Valuation of inventory of live biological assets:

Measurement, value relevance and usefulness to equity investors

By

Bjarne Møller

Dissertation submitted to the Department of Accounting, Auditing and Law at the Norwegian School of Economics and Business Administration, April 2021

Acknowledgements

- EY for making the project financially possible
- Erik Mamelund EY for his all-embracing interest for valuation and uncertainty
- Bjørn Einar Strandberg PwC for sharing my interest for the subject over the last 20 years
- Prof Trond Bjørnenak for hiring me as lecturer and PhD Candidate
- Kristian Ellingsen, CFO, and Lars Tore Andersen at Mowi who allowed be to gain insight into details of Mowi's valuation processes
- Prof Kjell Henry Knivsflå for many enlightening discussions
- The directors of all Norwegian Investment banks that participated with analyses and interviews
- Prof Frøystein Gjesdal for being my supervisor
- Prof Kenth Skogsvik for valuable comments to Paper 1
- Prof Leif Atle Beisland for valuable comments to Paper 2
- Assc Prof Benita Gullkvist for valuable comments to Paper 2
- Assc Prof Tzu-Ting Chiu for valuable comments to Paper 3
- Research Fellow Wei Shi for valuable comments to the econometrics
- Dr Bruce Stuart for valuable comments on structure and language
- Yngve Kaldestad EY for many discussions about valuation problems
- Prof Thore Johnsen, Prof Knut Aase and Prof Gunnar Eskeland for inspiring lunch conversations
- Assc Prof Finn Kinserdal for many discussions about valuation problems

I General introduction to the Dissertation

1 Introduction

1.1 Historic overview - Norway

Norway implemented IFRS from 2005 and the salmon farming industry should according to IAS 41 report inventory of live fish based on fair value, but they jointly called upon a reliability exception for fish below harvestable size; that is, below 4 kg. Brandsberg (2007) gives an extensive description of the implementation process. Although the fish farming industry probably had less reliable estimates of their biomass back in 2005 and also less reliable estimates of expected price at the time of harvesting, the assertion about low reliability was apparently to some extent built on confusion about the concepts ‘risk’ and ‘uncertainty’.

- The prices may change in the future, the feed prices may change and the fish may perish. These are all ‘operational risks’ pertaining to future periods. The cash flow estimates should, however, be based on expected values, and risk related to the future may of course affect the ability to predict cash flows.
- The price at the time of harvesting and also cost to completion are both uncertain which contribute to ‘measurement uncertainty’. That is, the estimates are uncertain because a sample of analysts may arrive at different conclusions even when presented with the same information. It may be a consensus about an expected increase in supply of 5%, but differences of opinion about the price impact. Measurement uncertainty could be caused both by differences in judgement and different valuation models. The number of fish and their weight at the time of measurement are also uncertain estimates.

For the information to be useful it must be a faithful representation; measurement uncertainty will affect faithful representation negatively. If we compare fair value of inventory of fish with other accounting estimates, for example unlisted shares, construction contracts and impaired fixed assets or goodwill, it is difficult to comprehend that the uncertainty should be larger; in particular if the diversification effect associated with multiple populations is taken into consideration.

Financial Statements Oversight Board (FSOB)[i] rejected the arguments about lack of reliability back in 2005 and forced the industry to apply fair value from 2006. The industry came to the conclusion that historic cost was a reasonable proxy for fair value below a 1 kg threshold, due to low biological transformation. In the interval 1 kg to 4 kg, the industry applied a model where expected farming profit was accrued linearly in weight increase on top of full cost absorption, while observed spot price was applied above 4 kg. In 2015 the FSOB issued a report on a new review of the industry's reporting practice, prompting the industry to make changes to their valuation practice. FSOB was in particular critical to the fact that full cost absorption was the starting point for the valuation model. However, the report did however not address any conceptual problems. In 2017 the industry introduced a new model based on non-linear interpolation between the fair value of smolt ready to be released into sea cages and the expected value at the time of harvesting. [ii]

1.2 The conceptual issues

In the fish farming industry a licence to operate is required. Serving as an effective barrier to entry, the license is a highly valuable intangible asset measured at historic cost. The fair value of the licences (and high expected profitability) is evidenced by a high market cap (Price) to booked net asset value (Book).

As of December 31, 2015 the Enterprise Price / Book ratio

$$\frac{\text{Market Capitalisation plus Net Interest Bearing Debt (Price)}}{\text{Net Operating Tangible Assets (Book)}}$$

ranged from 1.2 to 4.9 with an average of 2.7.[iii] During the period from December 21, 2015 to December 31, 2016, the Oslo Stock Exchange Seafood Index (not dividend adjusted) increased from 618 to 974, by 58%.

The valuation problems pertaining to assets below Cash Generating Unit (CGU) level are well known from impairment testing. When 2 assets share the same cash flow and both have unobservable fair value, we get allocation problems. We may be able to estimate the aggregate Value in Use (VIU) of the CGU, but not the VIU of individual assets.

If the licence is the net present value of residual earnings on the farming operation, a transfer of fair value from the licence to the inventory will take place during the production cycle. In a model covering one production cycle, but several reporting periods, 0% of the cash flow is allocated to inventory before the cycle starts and 100% is allocated to the sub-licence that covers one farming cycle. 100% of the cash flow is allocated to inventory at the time of harvesting while 0% is allocated to the sub-licence that has become worthless. Hence, we need to establish when this transfer of fair value happens, and we need to establish how to treat changes in estimates during the production cycle. A change in expected price at the time of harvesting that occurs during the production cycle, will cause the aggregate fair value of the inventory of fish and the license to change, but we do not know how to allocate the change in cash flow between the license and the inventory.

These allocation problems exist irrespectively of the measurement basis for the licence. The combination of historic cost and fair value measurement for assets sharing the same cash flow, a mixed model, leads, however, to interpretational confoundment about the fair value adjustments in the profit and loss statement reported as ‘change in the fair value of inventory'. Looking at the inventory only, this fair value adjustment should be expected to comprise a remeasuring effect, an accretion effect and the effect of releasing previous fair value adjustments on harvested fish. The fair value of the inventory also increases because of the effect of transferring fair value from the licence, or other contributory assets, to the inventory. Hence, the fair value increase will also capture any (positive) difference between fair value and historic cost of the license realised during the period; that is, the amount of fair value transferred from the licence to the inventory may (partly) be the release of a hidden reserve. This could make it even more complicated for analysts to extract information. Empirical evidence (Paper 3) suggests that they do not even try.

We need to know the residual cash flow attributable to the sub-licence; that is, the part of the licence utilized for the current production cycle, in order to appraise the inventory (and vice versa).[iv] It is, however, worthwhile noting we do not need cash flow estimates beyond the realization of inventory at hand; that is, we do not need to know the fair value of the licence.

1.3 The dissertation

This dissertation is about the usefulness of fair value reporting of live biological assets, but is also about the allocation problems and interpretational confoundment that arises when different measurement bases; that is, fair value and historic cost are applied for assets that share a common cash flow when market observations are unavailable. The dissertation consists of four parts, this introduction and summary and 3 separate research papers that shed light on the research question from different angles and based on different methodologies.

- Paper 1 addresses primarily the allocation problems, but also the interpretational issues. It also seeks to find practical solutions to the allocation problems and seeks to evaluate the models applied by the industry. The approach is normative.

- Paper 2 addresses whether the benefits of incorporating information about fair value in the financial statements makes the financial statements (more) value relevant despite any allocation and interpretational issues, and
- Paper 3 investigates whether analysts actually make use of the fair value adjustments and whether such adjustments have any predictive or confirmatory value.

In this introduction and summary I will first motivate the work and develop the research questions before I discuss the relevant literature and accounting standards. Finally I will briefly present the papers and conclusions.

2 Motivation and Research Questions

2.1 Motivation

Worldwide and in Norway, fish farming is a fast growing industry. According to the Food and Agriculture Organization of the United Nations, the estimated value of the world's aquaculture production in 2013 was USD 157 billion. Ninety percent of the world's population of wild fish stocks are considered overfished, and in the future, most of any increase in consumption of seafood (considered to have positive health effects) will have to come from fish farming. The seven listed salmon farmers on the Oslo Stock Exchange had a market capitalisation of NOK 162 (EUR 18) billions, and as of December 12, 2016, these companies constituted 7.6% of the total market capitalization on the Oslo Stock Exchange.

The implementation of IAS 41 has been controversial in Canada, Brazil, Indonesia and Norway (Bernhoft, Fardal 2007; Brandsberg 2007), but perhaps for the wrong reasons. Increased volatility is not undesirable if the market is informed about the true underlying business risk, but if valuation models create the volatility or if the recognition of revaluation effects obscures performance measurement, accounting information may become less relevant. When other operational assets are revalued, gain is recognised under OCI;

presumably because the gain is assumed to make operational income less relevant. Under US GAAP, historic cost is applied for live biological assets.

Fish farming distinguish itself from other agricultural business in that the production cycle is much shorter than for forestry, but still longer than one year. The level of human involvement is similar to other meat production, save for cattle / sheep that are held on grazing land. The industry has been very profitable and the product prices are volatile, resulting in sizable fair value adjustments both in the balance sheet and profit and loss statement.

Norwegian fish farmers have claimed that the fair value adjustments are ignored by sell side equity analysts. When the industry claim that the fair value information is not relevant, it is not because of lack of reliability (or faithful representation),[v] but because the information does not fit into sell side analysts' valuation models and has neither predictive nor confirmative value. Information about product prices may be obtained more timely and with less risk of bias from other sources. Further, the fair value adjustments are based on closing the book procedures that are only undertaken in the public / statutory reporting. All management reporting is based on transaction based historic cost. This indicates that management finds historic cost based information better for both planning and performance measurement. The disclosures offered do not provide account users with information about size categories, management's price assumptions or assumptions about cost to completion. Information about total biomass is provided, but it is not possible to split the change in fair value into the effect of change in size distribution and the effect of change in farming margin.

Serving as an independent auditor for the industry, my interest for the subject was triggered by assertions; both from the reporting entities and from sell side equity analysts, about the uselessness of the fair value measurement. My aim has firstly been to explore whether reliable reporting is possible before I explore whether it is true that the fair value adjustments are ignored, and if so, whether the choice is rational.

2.2 Development of Research Questions

2.2.1 Allocation problem 1 – Ex ante

The ex ante solution to the allocation problem could be developed in a model without uncertainty. We may look upon the licence as a series of real options (sub-licenses) to start distinct production cycles. [vi] In an enterprise with two assets; inventory and licence, the fair value of the licence is the residual profit from farming the fish over one production cycle. Immediately after harvesting the previous cycle, the Enterprise Value (U_0) is simply the fair value of the licence for the next cycle; V_0.[vii] There are no other assets, and without loss of generality there is no production cost. In a deterministic model, $U_t = (V_t + W_t) = V_0 e^{kt}$ for t=0,…,T. Where k is the discount rate per period, T is number of periods in the production cycle and W_t is the fair value of the inventory.[viii]

At t=T all the return on (and of) the licence is released to inventory $U_T = W_T = V_0 e^{kT}$ and the entire fair value is attributable to inventory. In a single production cycle model $V_T=0$.[ix] If we look over the production cycle, which may exceed one reporting period, the residual cash flow is also the amount that is transferred from FV of the contributory assets (the licence) to FV of the inventory. Since the licence is accounted for at cost and inventory at FV, the allocation problem is also about income recognition.

When the production cycle is split into several reporting periods, we have to find an allocation method. The relation $(V_t + W_t) = V_0 e^{kt}$ can be linked to valuation theory. We can also link $W_T = V_0 e^{kT}$ to valuation theory because $V_T=0$, but for any $0<t<T$ we have no obvious solution.

In a deterministic model, where the only observables are time and cash flows, replacing the discount rate, k, by the internal rate of return, may solve the problem. We are, however, in a situation where a physical inventory is observable, and the growth may be very different from the effect of releasing the effect of discounting as we approach the cash flow from harvesting. In salmon production approximately 0.8% of the total weight increase takes place during the first month in sea-water while approximately 17% takes place the last month before harvesting. We neither have a logical model nor empirical evidence for the fair value of inventory of immature biological assets. The timing when FV increase is transferred from V to W matters.

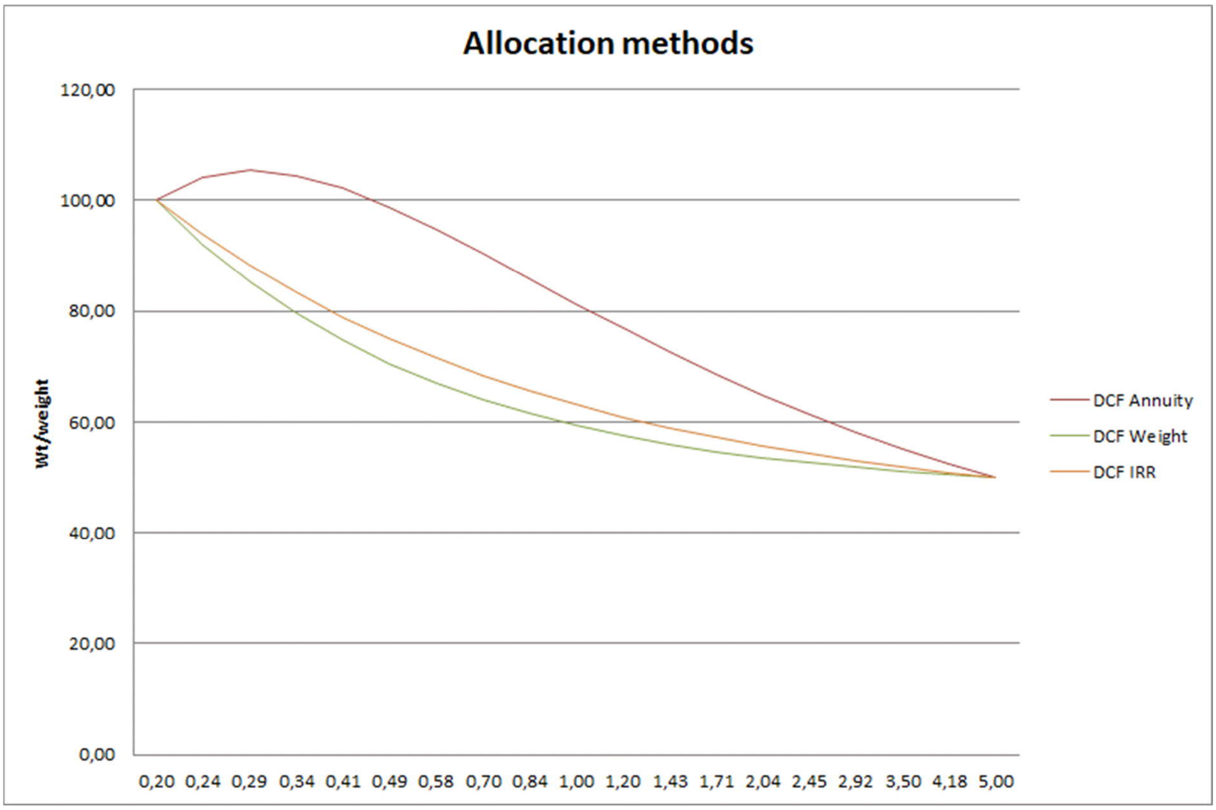

Figure 1: Note the non linear X-axis. The axis labels are kg, but 1 kg is about halfway in the production cycle. The figure shows the development of fair value per kg of inventory from release into sea cages to harvesting based on transfer of fair value from licence to inventory where the driver is Time (annuity), Weight Increase and Internal Rate of Return. The production cost is not nil as described in the example above - The fish released in into sea cages has a cost of and the fish is subsequently fed.

