coefficients on industry and year dummies are not reported.

List of D-CAF's Working Papers
2006 -

1. B.J. Christensen and M. Ørregaard Nielsen (March 2006), *Asymptotic normality of narrow-band least squares in the stationary fractional cointegration model and volatility forecasting.*
2. B.J. Christensen and M. Ørregaard Nielsen (March 2006), *The implied-realized volatility relation with jumps in underlying asset prices*
3. B.J. Christensen and P. Raahauge (March 2006), *Latent utility shocks in a structural empirical asset pricing model*
4. B.J. Christensen and M. Ørregaard Nielsen (March 2006), *The effect of long memory in volatility on stock market fluctuations*
5. T. Busch, B.J. Christensen and M. Ørregaard Nielsen, *Forecasting exchange rate volatility in the presence of jumps* .
6. B.J. Christensen and N.M. Kiefer (March 2006), *Investment in advertising campaigns and search: Identification and inference in marketing and dynamic programming models*
7. T. Busch, B.J. Christensen and M. Ørregaard Nielsen, (March 2006), *The information content of treasury bond options concerning future volatility and price jumps*
8. O.E. Barndorff-Nielsen, P. Reinhard Hansen, A. Lunde and N. Shephard (June 2006), *Designing realised kernels to measure the ex-post variation of equity prices in the presence of noise.*
9. F. Armerin, B. Astrup Jensen, and T. Björk (June 2006), *Term Structure Models with Parallel and Proportional Shifts.*
10. J.M.P. Albin, B. Astrup Jensen, A. Muszta, and M. Richter (June 2006), *On Volatility Induced Stationarity for Stochastic Differential Equations.*
11. T. Busch, B.J. Christensen, and M.Ø. Nielsen (July 2006), *The role of implied volatility in forecasting future realized volatility and jumps in foreign exchange, stock, and bond markets.*
12. P.O. Christensen, H. Frimor, and F. Şabac (July 2006), *Earnings Management, Leading Indicators, and Repeated Renegotiation in Dynamic Agency.*
13. T. Engsted, S.V. Møller, and V.M. Tuong (September 2006), *Habit persistence and asset pricing: Evidence from Denmark.*
14. A. Anand, C. Tanggaard and D.G. Weaver (November 2006), *Paying for Market Quality.*
15. P. Løchte Jørgensen (November 2006), *Traffic Light Options.*
16. P. Løchte Jørgensen (November 2006), *Lognormal Approximation of Complex Path-dependent Pension Scheme Payoffs.*
17. J. Lyng Forman and M. Sørensen (November 2006), *The Pearson diffusions: A class of statistically tractable diffusion processes.*
18. C. Christiansen, J. Schröter Joensen and Jesper Rangvid (November 2006), *Gender, Marriage, and the Decision to Invest in Stocks and Bonds: Do Single Women Invest More in Less Risky Assets?*
19. U. Küchler and M. Sørensen (January 2007), *Statistical inference for discrete-time samples from affine stochastic delay differential equations.*
20. C.-O. Ewald, R. Poulsen and K.R. Schenk-Hoppé (January 2007), *Stochastic Volatility: Risk Minimization and Model Risk.*
21. R. Poulsen (January 2007), *Four Things You Might Not Know about the Black-Scholes Formula.*
22. H. Kraft and C. Munk (January 2007), *Bond Durations: Corporates vs. Treasuries.*

23. M. Bladt and M. Sørensen (February 2007), *Simple simulation of diffusion bridges with application to likelihood inference for diffusions*.
24. L.E. de la Rosa (April 2007), *Overconfidence and Moral Hazard.*
25. Ken L. Bechmann and Toke L. Hjortshøj (April 2007), *Disclosed Values of Option-Based Compensation – Incompetence, Deliberate Underreporting or the Use of Expected Time to Maturity?*