The figure shows different allocation patterns. The annuity or linear allocation leads to an early increase in FV per kg because the weight increase in kg is slow under a constant growth ratio. Allocation based on weight and internal rate of return are quite similar, the difference being that IRR gives return on the relatively high initial investment in smolt.

IAS 41.26 commands that fair value gain should be recognised as income, while the basis for conclusion seems to focus more on biological transformation as the observable criterion for income recognition (B14; …the effects of changes brought about by biological transformation are best reflected by reference to the fair value changes in biological assets). In fish farming biological transformation is weight increase, but generally, biological transformation may be an obtuse observable.

IAS 41.10 does establish some criteria for initial recognition, but it is unclear whether these, intentionally or not, prevent the apple farmer from recognising an income in February when no apples are observed. If no income is recognised, this does not conform to the economic reality, but is rather a consequence of historic cost measurement of contributory assets.

2.2.2 Allocation problem 2 – Ex post

We have to consider how to deal with changes in estimates or uncertainty. We may look upon the transfer of fair value from the licence to the inventory as a rent paid from the farmer to the holder of the licence. As the rent is paid, the net present value of the cash flow attributable to the inventory increases.

An increase in product price, causing the enterprise value (net present value of proceeds from harvesting) to increase, must somehow be s allocated between license and inventory. Should the full effect, save for the discounting effect, immediately be allocated to inventory or should it be allocated to the license. Should the rent be changed based on the updated information, and if yes, should the effect be applied retrospectively or prospectively; that is, should some of the effect be released immediately (effectively allocating to inventory) or should the effect be released over the remaining production period. Unfortunately, FV measurement does not completely eliminate the all allocation problems, in particular not when combined with historic cost measurement.

2.2.3 Usefulness

Fair value assessments of non-operational assets fit directly into analysts' valuation models while the analysts seem to be more focused on the profit and loss statement for prediction of the cash flow from operations. The theoretical basis for fair value measurement is well explored, but even in a case with a single asset with a definite remaining useful life, the fair value adjustment in the profit and loss statement requires decomposition to be useful for the purposes of cash flow prediction. (Hitz 2007; Hodder, Hopkins and Schipper 2013).

The allocation problems discussed above are the result of two assets sharing the same cash flow and has nothing to do with the use of a mixed model; that is, combining fair value and historic cost measurement. The mixed model, does, however, create an additional problem. When income is generated through an interaction between several assets and where such assets are partly measured at fair value and partly measured at historic cost, the interpretation of and usefulness of the fair value adjustments in the profit and loss statement becomes unclear. The figure reported as 'change in fair value of inventory' will include both expected and unexpected return on the licence realised during the period, but the amounts are undisclosed.

2.3 Research Questions

The ***first paper*** addresses the question:

- *What is the fair value of live biological inventory?*

  -and do simplified industry models return unbiased estimates

The paper primarily addresses the ambiguity in the cash flow allocation and the interpretational issues with the reported figures and suggests a solution to the allocation problem based on valuation theory and the accounting standards. The paper also assess whether parsimonious models applied by the industry may return unbiased estimates based on comparison with a DCF model that is based on a set of valuation axioms.

The ***second paper*** addresses the subject of value relevance.

- *Is the fair value information provided value relevant*

  -despite the allocation problems and interpretational issues?

Value relevance does not warrant usefulness, but lack of value relevance indicates low (incremental) information content. The second paper makes a bridge between the first and third paper. Value relevance may prove that despite the allocation and interpretational issues, the reported figures have information content, and it may disprove the lack of reliability argument.

Value relevance, if proven, is merely an association between share price (return) and accounting figures and does not mean that analysts do (or should) apply the reported figures as input in their valuation model.

The ***third paper*** addresses the question?

- *Is it correct that analysts do not use the fair value information?*

  -and whether such practice, if evidenced, is rational

The paper both addresses whether the fair value adjustments are relevant as direct input to the analysts' valuation model, whether the adjustments have capacity to predict earnings or cash flows and finally whether the fair value estimates contribute to the analysis of key performance indicators.

2.4 Positioning and contribution

Real estate and financial instruments will normally have separate and independent cash flows and the research in field of fair value measurement of such assets cannot be generalized to operational assets. The allocation problem is common for all the valuation of all operational assets where a cash flow is generated through an interaction between two or more assets. Salmon may be different from other biological assets with respect to production cycle, level of inventory, degree of human involvement in the production process, volatility of the prices and the importance of contributory assets. Hence, inferences to other biological assets or inventory in a production company in general should be made with caution. On the other hand, this also means that the (limited) research done on other biological assets has little relevance for the fish farming industry.

The work should be of particular interest for the salmon industry, for financial analysts following the industry and for the Financial Reporting Supervisory Authorities. In a broader perspective it should be a contribution to a debate about the usefulness of fair value measurement for operational assets.

3 Background for fair value measurement

3.1 The appliance of Fair Value Measurement

The use of fair value measurement is widespread in the financial industry, and financial instruments held by companies outside the financial industry are also largely measured at fair value, IFRS 9.

A heated debate about fair value measurement developed in the aftermath of the financial crisis (Laux and Leuz 2010a; Laux and Leuz 2010b), a debate primarily related to fair value measurement in the financial industry. This debate, however, did not focus attention on the financial reports of production companies or on whether fair value measurement might be useful in such reporting. This does not, however, mean that fair value measurement has not been criticised. Penman (2007) is highly critical of the use of exit prices for assets held by an enterprise that does not speculate in fluctuation in asset prices, but realises value from holding assets and executing a business plan. Fair value is meaningless if there is no link between shareholder value and exit prices. The distinction between exit prices and value in use may, however, be less relevant in fish farming as the valuation is based on the assumption that the fish is grown until it is harvestable.

Fair value measurement comes in different guises. We may distinguish between unconditional and conditional fair value measurement where the first applies for financial instruments, investment property and live biological assets while the latter is found in for example impairment tests (IAS 36) and net realisable value tests (IAS 2). We may also distinguish between unrestricted value-in-exchange (VIE) measurement where the purpose is to arrive at a hypothetical transaction price under current market conditions, and different sorts of value-in-use (VIU) measurement where certain valuation rules apply. Valuation rules may for example put restrictions on the cash flow estimates or whether real-options may be taken into consideration. Valuation rules may be imposed to counter balance the risk of earnings management (manipulation) and well-known management biases, as a result of balancing conflicting interests or to promote comparability between account producers. Valuation rules are found in IAS 16, IAS 19, IAS 36, IAS 38, IAS 40 and IFRS 5. In some cases fair value measurement is optional as revaluation options are found in IAS 16 and 38.

The measurement basis may be determined based on asset characteristics or intended use. An aluminium ingot is a commodity with observable price in a liquid market, but for an enterprise it may be raw material, work in progress, finished goods or a trading object. As management’s intentions may be difficult to reveal and asset characteristics may not be informative about the use, focus has turned to the business model (IFRS 9) as determinant for the measurement basis.

A producer of aluminium wheels may not in general benefit from increased aluminium prices, but ceteris paribus he benefits from holding an additional ton of aluminium when prices go up, regardless of whether the aluminium is a purchase contract, raw material, work in progress or finished goods (any long position).

Biological assets differ from aluminium and the wheel producer as the inventory is produced, not procured. There is no doubt about the benefit of increased salmon prices for the salmon farmer, in particular when the price increase is demand driven. The primary reason for applying fair value as measurement base is however to capture the effect of biological transformation; that is, move income recognition from the time when the finished product is transferred to a buyer to the time when the value is created. From such perspective income recognition is more important than remeasurement.

Fair value measurement allows information from the outside world (product prices) to be incorporated into the financial statements and it also offers management an opportunity to disperse private information about the health status of the fish, farming conditions and expected future production cost. On the other hand increased room for discretion also leaves more room for earnings management. IAS 41 is the only accounting standard which commands the use of fair value for operational assets and also which commands that gain or loss from changes in fair value is part of net operating income. The remeasurement aspects have been held against IAS 41 rather than in favour of it, in particular when the prices are volatile, but perhaps for the wrong reasons. Volatility is not undesirable as it informs the stakeholders about the underlying business risk, but volatility may appear as noise in for example analyses of historic performance. Model created volatility is of course always undesirable and may for example arise if a model does not consider negative correlation between input parameters or if the sample space is set too wide.

3.2 The fair value hierarchy

Levels 1 and 2 of the fair value hierarchy (IFRS 13) are mainly available for financial instruments and commodities. Fresh salmon is close to a commodity, and there is a derivative market, but the product is perishable, the inventory has to go through a production process and it has to be harvested within a relatively narrow time window and be brought to the customers. Although the derivative market may be an important source for information about future prices, the large producers cannot sell (or hedge price risk) of a substantial part of their production in the financial market.

Even if an external price is deemed to be observable, the valuation relies on important assumptions about cost to completion, size and quality distribution and future mortality, that all are unobservable, IFRS 13.82. Hence, the valuation drops to level 3, IFRS 13.73. Two studies examine whether there is a difference in value relevance between level 1 and 2 and level 3 valuations (Danbolt and Rees 2008; Song, Thomas and Yi 2010). Both studies conclude that level 3 valuations may be less relevant. This may be of particular interest when I look at an asset that is appraised by level 3 and has to undergo a production process that means that the earliest possible realisation is months or even a year ahead. By contrast to these two studies, Altamuro and Zhang (2013) found that level 3 valuations may benefit from management's private information in a way that outweighs potential problems with bias whenever infrequently traded assets are appraised. Research on the differences in usefulness of fair value reporting between the different levels in the fair value hierarchy has been criticised for lack of control for true underlying differences in the assets measured; for example, differences in liquidity (Hodder et al. 2013).

3.3 The fair value adjustments

Fair value measurement of live biological assets moves the income recognition forward from the point of transaction were risk is handed over to a customer to when the value creation (fair value increase) takes place. This is accretion accounting by Phillips (1963). Biological transformation may drive fair value increase, but fair value may also change for other reasons than biological transformation. In particular, fair value measurement leads to remeasurement as information about product prices are incorporated into the financial statements. When levels of inventory are high and product prices volatile, the remeasurement effect could be significant.

Fair Value (FV) measurement provides information about the amount, timing and risk of future cash flows in the balance sheet and may therefore be relevant to the decision making of equity investors (FASB 2018; Hodder et al. 2013). If, however, there are assets that are not measured at fair value, or not even recognised at the balance sheet, changes in estimated cash flows will only be incompletely reflected in the financial statements because only a part of the cash flow is allocated to assets measured at fair value. The interpretation of the fair value adjustments will not be clear and the investors will need more information to estimate future cash flows.

Under full fair value measurement, the net profit will reflect:

- expected return on assets, that is, the expected cash flow plus the expected change in fair value of the assets
- unexpected return, which is deviations from expected cash flow plus unexpected changes in fair value of the assets which could relate to both the amount, timing and risk of future cash flows. FV of assets could also change as a result of changes in the discount rate that does not relate to the risk associated with the cash flows.[x]

Even in a single asset enterprise the amount recognised as change in fair value in the profit and loss statement is not very informative for equity investors without further specification.

Both expected and unexpected return on the licence that is realised during the reporting period will be reported as part of the gross margin or as a fair value increase on inventory. As the fair value of the licence and any changes to this is undisclosed, this will cause interpretational confusion about the amount reported in profit and loss.

Both IAS 16.31 and IAS 38.75 have revaluation options, but in particular under IAS 38.76-84 its use is very restricted, and revaluation gain should be recorded in OCI (IAS 16.39 and IAS 38.85). It should also be noted that a revaluation of the licence would also have to take changes in estimated cash flows beyond the current production cycle into consideration. Accordingly the booked value of net assets is likely to come closer to the market value of the company, but the amount reported in profit and loss (or OCI) is unlikely to solve any interpretational problems. In practice the revaluation option is not applied in the fish farming industry.

3.4 Fair value measurement of live biological assets – accretion accounting

Fair value measurement of live biological assets is unconditional although there is a reliability exception in the standard, IAS 41.30. IAS 41 does not impose any particular valuation rules in addition to IFRS 13 except that it should be fair value less cost to sell; that is, less the cost of bringing the inventory to the market, IAS 41.12. The cost of selling, for example indirect cost in the sales department should not be deducted.

The motivation for FV measurement of live biological assets may have been to move the recognition of value creation from the point of transaction to the point of biological transformation or value creation (IASB 2012). Biological transformation, which may be difficult to observe, may cause fair value to change, but fair value may also change for other reasons. IAS 41.10 regulates when a new biological asset may be recognised. This may not be very important in some agricultural business. In cattle farming the fair value of the herd does not change when the expected number of calves are born, but fair value will be transferred from the cows to the calves.

Fair value may increase also when no biological transformation is visible. Does the recognition criteria in IAS 41.10 prevent the apple farmer from recognising a fair value gain in February since the apple trees are measured at historic cost?

To move income recognition to the point of value creation may in particular be important for forestry where the production cycle may be very long and where logging may differ from regeneration. Forest could grow with little or no human involvement, and hence cost incurred may give little information about value creation. Other biological assets may have shorter production cycle and require more human involvement and other contributory assets. Fish farming needs cages, boats, feeding equipment as well as a licence to operate and the fish are fed daily. No biological transformation occurs unless the fish is fed. Hence, we may be in a situation where we are much closer to industrial production. The case for rejecting IAS 2 and full cost measurement may not be equally strong. On the other hand, IAS 41 may not be harmful even if it may be unnecessary.

Although spot timber prices may be volatile, the impact of volatile timber prices on standing timber that is a decade or more from harvesting may be moderate. It is reasonable to assume that price estimates, perhaps decades ahead, are based on Bayesian models or assumptions about mean reverting prices. Hence, the remeasurement effects may be less pronounced compared to salmon.

3.5 FV measurement vs FV Accounting

In the salmon industry FV measurement is presented as an adjustment to historic cost measurement in a transaction based financial statement, i.e. cost incurred during the period is capitalised on inventory based on full cost. The FV adjustments are closing the books adjustments in addition to the historic cost accruals and accordingly intra period FV fluctuations are not recognised. The FV figures are presented directly in the balance sheet, while the reconciliation to historic cost is found in the disclosures. The profit and loss statement is transaction based and change to the fair value adjustment of inventory is presented separately[xi].

Under FV accounting we may leave the transaction basis and recognise income based on increase in FV. Income will be the accretion measured at current prices plus remeasuring of inventory at hand. All expenses could be charged directly to the profit and loss statement although we may still chose to apply accrual accounting for inventory of raw material (feed) and fixed assets. There will be no cost of goods sold presented in the financial statements, and historic cost of the inventory will not be available. Assuming that FV is remeasured continuously, sales will just be asset shifting between inventory measured at fair value and cash / accounts receivables. As the FV measurement always is updated by the most recent prices observed, there will be no gain or loss effect from realisation.

Disclosure requirements acknowledge the fact that the figures presented in the balance sheet or profit and loss statements may need to be specified or that supplementary information may be required. Value relevance studies may compare which of historic cost and fair value measurement is the most value relevant measurement basis, and also if the fair value adjustments are incrementally value relevant. We can, however, not infer any causal relations. Even if fair value measurement should explain more of the volatility in share prices compared to historic cost measurement, historic cost figures may still be instrumental to the work of the sell side equity analyst.

The production of salmon requires substantial human involvement and biological transformation / growth cannot take place without feeding the fish. Strategically salmon producers are facing the same price for a close to commodity product and hence they are competing in an industry where cost leadership is the only viable strategy. Intuitively we may think that cost per kg sold is a more important differentiator and performance measure than net income per kg produced, in particular as prices are highly volatile.

The concept cost per kg may have different definitions. In a transaction based historic cost environment ‘cost per kg sold’ will have a highly verifiable denominator while cost, the nominator, always will be measured with some uncertainty because cost accruals are less verifiable. Under fair value measurement ‘cost per kg produced’ may have a more verifiable nominator as the amount of accruals is lower if cost is charged directly to profit and loss (or there is no incentive to manipulate them) while kg produced is less verifiable than kg sold as kg produced is the difference between to uncertain volume estimates.

3.6 Inferences to inventory of other goods

According to IFRS Conceptual Framework 6.2 (IASB 2018) ‘consideration of the qualitative characteristics of useful financial information and the cost constraint is likely to result in the selection of different measurement bases for different assets, liabilities, income and expenses’.

The effect of applying IAS 41 compared to IAS 2, will, among other factors, depend on when the price shift occurs, the size of the balance of inventory and whether cost is incurred in the production. We may consider an enterprise producing and selling 10 units at CU 2 per unit and holding an inventory of 40 units in period t. Production cost is CU 1 per unit. We observe a permanent price shift to CU 3 per unit. The recurring profit increases from CU 10 to CU 20 for all future periods. We look at 4 scenarios:

1. Transaction based historic cost, the price shift occurs at the end of the reporting period. We report profit of CU 10 in period t. No signal about level of future recurring profit.
2. Transaction based historic cost, the price shift occurs at the beginning of the reporting period. We report profit of CU 20 in period t. Reported profit is equal to new recurring level.
3. Fair value, the price shift occurs at the end of the reporting period. We report profit of CU 50 (10+40) in period t. The fair value adjustment moves the reported profit away from its recurring level, but a noisy signal about an increase in the level of future recurring profit is sent.
4. Fair value, the price shift occurs at the beginning of the reporting period. We report profit of CU 60 (20+40) in period t. The fair value adjustment moves the reported profit even further away from the future recurring level.

We observe that the FV adjustment will take the reported profit away from the recurring profit if the price shift occurs in the beginning of the period and that the effect increases in the level of inventory relative to sales in the reporting period. When the price shift occurs by the end of the period, the FV adjustment will send a noisy signal about a change. Seasonal changes in prices and level of inventory may smooth or exacerbate these effects. Some terrestrial agricultural business will have seasonal variations that are much stronger than fish farming. We may infer that observations based on terrestrial agriculture or forestry may not apply to fish farming and vice versa.

In the example above there is only finished goods, i.e. the full effect of the price increase hits the inventory. The fish farming case is more complicated as the fish farmer holds a limited quantity of harvestable fish (finished goods). An increase in the price we expect to realise for work in progress is partly attributable to future production and will increase the residual profit and hence the fair value of contributory assets. An increase in expected price at the time of harvesting will not result in a fair value increase equal to expected price times expected volume. The interpretational issues in the profit and loss statement become even more complicated when more than one asset shares the same cash flow and in particular if contributory assets are measured at cost. We may perhaps also infer that the relative importance of contributory assets may be important.

We may come to different conclusion for different types of biological assets. Fish farming has a much shorter production cycle than forestry and no biological transformation takes place unless the fish is fed. Hence, incurred costs give a reasonable representation of the value added. As harvesting on average is closer in time, expected price at harvesting tends to be more volatile.

If we look beyond biological assets, a producer of aluminium wheels is obviously better off by holding inventory, regardless of stage in the production process, when the aluminium prices go up, but from a cash flow perspective the increased FV of inventory may be tied up in a permanent increase in working capital and the conversion margin from converting aluminium ingots to wheels may even decrease. Fish farming is, based on the degree of human involvement and length of the production cycle, closer to industrial production than to forestry, but as opposed to the wheel producer, the effect of increased salmon prices is undoubtedly positive. This may still give sufficient reason for the use of IAS 41.

4 Review of literature and the standards

4.1 Literature

The research about the value relevance of fair value measurement of financial instruments is abundant. (See Barth 2000, Beaver 2002, and Beisland 2008, for overviews of value relevance research.) As financial instruments normally have separate, independent cash flows, we should be careful about making inferences to assets that interact to create a common cash flow.

We also have a good understanding of the analyst's role in the capital market and what they do (Bradshaw 2011). Both valuation of enterprises and single assets are thoroughly described in abundant valuation literature – also intangible assets. Inventory is a part of the enterprise value (working capital), and we rarely see any attempt to appraise inventory separately, save for tests of net realisable value ref IAS 2 and IFRS 13. This may be because inventory does not receive a separate independent cash flow. Rather the cash flow realised from selling the inventory should give return on and of capital employed in all operational assets. Cash flow based valuation methods either assumes that there are separate independent cash flows or they try to construct such through the use of residual or differential methods (Reilly and Schweihs 1998).

This may also be the reason why the use of the revaluation options in IAS 16 and 38 is limited. Sellhorn and Stier (2017) reviews research evidence on long-lived operating assets. Except for real estate, accountants rarely use fair value for PP&E and intangible assets. Aboody, Barth and Kasznik (1999) and Easton, Eddey and Harris (1993) conducted studies on revaluation reserves on PP&E, and both studies found a positive association with stock prices. Barth and Clinch (1998) found on an Australian sample revaluations of plant and equipment insignificantly value relevant for nonfinancial firms while they found revaluation of intangible assets value relevant for all firms.

IAS 41 is the only accounting standard that commands fair value measurement for operational assets, as opposed to revaluation options, which are self-selected into. Our knowledge about the value relevance of fair value measurement for operational assets, the usefulness of such and whether fair value information is actually used, is more limited. The rationale for fair value reporting is also less obvious (Penman 2007).

Argilés, Garcia-Blandon and Monllau (2011) looked at the differences in short term cash predictive capacity between fair value and historical cost accounting in Spanish agriculture. They found no differences between historic cost and fair value measurement with respect to cash flow prediction.

Argilés-Bosch, Miarons, Garcia-Blandon, Benavente and Ravenda (2018) studied the usefulness of fair value measurement for cash flow prediction by comparing companies that use either historic cost or fair value measurement in a broader context and found that it becomes increasingly difficult to predict cash flows when the portion of biological assets to total assets goes up, but the studies demonstrated that this effect is mitigated, but not necessarily offset, by the use of fair value measurement.

Huffman (2014) matches measurement to asset use in an IAS 41 setting and finds that companies that are matching asset use to measurement; that is, those that apply fair value for in exchange assets and historic cost for assets in use, provide more value relevant information. Apparently, the distinction between in use and in exchange assets is the distinction between bearer plants and biological assets produced to be harvested and sold. Bearer plants are long-lived assets, not inventory, and subsequently bearer plants are scoped out of IAS 41.

Botosan and Huffman (2015) concludes that fair value is more decision useful for assets expected to be realised in exchange while historic cost is more decision useful for in use assets and cash flow prediction. Their work makes use of accounting theory as well as valuation theory and practice. The distinction between ‘in exchange’ and ‘in use’ assets does not fit very well for a production company, however. The concept of decision usefulness is itself problematic; standard setters, scholars and practitioners have not yet agreed on an undisputed measure of decision usefulness (Gassen and Schwedeler 2010). Neither of these works discusses the quantitative sides of the cash flow allocation problem and the interpretational problems with the fair value adjustment.

Goncalves, Lopez and Craig (2017) tests the value relevance of biological assets with no comparison to historic cost, i.e. whether biological assets have a significant coefficient when partitioned out from net assets[xii]. Assuming fair value measurement of any asset or liability will bring net assets closer to the share price, there should be a strong case for finding value relevance unless the fair value measurement is completely unreliable and the reported figures are just noise. The study finds a significant coefficient, but it also concludes that no more of the variability in share prices is explained by partitioning out biological assets. The study does not separate the effect of applying fair value from for example fluctuations in physical quantity and does not contribute to the discussion about which measurement basis to apply.

Filho, Machado and Machado (2013) found historic cost more value relevant than fair value when studying 25 listed Brazilian firms between 2008 and 2009. In a cross-country study, Silva and Nardi (2018) found that the variation of biological assets and the fair value of those assets irrelevant to the capital market.

Bradshaw (2011) summarizes an understanding of analysts' role in the capital markets and an understanding of analysts' activities. Both input and output are extensively studied. The processes of analysis and various analytical approaches are studied by Demirakos, Strong and Walker (2004) and Brown, Call, Clement and Sharp (2015). The valuation models applied by analysts can be identified and described from the extant valuation literature and from previous research in several fields.

Barniv and Myring (2006) look at historical and forecasted earnings in the accounting based valuation models in different countries and within various accounting regimes. The primary findings suggest that the forecast model performs better than the historical in most regimes and countries.

Badenhorst (2018) shows that the increased use of fair value has a negative impact on analysts’ ability to predict earnings and book values, but the study focuses on use of fair value in general, but not specifically on operational assets.

Except for financial instruments, fair value measurement is only applied for biological assets and investment property.[xiii] Liang and Riedl (2014) found that historic cost measurement was preferable to fair value measurement for predictive purposes in the real estate industry. Hitz (2007) adopts a theoretical perspective on the decision usefulness of fair value reporting. Danbolt, J. and Rees, W. (2008) found FV more value relevant than historic cost for both Real Estate and Investment Fund.

4.2 The standards; IAS 41 and IFRS 13

Under IFRS the different standards tell when fair value should be applied any special valuation rules that should be applied while IFRS 13 is the general valuation standard defining fair value and setting out rules for measuring fair value.

4.2.1 IAS 41

Under IAS 41 live biological assets should be measured at fair value. Immediately after the biological assets are harvested, they become inventory accounted for in accordance with IAS 2. This may be important for the vineyard. Salmon producers may transfer fish from the farming activity to value added products, for example smokehouses, but generally they do not possess material inventory of slaughtered fish.

Also bearer plants are scoped out of IAS 41. An apple tree is a bearer plan. The apple farmer grows an apple tree with the purpose of harvesting apples. It takes several years from the tree is planted until it produces a crop, but afterwards it produces a crop every year. The apple tree is a contributory asset together with the land it is grown on and is accounted for under IAS 16; Property Plant and Equipment. This discussion deals exclusively with inventory within the scope of IAS 41. The decision to scope out bearer plants does not solve the allocation problem, but it eliminates the need for cash flow prognoses beyond the current production cycle[xiv].

IAS 41 defines fair value as fair value less cost to sell. The fish farming industry does however not apply market prices (level 1) directly, but as an input to a DCF calculation. In the fish farming industry, the normal sales contract is for slaughtered, gutted, fish boxed with ice delivered at a terminal / warehouse while the subject of valuation is an immature live fish in a sea cage. The inventory, i.e. the subject of valuation, consists of live fish at different locations and in different size categories. Transactions in live fish never occur except for in business combinations.

All costs that are incurred in order to bring the fish to the same state and to the same location as the price observation or premises for the price estimate are deducted in the DCF analysis.

Each fish is a unit of account, but IAS 41 accepts that assets, items of inventory, are grouped together for appraisal purposes. The typical unit of appraisal is a cage or a generation in a specific location. The appraisal will take into consideration that some of the fish will perish before it is harvested; that is, both the cost associated with the farming of fish that eventually will perish and the loss of income are considered in the DCF analysis.

IAS 41.10 has some requirements to be fulfilled before a biological asset may be recognised. These requirements are not particularly relevant for fish farming, but are discussed in the context of how to allocate a contributory asset charge.

Fish farming requires a licence to operate and apple production requires apple trees and a plot of land. IAS 41 focuses on fair value gain rather than biological transformation as criterion for recognising a gain, while the Basis for Conclusion emphasises the alignment of income recognition with value creation or biological transformation. Financially the proceeds from selling apples are partly return on the land and the apple trees. The standard does not deal explicitly with the allocation problem(s).

Biological transformation may happen with little or no human involvement or be a result of extensive human activity / business processes. The fair value may also increase as a result of increased product prices. IASB 2012 emphasise that fair value measurement is the only way of recognising the value creation related to biological transformation in a transaction based accounting system. This may be particularly important for forestry where the production cycles are long and where logging and regeneration volumes may be very different. The remeasurement effect of changing prices, increased volatility in reported figures, has been held against the standard, also during the hearing process.

The licence to operate is in practice linked to a specific geographical site and the fish cannot be moved. This is however not unique for fish farming. The trees in the forest are not possible to move. The apples cannot be moved or sold until they are ripe, but the standard does not prescribe any particular measures with respect to the valuation. It specifies that a DCF analysis is appropriate when the inventory is in a condition where it cannot be sold or where no price is observable.

4.2.2 IFRS 13

According to IFRS 13 fair value will, in the absence of observable prices, in most cases be determined based on an income approach, IFRS 13.62 B10-11. The standard does not place any particular restriction to the use of method and choice of assumptions except that the method must be appropriate (IFRS 13.61) and the input based on best estimate or expected values IFRS 13 B23.

The valuation should be based on assumptions about 'highest and best use' (IFRS 13.27) and sale in 'most favourable market' (IFRS 13.24); that is, immature fish are assumed to be grown to harvestable size. This also means that we have to apply the expected price at the expected time of harvesting in the DCF analysis.

Salmon prices are unlikely to be a martingale as opposed to the prices of certain financial assets and commodities. Frozen salmon is not a very close substitute for fresh salmon, and fresh salmon has very limited shelf life. Further, the large producers have complicated logistic operations and limited flexibility to adjust harvesting to take advantage of short time price fluctuations. Hence, we should expect the prices in the derivative futures market to be driven by expectations about the supply / demand balance when the contract expires.

IFRS 13.9 defines fair value as an exit price. When market prices are observable, this will mean the bid side of the spread. This would perhaps be the case for soya beans, but for most agricultural products, the expectations about future prices are based on several sources of information. IFRS 13.61 does however emphasise that most weight should be given to observable prices. Comparability across market participants calls for the use of observable prices even if internal estimates may be more relevant.

Even if IAS 41 does not have any particular valuation rules, IAS 41.10 does have some requirements that should be met in order to recognise a biological asset. The fair value of an apple farm may increase in February because of the passage of time, as we approach the cash flow from harvesting. Biological transformation may however not occur or may be invisible; that is, no apples may be observed. Hence a catch up effect may occur upon first time recognition. The decision to release a new generation of fish into sea cages follows from the business model and will generally neither affect the fair value of the enterprise nor the inventory. It is normal to apply historic cost as proxy for fair value before the fish is released into sea cages, but if the valuation model for fish in sea cages returns a day 1 profit or loss, at least one of the valuations are biased.

Neither IAS 41 nor IFRS 13 provide guidance that could help us to solve the particular valuation issues pertinent to biological assets, in particular related to the lack of separate independent cash flows. We may conclude based on IFRS 13 that a part of the cash flow should be allocated to contributory assets, but the allocation problem is not addressed.

Fair value according to IFRS 13.2 is a market specific, not an entity specific measurement, but each farming location is unique. Hence, cost to completion and also the residual cash flow attributable to the licence will be location specific. This means that the appraisal has to be based on location / owner specific input. If we, however, assume that the high contributory asset charge from a good (high value) licence is balanced by low farming cost (and vice versa), the fair value of the fish may still be independent of the location; that is, a 2 kg fish has the same fair value across different locations and owners.

5 Summary of findings and concluding implications

5.1 Paper 1

Assets that do not have an observable market price and that share a common cash flow, i.e. do not have independent separable cash flows, can only be appraised through a process where cash flows are allocated to the different assets. The cash flow allocation problem is commonly solved by the use of ‘residual‘ or ‘differential’ cash-flow models (Reilly and Schweihs 1998). IFRS 13 Appendix A B3(d) also suggests such methods. Differential cash flow models, for example ‘relief from royalty‘, are based on the assumption that even if the fair value of a comparable asset cannot be observed, rental agreements on the same asset may be observable. If this is not the case, the solution may be ambiguous, i.e. we are left with one equation with two unknowns. This is the case in the salmon industry where both the FV of the licence and the FV of the fish are unobservable at the valuation date. There is no rental market for licences.

In a model with only two assets, the inventory of live biological assets and the licence to operate, and a distinct farming cycle, enterprise value equals the fair value of the (sub) licence to start a farming cycle at t=0 when there is no inventory. As harvesting approaches, an increasing portion of the cash flow should be allocated to the inventory; that is, fair value of inventory increases / income is recognised through the release of a contributory asset charge. At the time of harvesting 100% of the cash flow is allocated to the inventory and the current part of the licence has nil FV. Hence, there is no allocation problem at the beginning and end of the farming cycle. The allocation problem is about the profile of the allocation scheme and how to deal with changes of estimates during the farming cycle, in particular when biological transformation is not closely related to the passage of time.

Because there is no market for immature fish, it is not possible to seek empirical evidence for a valuation model. We have to assess different valuation models and allocation schemes based on a set of valuation axioms in order to find a reasonable solution. In paper 1 I explore different valuation models and allocation principles and discuss the different properties and find that although an unambiguous solution does not exist; that is, no allocation scheme fulfils all valuation axioms, there may be both reasonable and practical solutions. I explore parsimonious models applied by or suggested by the industry and conclude that such models may return a proxy for fair value that comes relatively close to more complex Discounted Cash Flow models, but may be biased under certain circumstances.

Through the development of a formal model and numerical examples, I discuss the different aspects of the allocation problem. Fair Value in accordance with IFRS 13 should be market specific, not user or owner specific. The analysis discusses whether the valuation model has to be applied in full with location specific input for each location.

The analysis further discusses important theoretical aspects in particular related to the allocation of a Contributory Asset Charge (CAC). It may be useful to view the issue from the perspective of an internal rental contract, which resembles a situation where separate parties are holding the inventory and concession. This alternative allows us to agree on a rent for more than one period. From an accounting perspective we may also consider this as an allocation scheme or vector.

While we may limit our observables to cash flows and time in a DCF model, biological transformation may not be a function of time only, and we may observe biological transformation or weight and update estimated time of harvesting. The paper first discusses whether allocation of cash flow / transfer of FV from the licence to the inventory ex ante should be linear in weight or time or based on internal rate of return in a model without uncertainty. The figure below, which is similar to figure 1, also shows allocation based on two 2 industry models; 2006 R (accretion) and 2017 (interpolation).

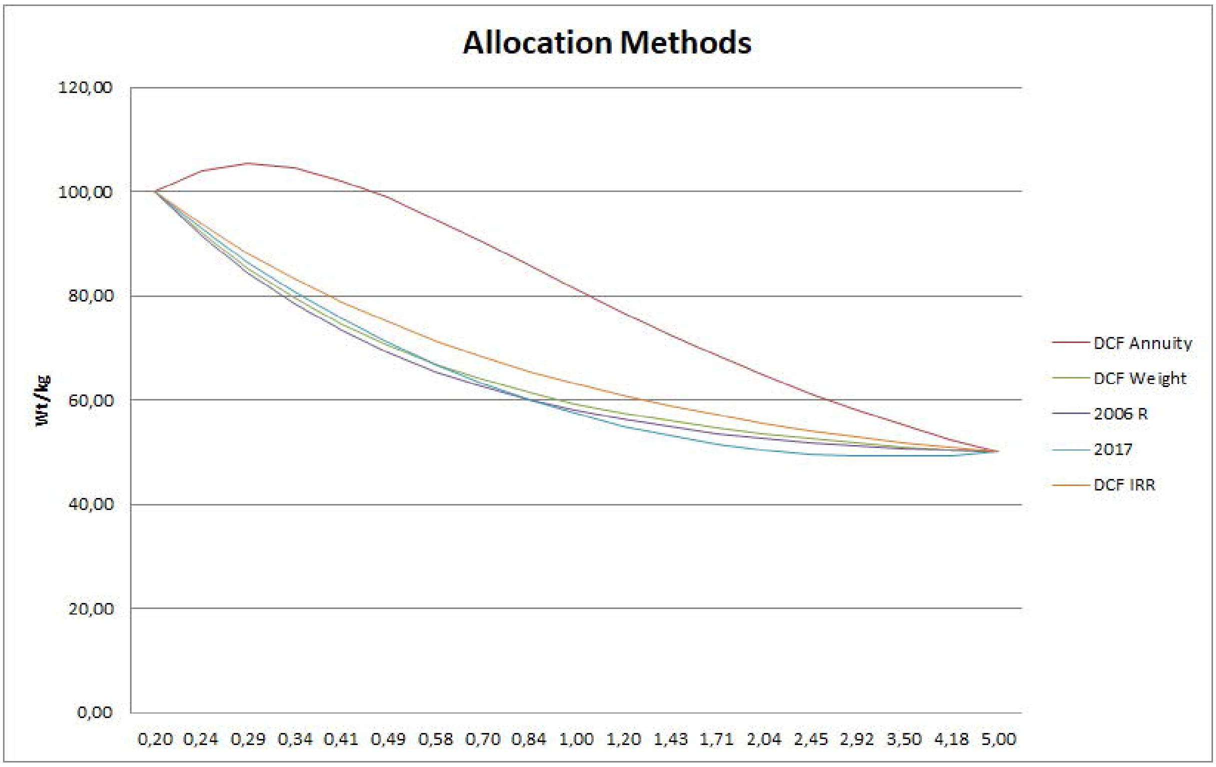

Figure 2: The figure is the same as Figure 1, but includes the 2 industry models “2006 R” and 2017.

A linear allocation in time (DCF Annuity) stands out and will result in a (strong) decrease in return on the investment in inventory, the reason being that weight increase (and cost incurred) is far from linear. Further, fish of equal weight and quality will be valued differently based on the efficiency (quality) of the location.

Biological transformation in fish farming is weight increase, and as the fish does not grow if it is not fed, there is a strong correlation between cost incurred and weight increase. With a constant growth ratio, the weight increase is exponential. With the exception of DCF Annuity allocation schemes are functions of weight increase or cost incurred. Although the schemes produce similar results under the assumptions chosen, they are conceptually different, and the differences could be material from an accounting perspective. The models also show somewhat different sensitivities to changes in assumptions (not shown).

The paper also discusses the effect of changes in estimates (ex post allocation) for different allocation schemes in a model with uncertainty. The alternatives for how to consider the impact of changes in assumptions are however common and are explored in a DCF setting:

- Fixed fee – random return on farming
- Fixed return on farming = cost of capital
    - Alternative 1 – the full effect of changes in future cash flows is allocated to the licence. The CAC is updated for the current and future periods. This method resembles prospective implementation.[xv]
    - Alternative 2 – the fair value of inventory makes a jump because previous CAC are updated; retrospective implementation.

One major takeaway is that we do not need to estimate product prices beyond the production cycle and hence we do not need a full appraisal of contributory assets. Another important takeaway is that fixed fee random return implies that FV of the inventory is not based on current market conditions. Although a contracting party may want to enter into a fixed fee contract for the entire farming cycle, the analogy does not lead to a reasonable allocation. Our prior beliefs about expected price at the time of harvesting (the time the fee was fixed), cannot possibly be relevant to the fair value of inventory at any future time. Fixed return and prospective implementation of changes suffers from the same problem, as it creates a path dependency from the time the estimate was updated. The result is smoothing of gains and losses.

None of the suggested models are purely forward looking, which we should expect FV estimates to be. All the models are taking cost incurred into consideration when the allocation scheme is updated, but the problem could be diminished through normalisation. The allocation problem has no unambiguous solution or ‘gold standard’.

The paper also addresses the inconsistency and interpretational confoundment that arises from the use of a mixed model where fair value measurement of inventory and historic cost measurement of contributory assets are combined. This issue is raised under IAS 41 BC. The use of the revaluation option in IAS 16 and 38 does not solve the problem that a FV increase on inventory may be a result of releasing hidden reserves in the licence, partly because revaluation gain on fixed assets is presented under OCI, but also because the fair value measurement is practised as a closing the book procedure, meaning that classification in the profit and loss statement will depend on whether price changes occur early or late during the reporting period.

5.2 Paper 2

There is a strong logical case for the value relevance of fair value measurement in the balance sheet; that is, fair value measurement of assets brings net assets closer to the share value. When salmon prices increase both the share price of a salmon producer and the fair value of the inventory are likely to go up. The logical case for fair value measurement in the profit and loss statement is less clear as fair value measurement may bring earnings away from its recurring level. Further, the fair value adjustment may not be what it purports to be.

Value relevance studies attempt to assess the relevance and the reliability of accounting amounts and are carried out through regression of share prices or returns on accounting data based on a well-accepted valuation model (Barth, Beaver and Landsman 2001). In a linear model, it is common to regress share price against current book value and earnings (Collins, Maydew and Weiss 1997; Francis and Schipper 1999; Gjerde, Knivsflaa and Saettem 2008). Ohlson (1995) and Feltham and Ohlson (1995) show that this is meaningful under certain conditions.

If fair value measurement explains share prices or returns better than historic cost measurement it could simply be the effect of incorporating product prices in the accounting information. Due to the accretion effect; that is, income is recognised when biological transformation occurs, the fair value adjustments may have information content beyond product prices.

A study of value relevance gives information about the reliability of the information provided. High measurement uncertainty or low reporting quality, regardless of reason, should result in low value relevance.

Value relevance of fair value measurement has occasionally (Goncalves et al. 2017) been tested by partitioning biological assets, BA, out of net assets, NA, on the format; $\text{Share Price} = \alpha + \beta_1 BA + \beta_2 (NA - BA) + \varepsilon$. If β_1 is found to be insignificantly different from nil, this is a very clear signal about low reliability. The analysis format does however not isolate the effect of fair value measurement. Any source of low reliability, also uncertain volume estimates, could result in a β_1 that is not significantly different from nil.

In paper 2 I compare fair value and historic cost measurement and also test the incremental value relevance of fair value adjustments in a transaction based historic cost setting. The results of paper 1 have some bearings on our expectations about the value relevance of the fair value adjustment in the profit and loss statement. High levels of inventory relative to reporting period revenue make the fair value adjustment a noisy predictor of future earnings (and share prices). Allocation problems cause interpretational confounding and a mix of fair value and historic cost measurement is likely to exacerbate the problem.

The Norwegian fish farming industry has a long production cycle and relatively high levels of inventory in progress. This makes the fair value adjustments significant to earnings from operations and to net assets. Interim financial data for the eight companies are hand-collected for each quarter for the periods from the fourth quarter 2006 through the fourth quarter 2015, giving approximately 240 data points. The dual reporting—historic cost and fair value--provides a unique opportunity for a 'within company within period' study. All other information about share prices, salmon prices and foreign exchange rates are obtained electronically from publicly available sources.

The data set with both historic cost and fair value measurement for the same entities puts me in a position to perform a within subject, within period study that is rather unique. Although the subjects differ in size and geographical diversification, they could still be characterised as pure play competitors or peers. This gives strength to the data set, although the number of data points is not very high.

Separate regressions based on historic cost and fair value measurement show that we are looking for small effects. The overall picture is that fair value measurement is incrementally value relevant in both the balance sheet and the profit and loss statement. The stronger assertion, more value relevant, is supported for the balance sheet based on a price specification, but not for the profit and loss statement. In a return specification, fair value measurement is more value relevant than historic cost, based on an R squared comparison, but the significance is not very strong. The support of the conclusion that fair value measurement is value relevant is not robust, and it is certainly questionable whether the fair value adjustments convey any information above the salmon prices.

The fact that there may be little information content other than salmon prices is not an argument against fair value measurement, because one of the key roles of the financial statements should be parsimoniously to aggregate relevant information (Beaver 2002). If information about the salmon prices is relevant, it may well be incorporated in the accounts.

We may safely conclude that the fair value estimates are not completely unreliable and they must carry some information.

It is not surprising that the results are different from research on non-operational assets with separate independent cash flows. The most significant difference is that a reported change in fair value of operational assets may cause investors to update their cash flow estimates also for periods beyond the realisation of assets currently held on the balance sheet. The results confirm that the relevance of fair value is asset and context specific.

5.3 Paper 3

Paper 1 indicates that earnings based on fair value measurement may not have strong predictive capacity of future earnings / cash flows. This is partly supported by the study of value relevance. The association between share prices and earnings is not (or only marginally) improved by fair value measurement. Volatile fair value measures are also unlikely to be more informative about historical performance.

Bradshaw (2011) summarizes an understanding of analysts' role in the capital markets and an understanding of analysts' activities. Both input and output are extensively studied. The processes of analysis and various analytical approaches are studied by Demirakos et al

(2004) and Brown et al (2015). The valuation models applied by analysts can be identified and described from the extant valuation literature and from previous research in several fields. Brown et al 2015 takes a broad perspective on the input used by analysts. Green, Hand and Zhang 2016 looks at how sell side analysts execute their valuations.

This forms the background for paper 3. Sell side equity analyst's use of fair value estimates may be explored through review of valuation reports and interviews while the rationale for their choice may be analysed based on valuation theory, empirical research and inferences made from the study of value relevance.

Paper 3 is partly based on the same dataset as paper 2. In addition paper 3 is based on valuation reports collected from Norwegian investment banks. All the Norwegian investment banks that cover the salmon industry submitted reports, hence constituting a complete universe. Interviews with the analysts are conducted, but the information obtained is of confirmatory nature and does not change the picture obtained from the document review.

Most sell side equity analysts develop cash flow estimates for maximum 2 years and many apply simple heuristics. The most commonly used model could be synthetized as follows:

$$\text{Equity Value} = \frac{CF_1}{(1+K_A)^1} + \frac{CF_2}{(1+K_A)^2} + \frac{CF_2(1+g)M}{(1+K_A)^2} - \text{NIBD}$$

Equity Value is the discounted value of the Cash Flows (CF_i) for the next two years plus a Continuing Value where $M=1/(K_A-g)$ is based on Gordon's Growth, and NIBD is Net Interest Bearing Debt. In this model, fair value information may be incorporated in NIBD for non-operational assets or in the cash flow estimates for operational assets.[xvi]

When analysts are assessing the fair value of an enterprise, they try to estimate future cash flows. Although fair value estimates provided by management comprise aggregate information about amounts and timing of future cash flows, such estimates are only useful as direct input to the valuation model for non-operational assets. The primary reason is that financial analysts make an estimate for the aggregate cash flow generated from all operating assets that interact to produce the cash flow from operation, i.e. within the Cash Generating Unit.

To the extent analysts make full-fledged DCF analyses, they apply a top down approach based on expectations about total volumes harvested, prices and farming cost per kg. These estimates include proceeds from sales of the current inventory. Expectations about prices are their own, while guiding from the companies, independent analysts and publicly available statistics are important for the formation of volume expectations. Information about farming cost is more easily obtained from analyses of historical performance.

Fair value measures are not a natural input to sell side equity analysts valuation models and information about product prices may be obtained more timely and with less risk of bias from other sources. Other information is difficult to extract.

In an empirical study of the cash-flow predicting ability of earnings based on fair value shows that historic cost better predicts next period earnings. Earnings are chosen as proxy for cash-flow partly because analysts try to predict earnings, not cash-flow, but also because earnings should be easier to predict as it is not influenced by random changes in working capital. Earnings for the next period are perhaps the most significant measure of analysts' performance, given their valuation models.

The primary takeaway is that sell side analysts rationally ignore the fair value measurements.

5.4 Implications and Guidance

The 3 papers together indicate that the case for fair value measurement may not be very strong when prices are volatile, the biological transformation largely is a result of a production process, the production cycle is medium long and substantial contributory assets, measured at historic cost, are involved.

We cannot determine fair value without making an incorrigible (Thomas 1975) allocation of cash flows between the licence and the inventory. The author suggests that weight increase, as opposed to time, is used as major observable. Given the length of the production cycle and the relatively high fair value of the licence, fair value measurement does not, at least for salmon farming, solve the allocation problems pertaining to historic cost measurement.

Fair value measurement does not have low value relevance. In a regression of share prices against net assets and earnings based on fair value measurement, R squared exceeds 0.7 and the coefficients are highly significant (paper 2). The issue is that fair value measurement is hardly significantly more value relevant that historic cost and that the fair value adjustments, although significantly incrementally value relevant, carry little, if any, information beyond product prices. It could be claimed that this is due to low reporting quality (noise), small samples and lack of statistical power. A stronger statistical material could possibly have caused me to more boldly reject the null hypothesis; 'historic cost measurement is more value relevant than fair value measurement'. Given the expectations formed by paper 1 and the empirical evidence from paper 2, there is no reason to believe that we are looking for much stronger effects.

Paper 1 indicates that fair value measurement always will suffer from model created uncertainty both because there are allocation problems that do not have a unique solution and because simplified models may suffer from biases and model artefacts. Still, there are not sufficiently strong reasons to reject fair value measurement based on lack of reliability. More importantly, Paper 1 points to the interpretational problems relating to the fair value adjustment in the profit and loss statement. The fair value adjustment itself has no clear interpretation and it is difficult to extract relevant information from it.

Hence, it does not come as a surprise that analysts disregard the fair value adjustments. Paper 3 support the industry's assertions about lack of usefulness. The fair value adjustments do not fit into the analysts' valuation models, they are not very informative about short-term cash flows and they are not very informative about historic performance either. Analysts seem to rationally ignore the fair value adjustments. There are reasons to believe that if the account producers ceased to report historical cost figures, which they could do within IFRS, the work of the analysts would be more complicated and the quality of their analyses could potentially go down.

The overall implications of my work are that equity analysts prefer accounting information that could be used directly as input to their valuation models. When they receive new information their major concern is to update their predictions, and hence they want to compare estimates with actuals. The fair value adjustment in the profit and loss statement is difficult to interpret and comprises price effects, volume effects, effects of changes in size distribution and also unexpected changes in licence value realised during the period. It is difficult to form an expectation about the adjustment and even more difficult to compare actuals to expectations.

We should be careful about making inferences to other biological assets. The accretion effect is likely to be more important for example for forestry where the production cycle is longer and the case for fair value measurement may be stronger.

My work does not explore other potential benefits of fair value measurement. Fair value measurement could make the accounts more informative about the volatility of the industry, but also potentially overstate the volatility. If product prices are changing early in the reporting period, there will be an element of double counting as the effect of the price change is already captured by the historic cost figures.

Although fair value measurement is judgemental and leaves room for earnings management, it also eliminates certain possibilities for earnings management. Timing of harvesting and picking of low/high cost populations will no longer have an effect. Earnings management could possibly be revealed by looking for time lags, whether the fair value adjustments are more or less volatile than we should expect from a simple pricing model or whether the effects of price changes are symmetrical. If management has the firm belief that analysts ignore the fair value adjustments, their incentives to manipulate such should, however, be fairly low. The data set does however not lend itself to such analyses.

The total research on fair value measurement of operational assets is still limited. Biological assets are different from other operational assets in the accretion effect, but this effect depends on the level of human involvement in the production process. In the future research should be expanded to cover assets with different characteristics.

---

[i] Finanstilsynet – Regnskapstilsynet (At that time Kredittilsynet)

[ii] There are variations in the new model across industry participants

[iii] The focus is on tangible assets because some licences are acquired in the market at very different acquisition price while others are granted by the government without any consideration.

[iv] I use the term sub-licence for the hypothetical right to operate from release to harvesting on one generation

[v] The industry called upon a reliability exception when fair value only was applied for fish above 4 kg in 2005, but the industry has subsequently accepted the FSOB's interpretation and also left the assertion about lack of reliability.

[vi] This is necessarily not the way the farmers operate, but no generality is lost in a parsimonious example.

vii This may also be land, bearer plants or PPE.

[viii] For simplicity these is no cost incurred

[ix] The sub-licence for one production cycle has no value when the cycle is completed.

[x] The discount rate may change as a result of changes in the time value of money or as a result of changes in the Equity Market Risk Premium

[xi] IAS 41 leaves a choice about whether subsequent cost incurred should be capitalised on inventory or expensed. In practice the only difference is that of classification in profit and loss. No biological transformation takes place with salmon unless the fish is fed, and the right to choose does not seem to make much sense. For biological assets with long production cycle, where biological transformation takes place with less human involvement, and where the association between a FV increase and cost incurred is more obtuse, the right to choose is more meaningful.

[xii] In a price specification; $\text{Share Price} = \alpha + \beta_1 BA + \beta_2 (NA - BA) + \varepsilon$ where BA is biogical assets and NA is Net Assets

[xiii] Revaluations under the revaluation option in IAS 16 are not included in net income.

[xiv] Such prognosis could of course be needed for other purposes

[xv] Ref IAS 8

[xvi] In this context, a non-operational asset does not interact with other assets and may be disposed of without any effect on the future cash flow from other assets.

II References

Aboody, D., Barth, M. E., and Kasznik, R. (1999) Revaluation of fixed assets and future firm performance: Evidence from the UK. Journal of Accounting and Economics 26 (1-3): 149-178.

Altamuro, J. and Zhang, H. (2012). The financial reporting of fair value based on managerial inputs versus market inputs: evidence from mortgage servicing rights. SSRN: https://ssrn.com/abstract=1832606.

Argilés-Bosch, J. M., Miarons, M., J. Garcia-Blandon, C. Benavente, and D. Ravenda. (2018) Usefulness of Fair Valuation of Biological Assets for Cash Flow Prediction. Spanish Journal of Finance and Accounting / Revista Española de Financiación y Contabilidad 47 (2): 157-180

Argilés, J. M. Garcia-Blandon, J. and Monllau, T. (2011). Fair value versus historical cost-based valuation for biological assets: predictability of financial information. Revista de Contabilidad-Spanish Accounting Review Vol. 14 - No 2, 87-113.

Badenhorst, W. M. (2018). Fair Value Intensity and Analyst Forecasts. Journal of Economic and Financial Sciences 11(1)

Barniv, R. and Myring, M. (2006). An International Analysis of Historical and Forecast Earnings in Accounting-Based Valuation Models. Journal of Business Finance & Accounting, 33(7) & (8), 1087-1109 September/October 2006

Barth, M. E. (2000). Valuation-based accounting research: Implications for financial reporting and opportunities for future research. Accounting and Finance 40, 7-31.

Barth, M. E., Beaver, W. H. and Landsman, W. R. (2001). The relevance of the value relevance literature for financial accounting standard setting: another view. Journal of Accounting and Economics 31 2001, 77-104.

Barth, M. E. and Clinch, G. (1998). Revalued Financial, Tangible and Intangible Assets: Associations with Share Prices and Non-Market-Based Value Estimates. Journal of Accounting Research. Vol. 36 Supplement

Beaver, W. H. (2002). Perspectives on Recent Capital Market Research. The Accounting Review. Vol. 77, No. 2. April, 453-474.

Beisland, L. A. (2008). Essays on the Value Relevance of Accounting Information. PhD dissertation NHH.

Bernhoft, A. C. and Fardal, A. (2007). IFRS and Fish Farming, Magma 6, 49-58.

Botosan, C. A. and Huffman A. A. (2015). Decision-Useful Asset Measurement from a Business Valuation Perspective. Accounting Horizons Vol. 29, No. 4 2015 pp. 757-776

Bradshaw, M. T. (2011). Analysts' Forecast: What Do We Know After Decades of Work? http://ssrn.com/abstract=1880339

Brandsberg, N. R. (2007) IAS 41 Agriculture, -Implemented in Norwegian fish farming; -User relevance and "earnings management". Master Thesis, University of Tromsø https://munin.uit.no/bitstream/handle/10037/1049/thesis.pdf?sequence=1&isAllowed=y

Brown, L. D., Call, A. C. and Clement, M. B., Sharp, N. Y. (2015). Inside the «Black Box» of Sell-Side Financial Analysts. Journal of Accounting Research. Vol. 53 No. 1 March 2015.

Collins, D. W., Maydew, E. L. and Weiss, I. S. (1997). Changes in the Value-Relevance of Earnings and Book Values over the Past Forty Years. Journal of Accounting and Economics, 24 (1), 39-67.

Danbolt, J. and Rees, W. (2008) An Experiment in Fair Value Accounting: UK Investment Vehicles. European Accounting Review Volume 17, Issue 2, 271-303.

Demirakos, E. G., Strong, N. C. and Walker, M. (2004). What Valuation Models Do Analysts Use? Accounting Horizons Vol. 18, No. 4 December 2004 pp. 221-240

Easton, P. D., Eddey, P. H. and Harris, T. S. (1993). An investigation of revaluation of tangible long-lived assets. Journal of Accounting Research 31 (Supplement), 1-38.

FASB (2018). Conceptual Framework. Statement of Financial Accounting Concepts No. 8 August

Feltham, Gerald A., James A. Ohlson. (1995). Valuation and Clean Surplus Accounting for Operational and Financial Activities. Contemporary Accounting Research Vol. 11 No. 2 Spring, 689-731.

Filho, A. C. da C. S., Machado, M. A. V. and Machado, M. R. (2013) Historical cost X fair value: Which information is more relevant on the measurement of biological assets? Custos e Agronegocio, 9(2), 27-50.

Financial Statements Oversights Board's (Finanstilsynet), 2015, Rapport fra Tematilsyn Oppdrettsforetak. Available at https://www.finanstilsynet.no/contentassets/2c0a3597734849b5a5ff98b07f891739/tematilsyn-oppdrettsforetak-11-2015.pdf

Francis J. and Schipper, K. (1999). Have Financial Statements Lost Their Relevance? Journal of Accounting Research 37 (2), 319-352.

Gassen, J. and Schwedler K. (2010) The Decision Usefulness of Financial Accounting Measurement Concepts: Evidence from an Online Survey of Professional Investors and their Advisors. European Accounting Review Vol. 19, No. 3, 495-509

Gjerde, O, Knifsflaa, K. and Saettem, F. (2008). The value-relevance of adopting IFRS: Evidence from 145 NGAAP Restatements. Journal of International Accounting Auditing and Taxation 17, 92-112.

Goncalves, R., Lopes, P. and Craig, R. (2017). Value Relevance of Biological Assets under IFRS. Journal of International Accounting, Auditing and Taxation 29, 118-126.

Green, J., Hand, J. R. M. and Zhang, X. F. (2016). Errors and questionable judgements in analyst's DCF models. Review of Accounting Studies. June 2016, Vol. 21 Issue 2, p596-632. 37p.

Hitz, J-M. (2007) The Decision Usefulness of Fair Value Accounting – A Theoretical Perspective. European Accounting Review, Vol. 16, No. 2, 323-362

Hodder, L., Hopkins, P. and Schipper, K. (2013) Fair Value Measurement in Financial Reporting. Foundations and Trends in Accounting, Vol. 8, Nos. 3-4, 143-270

Huffman, A. A. (2014) Matching Measurement to Asset Use: Evidence from IAS 41. Working Paper.

IASB (2018). Conceptual Framework for Financial Reporting. July

IASB (2012). Staff Paper Emerging Economies Group 28-29 May

Laux, C. and Leuz, C. (2010a). Did Fair-Value Accounting Contribute to the Financial Crisis. Journal of Economic Perspectives – Volume 24, Number I-Winter, 93-118.

Laux, C. and Leuz, C. (2010b). The Crisis of Fair-Value Accounting: Making Sense of the Recent Debate. Accounting, Organizations and Society, 34((6-7), 826-834.

Liang L. and Riedl, E. J. (2014) The Effect of Fair Value versus Historical Cost Reporting Model on Analyst Forecast Accuracy. The Accounting Review: May 2014, Vol. 89, No. 3, pp. 1151-1177.

Ohlson, J. (1995). Earnings, book values and dividends in security valuation. Contemporary Accounting Research 11, 661-687.

Penman, S. (2007). Financial Reporting Quality: Is Fair Value a Plus or Minus? Accounting and Business Research, Special Issue: International Accounting Policy Forum, 33-44.

Philips G. E. (1963), The Accretion Concept of Income. The Accounting Review, January

Reilly, R. F. and Schweihs, R. P, (1998) Valuing Intangible Assets, McGraw-Hill ISBN 0-7863-1065-0

Sellhorn, T. and Stier, C. (2017) Fair Value Measurement for Long-Lived Operating Assets: Research Evidence. Available at SSRN: http://ssrn.com/abstract=2991997

Silva, R. M. and Nardi, P. C. C. (2018) The (in) Difference Between Historical Cost And Fair Value for Biological Assets: a Cross-Country Study. Annual Meeting of the American Accounting Association, At Washington, DC.

Song, C. J., Thomas, W. B. and Yi, H. (2010). Value Relevance of FAS 157 Fair Value Hierarchy Information and the Impact of Corporate Governance Mechanisms. Accounting Review, (July) Vol. 85 no. 4, 1375-1410.

Thomas, A. L. (1975) The FASB and the Allocation Fallacy. Journal of Accountancy. November Vol. 140 Issue 5 pp 65-68

III Paper 1

A framework for valuation of biological assets under IAS 41

A framework for valuation of biological assets under IAS 41

Bjarne Møller

Department of Accounting Auditing and Law, Norwegian School of Economics, Bergen, Norway

bjarne.moller@nhh.no

A framework for valuation of live biological assets under IAS 41

Producers of live biological assets have to measure inventory at fair value in accordance with IAS 41 and to conduct the valuation in accordance with IFRS 13. Neither accounting standard sufficiently addresses the allocation issues that arise from the utilization of contributory assets that may have an unobservable fair value.

Assets that do not have an observable market price and that share a common cash flow, i.e. do not have independent separable cash flows, can only be appraised through a process where cash flows are allocated to the different assets. As harvesting approaches an increasing portion of the cash flow should be allocated to the inventory of live biological assets; that is, fair value of inventory increases / income is recognised through the release of a contributory asset charge. This raises allocation / income recognition problems with respect to both timing and how to deal with changes of estimates, in particular if biological transformation is not closely related to the passage of time.

When valuation models cannot be back-tested against observable transactions and the cash flow allocation is ambiguous, we cannot avoid model created uncertainty. Even in a deterministic model with no uncertainty about input parameters, there will be uncertainty both related to the validity of the model and the cash flow allocation. When we compare different allocation approaches there is no 'gold standard'.

I explore different valuation models / allocation principles and discuss the different properties based on a set of valuation axioms and find that although an unambiguous solution does not exists, there may be practical solutions. I also explore alternative parsimonious models applied by or suggested by the industry and conclude that such models may return a proxy for fair value that comes relatively close to more complex Discounted Cash Flow models, but may be biased.

Key words: IAS 41, Fair Value Measurement, Inventory, Agriculture, Contributory Assets

1 Introduction

The use of Fair value measurement under IFRS is extensive, but assets and liabilities measured at fair value, primarily financial assets and liabilities and also investment property, will normally have separate and independent cash flows and in many cases also observable market prices.

IAS 41 requires us to measure live biological assets at fair value. Inventory of live biological assets will normally not be a separate Cash Generating Unit ('CGU'). The task of appraising one operational asset within a CGU leaves us with certain allocation problems known from for example Impairment Testing (IAS 36) and Purchase Price Allocations ('PPA') (IFRS 3).

In most jurisdictions the farming of Atlantic salmon requires a licence (public permit) to operate. Although the reason is to control externalities, a side effect is that the licence has become a barrier to entry and hence a valuable Contributory Asset to the farming operation.

This article addresses the allocation problem; that is, how to appraise the inventory of live biological assets when both the fair market value of inventory and contributory assets are unobservable, when the fair value of contributory assets are substantial and when there is no rental market for such.

Financially we may consider the fair value of the licence to operate to be the net present value of future abnormal earnings (Ohlson 1995) from the farming operation[i]. Legally a farming licence is considered to have indefinite life. From a financial modelling perspective, it may be practical to consider an operation with distinct production cycles and the licence as a series of real options to start new production cycles. Hence, the fair value of the licence is also the fair value of a series of options to start a new production cycle. An alternative analytical approach is to assume steady state from the closing of the first production cycle. This save us from, or greatly simplify, the problem of assessing the fair value of the licence at the end of the farming cycle.

In a one production cycle model with two assets; inventory of live biological assets and the licence (we may have several points of measurement or reporting periods within the production cycle), the fair value of the inventory is nil at the starting point and the fair value of the (sub)licence is nil at the end point. During the production cycle we have transferred fair value from the licence to the inventory; that is, gradually allocated more of the cash flow to the inventory. Further, if for example product prices changes, we have to change our allocation parameters. These allocation problems do not have an unambiguous solution, but we may find reasonable solutions.

Fish farmers measure the inventory of live biological assets at fair value and the licence at historical cost. This Mixed Model is without any consequences for the allocation problem, but will contribute to further interpretational confounding about the fair value adjustments in the financial statements, in particular the profit and loss statement.

Although the historical reason for fair value measurement of biological assets may have been to move income recognition from the point of harvesting to when biological transformation occur (IASB 2012), IAS 41 clearly links income recognition to increase in fair value. In a discounted cash flow model, fair value increases due to (upward) revisions of cash flow estimates, reduction of risk or simply the passage of time (the effect of moving closer to the positive cash flow from harvesting). Biological transformation will usually be a function of time, but changes in physical attributes may be difficult to observe and may develop very slowly during certain periods. Hence, remaining time to harvesting and biological transformation may develop differently and not necessarily be interchangeable as input factors to a valuation model. For some biological assets the estimated remaining time to harvesting will be revised based on observed biological transformation.

Initial recognition of biological assets requires (IAS 41.10) that the entity controls the asset as a result of a past event; it is probable that future economic benefit will flow to the entity, and the fair value or cost of the asset can be measured reliably. These criteria do not make it clear when the apple farmer may recognise an inventory of live biological assets. If time to harvesting is applied as value driver in a valuation model, a catch-up effect may arise at initial recognition.[ii]

In a model without uncertainty and where only time and cash flows are observed, the allocation problem could be solved through an internal rate of return model. This does however not preclude that alternatives may exist. In a model with uncertainty and where biological transformation is the observable, the allocation problem becomes more complicated.

In fish farming initial recognition is based on a distinct event, i.e. there is no doubt about whether the criteria for initial recognition is fulfilled. Subsequently, the growth is close to exponential. Less than 1% of the total increase in biomass takes place during the first month in sea-water while 17% takes place in the last month in a model with constant growth. In real life the growth is slowing somewhat down, but still the difference is more than a tenfold. Hence, it is not obvious that a model where fair value is transferred from the licence to the inventory based on time alone, is suitable. We should perhaps consider an allocation based on weight increase or capital employed in inventory.

The allocation issues translate into modelling issues and potentially ambiguous solutions, even with deterministic models, i.e. where future cash flows are assumed to be certain. The main motivation of this paper is to problematize these issues and to suggest solutions that may be put into practise.

1.1 Valuation approach – IFRS 13

Under IAS 41 inventory of biological assets has to be measured at fair value. According to IFRS 13 fair value will, in the absence of observable prices, in most cases be determined based on an 'income approach', IFRS 13.62 B10-11.

The objective of IFRS 13 is to 'estimate the price at which an orderly transaction to sell the asset or transfer the liability would take place …' (IFRS 13.2).

Many biological assets go through a biological transformation where there is no regular market for the assets until they are harvestable. In other situations, it may not be economically rational to harvest, and a valuation based on immediate harvesting would violate the 'highest and best use' (IFRS 13.27) or 'most favourable marked' (IFRS 13.24) assumptions, because the real option to grow the asset to optimal size is disregarded.

In fish farming the possibility to sell live fish before it is harvestable, is hypothetical. Due to regulatory constraints, the fish cannot be moved, and a buyer will have to buy or rent the production facilities to fulfil the production cycle on site. The buyers' potential to influence the production cost and in particular realise synergies within a production cycle, will critically depend on whether the buyer has other operations in close vicinity. Transactions in live fish are hardly observed outside business combinations.[iii]   When a market price is not observable, a valuation model has to be applied.

The fish is assumed to be grown to harvestable (optimal or near optimal) size on its current location and sold in the most favourable market at a future point of time at the expected price based on the expectations at the measurement date.   Fair value according to IFRS 13.2 is a ‘market specific’, not an ‘entity specific’ measurement. Further, fair value is, according to IFRS 13.9 defined as an ‘exit price’. IFRS 13 Appendix A B3 outlines the valuation premises for non-financial assets.

When individual assets held by an enterprise cannot be appraised based on the ‘market approach’ because prices on similar assets are not observable or because the assets interact with other assets such that ‘value in use’ (‘VIU’) exceeds ‘value in exchange’ (‘VIE’), we normally have to revert to the ‘income approach‘, but the income approach requires separate independent cash flows. The ‘cost approach’ may in some cases be available, but generally the cost approach is also useless when assets are interacting. The cost approach is mainly useful in highly competitive, supply driven industries or for assets that are generic and have an observable price.

1.2 Lack of separate independent cash flows

The valuation literature is extant and guidance to IFRS 13 is also provided. However, most valuation literature start with the assumption that independent cash flows are available, i.e. that the valuation is carried out on the lowest level where independent cash flows are observed. Under IAS 36, impairment tests are carried out on CGU level. The only IFRS standard that deals with allocation of cash flows is IFRS 3.

The cash flow allocation problem is commonly solved by the use of ‘residual’ or ‘differential’ cash-flow models (Reilly and Schweihs 1998). IFRS 13 Appendix A B3(d) also suggest such methods. Differential cash flow models, for example ‘relief from royalty’, are based on the assumption that even if the fair value of a comparable asset cannot be observed, rental agreements on the same asset may be observable. This is, however, not the case within the fish farming industry.

The magnitude of the allocation problem is related to the fair value of the licence, i.e. the level of abnormal earnings on the farming activities. A typical balance sheet measured at fair value on a debt free basis for a large Norwegian fish farmer as of December 31, 2016 would be.

NORMALIZED BALANCE SHEET FOR AN AVERAGE SALMON FARM

Assets		Liabilities and Equity	
Licence	75	Equity	92
Property plant and equipment	8	Current liabilities	8
Current assets	17		
Total Assets	100	Total Equity and Liabilities	100

Table 1: The figures are normalized to 100. Licence value is implied based on share price. Current assets is based on booked value where inventory is measured at fair value. PPE and Current liabilities are based on booked values. The entire difference between booked value of net assets and market capitalisation is attributed to licences. Net Interest bearing debt is substituted with equity.

Licences are measured at historic cost in the financial statements. The purpose of the table is to illustrate the magnitude of contributory assets. If the fair value of the licences is 75, the required return on capital is 6 %, the inflation is 2% and the farming cycle is 18 months, the fair value of a licence to operate for one farming cycle should be approximately 75 * (6% - 2%) * 18 / 12 = 4.5. This is a significant amount compared to inventory measured at fair value.

1.3 Market specific vs entity specific values

Licences are not homogenous, and the fair value of a licence will depend on location (quality) and the potential to realise synergies. Several licences in a cluster may be individually more valuable than one stand-alone licence. As the fair value of the licence is the net present value of abnormal return, the fair value is directly related to farming efficiency. A location, which is easily accessible, where the fish is growing fast with high feed conversion ratio and few health issues, is a good location. Lower operating expenses result in a higher residual cash flow and a higher fair value. This means that a valuation model cannot combine location specific input factors with company or industry averages.

The output of a valuation model is the fair value of the inventory at a specific location. However, as the fair value of the licence is based on the residual cash flow from the farming, a good location will command a high contributory asset charge, which is counterbalanced by low operating expenses. Hence, we still expect the fair value of fish of similar weight and quality to be comparable across locations and farmers provided that all are profitable. This should be also a vital property of any valuation model. A contributory asset charge based on the booked value of the licence, which may be nil, will make the fair value estimate of the fish dependent of the historic acquisition cost of the licence and hence an entity specific estimate.[iv]

1.4 Contributory assets – licence to operate

A licence is a permission to operate in a particular region or at a specific plot. The permission is restricted such that the biomass never should exceed a limit. The permissions are considered to have an indefinite duration and they are, with certain restrictions, tradeable. There is no regular market for licences. Most of the existing licences have been issued for free by the government, and the holders have (so far) not paid for the use of the locations. Neither have they paid for negative externalities. As a result of transactions in licences, the acquisition cost varies substantially across the producers.

1.5 Motivation / Research Questions (RQ)

IAS 41 requires live biological assets to be measured at fair value and IFRS 13 define fair value. When market observations are not available, we have to revert to valuation models. The purpose of the work is neither to clarify nor to interpret or criticize the standards, but to explore whether it is possible to:

(1) make logical estimates of fair value of an operational asset that is a part of a CGU where at least one more asset has a material but unobservable fair value

(2) find practical solutions; that is, whether a simplified model applied by the industry is capable of returning an unbiased fair value estimate of inventory across different salmon prices, different fish sizes and differences in production economy in accordance with the valuation framework outlined in IFRS 13.

I will in particular analyse whether it is possible to find a unique solution to the allocation problem or, if not, a set of solutions that are reasonable.

The allocation problem arising from contributory assets with unobservable market price is to my knowledge not addressed before. Inventory of salmon is different from inventory of other live biological assets in terms of length of production cycle, profitability, degree of human involvement or profitability, which may be the reason why this is not addressed before. The issue has, however, been debated for 15 years by the industry and the Financial Supervisory Authority in Norway. The empirical research in the field of fair value measurement is of little help.

IAS 41 addresses the issue of separating the timber from the land, i.e. that fair value of the timber may be found by deducting the fair value of raw land from the combined value of land and timber, but assumes that market price is observable for the raw land and for the combination of land and trees, but not for the standing trees alone. In such case the allocation problem is reduced to a trivial calculation.

The analysis discusses important theoretical aspects in particular related to the allocation of a Contributory Asset Charge (‘CAC’) that also could prove useful for the valuation of other biological assets and any other valuation that requires cash flows to be allocated to different assets, for example PPAs under IFRS 3.

1.6 Approach

The cash flow allocation problem is not an easy task, ref IAS 36 that allows impairment tests to be carried out on CGU level. In order to simplify the problem, I will, based on a case study of salmon farming in Norway, assume that all assets and liabilities except inventory and the licence,[v] i.e. the permission to operate, are fairly represented at historic cost. This means that all fair value fluctuations are attributable to the inventory and licence and that the allocation of cash flows to other assets is trivial. By doing this we may focus on a two assets model with a time horizon of one production cycle. This also implies that there is no inventory of feed, accounts payable or accounts receivable in the model and generally not necessary to distinguish between the accounting terms 'cost' and 'revenue' and the corresponding cash out- and inflows. This is done without loss of generality.

Any abnormal return is assumed to be attributable to the licence, that is; if the licence where held by a 3. party, the rent would be set such that the expected return in the farming operation is equal to the cost of capital. This is reasonable as the licence is the barrier to entry and presumably the major reason why an abnormal return exists.

We shall first develop a model, both formally and through a numerical example. Then I will evaluate alternative models using the model developed. I will look at 2 simplified models, both applied by the Norwegian industry:

- The model applied until recently by the Norwegian salmon industry. The model, which will be described in more detail, is historical cost based with a fair value adjustment based on an estimate of profit from farming assuming that the fish is harvested at an optimal size. The farming profit is allocated linearly in weight increase. Hence, the model is not entirely cash flow based, as the value reported is partly a consequence of historic cost absorption. Deferral of a part of the expected profit to future periods will secure a return to contributory assets.

- An interpolation method where fair value of smolt is assumed to be observable when these are released into the sea. Further, fair value at the time of harvesting is the expected (net) proceeds from sales. At the time of release a non-linear interpolation function is established.

The comparison will cover both different stages in the production process (weight) and different salmon prices. The differences observed might serve as input to the discussion of whether reliable information may be produced with reasonable effort and also whether a simplified model could be justified.

1.7 Insights

A number of insights are derived from the process

(1) The most important insight gained is that fair value of the inventory cannot be reliably estimated without considering a Contributory Asset Charge

(2) The CAC implies that cash flows are reallocated from the contributory asset to inventory as we approach harvesting. This raises an allocation problem that we perhaps thought that fair value measurement should solve. We must choose: Should time elapsed (or remaining time to harvesting), fair value of the inventory (weight) or internal rate of return be the allocation key?

(3) The licence could be considered as a series of rights to start a production cycle and only the fair value of the current right is released to inventory. Hence, the fair value of inventory is insensitive to changes in product prices (and licence value) beyond the production cycle of the current inventory.

(4) The use of a mixed model where the licence is recognised at historical cost implies that hidden reserves released during the period are recognised as fair value gain. This leads to interpretational confounding in the profit and loss statement. If both the licence and the fish were fair valued, a reallocation of cash flow between licence and inventory could be done with no profit and loss effect.

(5) Simplified models applied by the industry that are based on interpolation or deferral of income, may return approximations that may be acceptable.

(6) The use of location specific input should lead to fair value estimates that are comparable across locations despite differences in efficiency.

(7) The development of a cash flow model could contribute to the users' understanding of the impact of price fluctuations on the fair value of inventory and in particular to sensitivity analyses. The smaller fish is less sensitive to price fluctuations than we intuitively may think.

1.8 Literature

The value relevance and also the cash predicting capacity of fair value measurement of biological assets have been studied. The literature is summarised by Møller 2021 [Paper 2 and 3] and the picture is mixed. The case for fair value measurement of live biological assets is not very strong from a value relevance perspective.

Botosan and Huffman (2015) concludes that fair value is more decision useful for assets expected to be realised in exchange while historic cost is more decision useful for in use assets and cash flow prediction. Their work makes use of accounting theory as well as valuation theory and practice. Also Hitz (2007) adopts a theoretical perspective on the usefulness of fair value reporting. Møller [Paper 3] finds that analysts rationally ignore information about fair value. The profit and loss statement lacks predictive capacity and the information in the balance sheet does not fit into their valuation model. The concept of decision usefulness is itself problematic; standard setters, scholars and practitioners have not yet agreed on an undisputed measure of decision usefulness (Gassen and Schwedeler 2010).

IAS 41 suggests that the fair value of the timber may be found by deducting the fair value of raw land from the combined value of land and timber and thereby recognises that an allocation problem exists, but does not suggest a solution if the fair value of the land is unobservable. Also the valuation literature (Reilly, R. F. and Schweihs 1998) recognises the allocation problem, but assumes that market observations for comparable assets are available or that cost is an acceptable proxy.

To my knowledge no research is done into the valuation models applied for biological assets and how to solve the allocation problem arising from contributory assets with unobservable fair value. The industry addressed the matters at several occasions, but nothing has been published.

1.9 Impact

Fish farming is a fast-growing industry in Norway. The 7 listed fish farmers had a market capitalisation of NOK 162 (EUR 18) billions and the companies constituted 7.6% of the market capitalization at Oslo Stock Exchange as of December 12. 2016. Biological assets reported at fair value constituted 30 % - 50 % of the fish farmers' book value of total assets. According to the Food and Agriculture Organization of the United Nations the estimated value of the world's aquaculture production in 2013 was USD 157 billion. According to WHO (WHO 2019) the estimated value of the world's palm oil market is projected to USD 88 billion by 2022.

The issue of contributory assets is not unique for the salmon industry; the land is a contributory asset when the forest is appraised, and the land and the trees are contributory assets when palm oil is appraised, but Norwegian fish farming is particularly suitable to analyse the issue because the licence (government permission) to operate is an important intangible asset for fish farmers. Further, the production cycle is sufficiently long, and prices are sufficiently volatile to cause a valuation problem.

The number of listed companies within the agricultural sector is still low but could be expected to increase due to increased industrialisation of food production and also as capital markets develop in countries with large agricultural sectors. Goncalves, R., Lopes, P. and Craig, R. (2017) identified 132 companies with biological assets measured at fair value, while Silva and Nardi (2018) identified 174 companies, including 22 companies applying both fair value and historic cost.

--

The article is organised as follows: First I will make an introduction to the industry and put the valuation problem into a context in chapter 2. Then I describe the accounting practice and valuation methods applied within the industry in chapter 3. Readers that are only interested in a theoretical discussion of the allocation problem may start with chapter 3. In chapter 4 I describe and discuss the allocation problem through the use of formal and numerical examples.

In chapter 5 I develop a simple DCF model and illustrate the different allocation alternatives. I present the models applied by the industry based on similar assumptions.

In chapter 6 I make comparisons and discuss the properties of the different models. Finally in chapter 7 I summarize and conclude.

2 The salmon industry

The purpose of this chapter is to briefly describe the industry and biology. A in-depth description is presented in Marine Harvest (2018). Later I will develop simplified models and this chapter is relevant for those who want to assess the reasonability of the models and the simplifications made. Those who want to move directly to the examples and models may skip this chapter.

2.1 Production cycle

SALMON FARMING PRODUCTION CYCLE

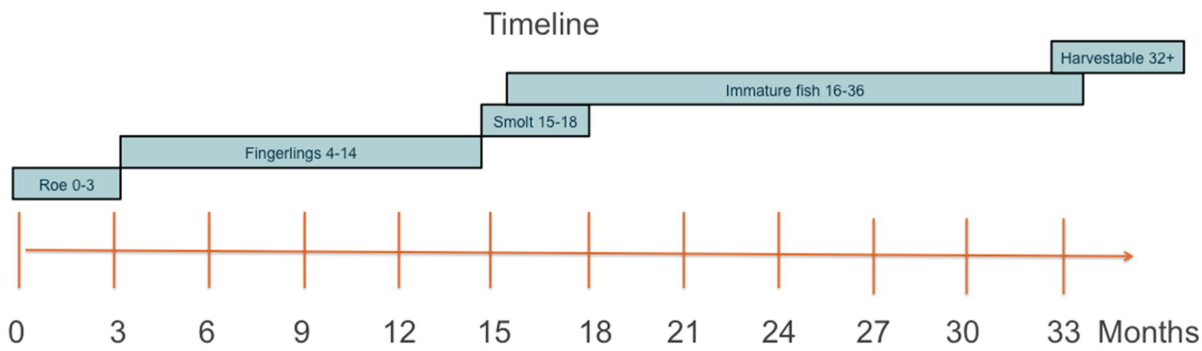

Figure 1: The figure shows the life cycle of one generation. The farmers hold separate broodstock; that is, fish held for meat production will not reproduce.

The life cycle starts with the fertilization of eggs. The eggs are collected from broodstock. Already at a very early stage, eggs that are going to be the next generation of broodstock are selected. The breeding takes place at plants separated from the on-growing fish. Special measures are taken to ensure the health condition of the broodstock, which means that more cost is incurred. Although a surplus may be sold as food at an early stage, the purpose of the production is to produce eggs, and broodstock is not measured at fair value. Late in the production process the sexually mature fish are not suitable for consumption. The broodstock is an input or raw materiel in the egg production. Surplus eggs are not fertilized and may be sold as caviar.

The eggs are hatched, and the juveniles also named fingerlings are fed in onshore freshwater tubs until the smolt stage. For simplicity all fish is named smolt until it is released into seawater. At this stage the industry considers cost to be a reasonable approximation for fair value, IAS 41.24.

Salmon farming is industrialised food production with significant fixed cost, and the decision to release smolt into sea cages has historically been made independent of expected prices, i.e. sufficient smolt have been released to ensure that the seawater capacity is fully utilised. Hence, to release smolt comes with the business model. The stock market expects each producer to fully utilize the production capacity. Release neither affects expected cash flows nor risk.

Salmon has a production cycle of 30-36 months of which about 16-20 months in seawater, see timeline above. Harvesting takes place during a relatively narrow window of time at prevailing market price.[vi] Harvesting may occasionally be pushed forward due to health issues, lack of harvestable fish or capacity constraints. Similarly harvesting may be delayed to utilise spare capacity, but mostly the fish is harvested at a pre-determined size. An opportunistic change to harvesting plan based on observed prices rarely occurs in particular with the large industrialised producers.

The pace of growth will depend on farming conditions outside the farmer's control, and hence the estimated time of harvesting is updated based on the observed weight and expectations about future farming conditions. Hence, weight observed is the important state variable whereas time lapsed since release is less informative because this figure alone neither carry precise information about weight nor time to harvesting.

A 70 g smolt is clearly raw material and while a 4 kg fish usually is input to the production of a 5 kg fish, 4 kg fish are occasionally harvested either because the fish in a cage are not of equal size or because the harvesting is pushed forward. A 5 kg harvestable fish is close to a commodity.

The long production cycle and the different characteristics of a 70 g smolt and a 5 kg mature fish makes the relation between price changes and the fair value of inventory obscure. Firstly, they will be harvested at different time at different prices and secondly the CAC reduces the price sensitivity of small fish while the CAC has little or no effect on mature fish. Hence the price sensitivity depends on the size distribution, which is not constant throughout the year.

For salmon the accretion element is less important than in forestry, which may grow with little human involvement. Salmon farming is industrialised production of food with a great human involvement and significant amounts of cost are incurred during the production process, in particular wages and feed. However, as the industry at least during some periods has been more profitable than other agricultural business, the effect of moving the income recognition from when the fish is sold to when it is produced has been noticeable.

The natural life cycle is that smolt returns to seawater from the rivers in May. Industrialised fish farming may also release smolt during the fall, but still the industry has some seasonal variations relating to when the fish is released into seawater and seasonal variations in farming conditions, the fish sensitivity to light and demand. This will affect prices, stock level and size distribution.

The typical listed company has many licences and many locations. Normally one generation / production cycle is completed at one location before the location is temporarily fallowed; that is, there is only one generation at each location.

2.2 Biological transformation and cost structure

Biological transformation is weight increase. The growth of the salmon in seawater is exponential. Let M_t^τ be the predicted weight at t as of τ

$$M_t = M_\tau \times e^{\gamma(t-\tau)} + \varepsilon$$

If expected daily growth rate=γ=0.6%, M_T = weight at harvesting = 5 kg and M_0 = weight at release = 0.2 kg, we have that implied time in seawater T=537 days or approximately 18 months. t is the number of days since release. The remaining time in seawater is T-t. ε is a generic random term.

The actual growth rate will depend on temperature, light and other conditions given by Nature. The growth rate is also different between sites and populations; there will be high performers and low performers. In addition, the growth rate tends to slow down as the weight increases. Hence, γ is not a function of t, but still a model with constant growth may be an acceptable approximation.

It should be noted that at any valuation date t we observe the weight of the fish, which may deviate from previous expectations. If we maintain our estimate for γ, we will have to update T, but we may also choose to update γ based on experiences.

While forest may grow with little or no human involvement, the fish has to be fed in order to achieve growth / biological transformation. Feed prices, feed conversion rate, health expenses, including mortality and labour are important cost drivers. There will not be a constant relation between cost incurred and weight gain. Small fish will have the highest growth rate γ, but the weight gain is relatively low. On the other hand, expenses are relatively high compared to the low biomass, even if the small fish has a favourable feed conversion factor compared to large fish. Generally, the cost of a unit of weigh increase is high the first 2-3 months after release. Cost per unit of weight increase may go up again late in the production cycle, because mortality on large fish is very costly and because the feed conversion factor is decreasing. There are large variations in cost incurred per kg (historic cost) between sites, populations and producers.

Most of the large salmon farmers are vertically integrated; that is, they produce their own smolt.[vii] In 2016, smolt cost constituted less than 10% of production cost for harvested salmon

SALMON FARMING AVERAGE COST STRUCTURE

	Salmon	Smolt
Smolt (eggs in smolt column)	9.4 %	17.5 %
Feed	43.0 %	18.1 %
Salary	6.7 %	20.2 %
Depreciation	5.3 %	8.7 %
Other operating expenses	25.7 %	35.5 %
Harvesting including freight	9.6 %	
Total production cost	100.0 %	100.0 %

Table 2: Cost Structure 2016, Source: Fiskeridirektoratet

These factors are important as valuation models assuming constant growth and constant cost per unit of weight increase may produce certain model artefacts. Hence, a complex model may be required to evaluate whether a simpler model may be sufficient.

Models that consider differences in growth factors and cost per unit of weight increase during the production cycle may, on the other hand, become unduly complex without gaining much predictive capacity.[viii]

A cage may be harvested at a certain day, but harvesting may also be extended over weeks and even months. This may be due to regulatory reasons, for example that the maximum allowed biomass at the site is reached or because there are large size differences in the population or because of delivery commitments. For modelling purposes harvesting is assumed to take place at an estimated date (point estimate) when the average weight reaches a certain threshold based on the estimated growth factor.[ix] This date may however be updated. The purpose of the model to be developed is to illustrate the valuation problems identified and to suggest a solution where the focus is on theoretical rather than practical problems.

2.3 *Time of harvesting*

The main state variable is weight. Weight at a certain point of observation may depart from the expected value due to random farming conditions. The observed weight, the planned size at harvesting and the future rate of growth will determine the point of time of harvesting and hence point of time for the price estimate. It will also determine the length of the production cycle. The future rate of growth is uncertain because it is influenced by nature and is not constant over the production cycle.

2.4 Salmon prices

The salmon prices have been highly volatile. It is the expected market's price at the time of harvesting that is relevant for accounting purposes. This price cannot be observed, but a financial forward market exists. There may however be liquidity / volume issues and there may also be systematic differences between markets with physical delivery and derivative markets with cash settlement.

Hence, future prices must be estimated will be subject to measurement error. It should be noted that future price fluctuations are not the issue, as these are business risks reflected in future accounting periods. When the future price is estimated, actual spot prices, observed prices on recent bilateral contracts for future delivery and external analyst reports may be supplementary sources of information about future prices. IFRS 13 puts more emphasis on external evidence, IFRS 13.67. The quality of the price estimates is outside the scope of this article, but clearly an estimation uncertainty exists.

As opposed to share prices, FX or interest rates, there is no reason to believe that salmon prices are unpredictable or random walk. The current price is not necessarily the best estimate for future price. Salmon is a perishable product and frozen salmon is not considered to be a very close substitute for fresh salmon. The production time is long, and shortage of supply may drive the prices for fresh salmon up. An expected future shortage in supply of fresh salmon or current over production cannot be solved by freezing today. The number and size distribution of all fish in the sea is known with some noise and hence future production and supply is also predictable and more or less fixed in the short run. The demand and in particular demand shocks are less predictable, but population growth and long-term trends in the consumption of seafood are also predictable. The derivative market does not have sufficient depth to allow the large producers to arbitrage against it. If larger producers like Mowi finds the futures price for March contracts attractive, they will find it difficult to short sell a significant part of their expected uncommitted harvest for March. Similarly, large producers and buyers may be willing to enter into bilateral contracts requiring physical delivery at prices that deviate from the futures market. This also means that the derivative market is not the only relevant source of information about future prices.

The observable price is per kg of slaughtered fish in a central warehouse. Both historical prices from Statistics Norway and futures prices are on this basis. In order to find a price applicable for live fish, it should be adjusted for transport from the farming location to the slaughter, cost and weight loss related to the slaughtering process and further transport to the central warehouse, so called back to farm adjustments. The correction is done on the format

$$P_m = (1 - \beta) \times P_\phi - \alpha$$

Where P_ϕ is the price observable per kg, where β is weight loss and α is slaughter and transport expenses per kg live fish. α and β are assumed to be certain without any loss of generalization. $P_{m,T}$ is the expected back to farm adjusted price for period T, i.e. at the point of harvesting. Thus we have to take the weight loss into consideration when we chose the observable. We have to observe the price on a 4 kg carcass if we want to estimate the fair value of a 5 kg fish.

In the models discussed P_m is applied, i.e. the back to farm adjustment is done outside the model. This also allows us to apply live weights, i.e. before slaughtering loss.

2.5 Biomass

Even if the individual fish is the unit of account, a cage is the lowest unit where an appraisal could practically be conducted. Most producers have only one generation of fish at each site or location and in such situation the site, rather than the cage, may be the unit of appraisal.

The number of fish released is based on counting. Subsequently weight increase may be estimate based on feed consumption or test weighting of a sample while mortality may be based on observation and experience. Scanning equipment located in the cage and counts will also give management information about weight and number.

The biomass at a certain point of time is estimated based on estimated number and average weight at that time. On cage level some uncertainty about volume, size distribution and quality will exist, in particular there might be an IBNR problem,[x] i.e. the fish could be sick or even escaped, but the problem is still not recognised. Well-managed companies experience little error with respect to the size of the biomass on aggregate level. Total biomass is disclosed, but not size distribution.

2.6 Mortality

If a cage contains Q_t=100 000 fish weighting 1 kg at the point of measurement, t, which is planned to be harvested at 5 kg and which is assumed to survive with the probability $p_t = e^{-\mu(T-t)}$, where μ is daily mortality and T-t is the remaining production period in days, the expected harvest is $B_T = Q_t \times p_t \times M_t e^{\gamma(T-t)} + \epsilon$. That is, we have an exponentially distributed probability of survival, and hence the probability of surviving from one day to the next is independent of age.

In a simple DCF based valuation, mortality does not raise any particular problems. Proceeds from sales stems from the harvesting of the final survivors and every day farming expenses, including feed expenses, are incurred for the population still alive. This means that we both need to estimate the total mortality and also the timing since the fish is fed until it perishes. In principle mortality already incurred (observed) is irrelevant because it does not affect on future cash flows. In practice the experience with a population will influence on our beliefs.

In a parsimonious model it is useful to assume exponentially distributed probability of survival. In practice the mortality is high shortly after release into sea-water. Further, if mortality is caused by illness or bad farming conditions autocorrelation is likely to exist.

While the mortality is high early in the process as the small fish is vulnerable, the financial impact is limited as the investment in each fish is still fairly small. Later in the process the mortality is lower, but the financial impact higher as more of the cost is sunk. Large deviations from an exponentially distributed probability of survival, may force us into a more complex model.

2.7 Cost to completion

We have defines the observed price as the price of a slaughtered fish delivered in a warehouse. The back to farm adjustment comprises all cost incurred from the sea cage to the warehouse and such cost is accordingly not a part of cost to completion. Incremental cost of selling, IAS 41.5, should be included in the back to farm adjustment.

Cost to completion is all farming cost incurred to bring the fish from its present weight to the planned weight at harvesting. Cost to completion comprises all future cost including overhead, except cost that is already included in the back to farm adjustment. Because some of the fish will perish, the amount to be grown will have to exceed the amount to be harvested. Following the example above, the harvestable biomass B_T is expected to increase by $(5\ \mathrm{kg} - 1\ \mathrm{kg}) \times Q_t \times p_t$. The gross biomass production is, however, higher because the weight increase on the perished fish must be included as well.

If the weight of smolt is 0.2 kg the weight at harvesting is 5 kg, cost of feed is 30 per kg weight increase and we start with 2 fish of which 1 dies at 2.6 kg, we will incur feed expenses of (5.0+2.6-2x0.2)x30 / (5.0-0.2) = 45 per kg increase in harvestable biomass. Hence, cost to completion is the total cost incurred to obtain the expected harvestable biomass. It is not sufficient to know the total mortality. We have to know the distribution as we have to feed the fish until it perish.

Cost to completion is subject to uncertainty about future feed prices, feed conversion factor, mortality, pace of growth, operating expenses, (impact of nature) etc.

Unfortunately the distribution of cost to completion is unlikely to be symmetrical. Mortality (diseases) and unfavourable conditions are likely to cause a fat tail. The cost cannot be very much lower than expected, but it can be very much higher. Further, cost to completion is unlikely to be fully independent of future prices. Unfavourable conditions are likely to reduce the industry output and hence influence prices. This effect is not observable on cage or farm level, but if the conditions are unfavourable on the entire Norwegian or Chilean coast, the effect is likely to be material although no data exists.

Fish farmers are likely to apply ‘most likely’ rather than ‘mathematical expectations’ (mode rather than mean) for production cost in their production planning systems. Planned cost is likely to be lower than expected cost. If the production planning system were based on the expected value, more than 50% of the populations would over-perform because some will under-perform very much (fat tail problem).

Hence, prospective information from the production planning systems is likely to be biased for valuation purposes.

There are differences in the quality of the locations. A good location will have lower cost and possibly faster growth. The number of fish, their condition, cost to completion, pace of growth and hence time of harvesting, are location specific. This means that the model ideally should be applied in full for each location.

Typically data are derived from a production planning system that is integrated with the accounting system. If prospective information in the production planning systems is based on targets or most likely scenarios as opposed to expected values, adjustments may be necessary.

2.8 Marketable product

As there are few transactions in immature salmon, fair value, the hypothetical price that a willing buyer and willing seller may agree upon, has to be assessed through a level 3 valuation, IFRS 13.72. The valuation is a level 3 valuation because several key value drivers, in particular cost to completion, are not observable. Such valuation should be based on the assumption that the fish is harvested at an optimal size, i.e. include the real option to harvest at the optimal time.

In the absence of observable transaction prices for similar assets, the fair value of a biological asset is, according to IFRS, assumed to be the discounted value of future proceeds from sales less the discounted value of future cost incurred to complete the production process and bring the product to the market / to a marketable condition (cost to sell). Transaction cost should not be deducted.

When a cage of fish is harvested at an average weight of 5 kg, all individuals will not be average. It will be a size distribution and a quality distribution. Hence, fair value should reflect the estimated distributions. Some fish will be undersized and other will have reduced quality.

The price that is observed when an undersized individual of 3 kg is sold, is taken into consideration when the average price is estimated, but when the fair value of a population of fish with an average weight of 3 kg is assessed, this population is assumed to be grown to an average of 5 kg. Hence, the price of a dead (slaughtered) 3 kg fish is below the value of an average living 3 kg fish because the value of the option to continue the on growing process is not included. Including the option value follows by the highest and best use (IFRS 13.31) and most favourable market assumptions (IFRS 13.24). The option value partly results from profits on further weight increase and partly from an increase in market price per kg.

2.9 Historic cost as proxy for fair value

Fair value may be assessed through different valuation techniques of which the cost approach is particularly mentioned.[xi] If we compare to forest / standing timber, the level of human involvement is very high in salmon farming. Under the cost approach, cost may be a proxy for fair value, in particular if little biological transformation has taken place.[xii] The industry is reporting historic cost in addition to fair value and is also using historic cost figures to estimate fair value. It is important to distinguish between (1) the historic cost principle and (2) historic cost as input to a valuation model and (3) historic cost as a proxy for fair value.

If a producer of solar cells is scrapping 10 % of the output, the cost of the scrapped units, less any scrap (salvage) value, is a part of the historic cost of the approved units.

Mortality is the fish-farming equivalent of scrapping and it is a normal production expense. A perished fish is obviously worthless, but if there is a normalised mortality of 10 %, the associated cost is a part of the total cost of raising the survivors. If historic cost is to serve as a proxy for fair value of the surviving stock, all production cost must be capitalized. The value of the survivors increases due to the fact that they survived. This does not mean that some individuals are predetermined to die or that high mortality today means lesser mortality tomorrow (most likely the opposite), but under normal market conditions a producer with normal mortality rates will still make a profit. This means that the best estimate for fair value of 100 000 fish with a average weight of 3 kg under normal circumstances will include production cost relating to raising the fish that has died. Normal mortality is taken into consideration when the number of smolt to be released is determined, i.e. in order to produce 100 000, perhaps 120 000 are released.

If a relation between production cost and fair value is assumed, such production cost should include historic mortality. Hence, if the industry capitalises the cost incurred on dead fish on the survivors, or rather all cost incurred are allocated to live fish, within the limits or normal mortality, it could be argued that the resulting capitalised value is a better proxy for fair value than if mortality were expensed. When salmon i survives period t fair value increases because it cannot possibly die in period t and the chances that it eventually will be harvested has increased. The reallocation of historic cost of those that perished is our best estimate of the fair value increase for the survivors[xiii].

2.10 Unit of account / Unit of valuation

Technically the individual fish or the tree in the forest is the unit of account (IAS 41.5), but when 100 000 smolt are put into sea, no attempt is made to predict which individual will perish or be slaughtered at a weight of 3 or 7 kg. IAS 41.15 allows the grouping of assets for valuation purposes. At the balance sheet date the valuation is based on an estimate of the actual number of fish and the actual average weight. For a cage or location with fish, information about average size, size distribution, health conditions etc. are available. When references are made to valuation of one fish or one kg of fish, I refer to an average. Still, the individual fish is the unit of account, even if the valuation takes place on group level.[xiv]

The unit of account issue may appear unimportant, but has given rise to a controversy in Norway; It may be argued that if each fish is a unit of account, it should be expensed if it perish and hence historic cost of the survivors cannot include cost of mortality. This interpretation may be formally right, but if so, the solution is different from the solar cell example, as each solar cell becomes a unit of account only when approved. It is also different from for example life insurance. The life insurance company has an obligation based on expected mortality. They pay out more than the provision for those who died, but reduce the provision for those who survived.

From a fair value measurement perspective the treatment of mortality under historic cost measurement does not matter when a DCF model is applied, but it will have an impact if historic cost is used as proxy for fair value. More importantly, the treatment of mortality will affect the classification in the profit and loss statement if gross margin is reported on transaction based historic cost and change in fair value (gain/loss) is reported separately. In a reporting regime where change in the fair value adjustment is reported as a separate caption in the profit and loss statement, the size of the fair value adjustment will be the change in the difference between fair value and historic cost in the balance sheet.

IAS 2.12 establishes a full cost principle. Under full cost mortality may be considered as an allocation issue. Under normal conditions or to the extent the inventory passes a lower of cost or market test, nothing should be expensed. Instead of expensing the cost of perished fish, we (re)allocate the cost to the survivors. The fish farming industry has never asserted that their historic cost figures comply with IAS 2 and the historic cost figures should be considered as auxiliary reporting.

It is a reasonable assumption that auxiliary information is offered because account users demand it. Hence, comparability across the producers should be equally important for such information.

3 Valuation practice within the Industry

3.1 Accounting practice

Norwegian companies have traditionally presented expenses by nature in the profit and loss statement. Hence, 'cost of goods sold' is really feed expenses adjusted for changes in volume of work in progress measured at full cost. The change in work in progress is not always shown separately – perhaps for materiality reasons.

The change in fair value adjustment, i.e. the change in the difference between the inventory measured at fair value and historic cost is reported separately in the profit and loss statement. Practically, the fair value adjustment is a closing the book adjustment; that is, the farmer does not keep track of fair value movements on a daily basis. Fair value of the inventory as of closing is estimated and an adjustment is recognised. At the same time the opening balance adjustment is reversed.

The net amount charged to profit and loss will comprise the difference between fair value and historic cost on the biomass produced, the release of the fair value adjustment on the biomass harvested and a remeasurement of inventory still at hand, but historically this spilt has not been disclosed by all producers.

The industry applies IAS 16 for PPE and none of the listed companies apply the revaluation option. Historically PPE has been less significant, but more recently some of the industry participants have invested heavily in equipment where the fish may be protected from the environment, i.e. where the fish is kept in closed cages. Linear depreciations are applied, which implies unconditional accounting conservatism if the cash flow is stable or increasing.

Investments in licences are considered as assets with indefinite useful life and accordingly not depreciated. Book value ranges from nil for licences granted by the government without consideration to close to fair value for licences recently acquired.

The producers commonly enter into long-term contracts for physical delivery of fish. Although such contracts are not considered to be financial and accordingly not marked to market, they are considered to be onerous if the agreed price is below the price assumptions applied in the fair value estimates of the inventory in accordance with IAS 41 and IFRS 13. This asymmetrical treatment implies a conditional accounting conservatism.

Cost has historically been considered as a good proxy for fair value of the inventory during the fresh-water phase of the production cycle because growth (biological transformation) is fairly slow and because supply and demand have been in balance. The starting point for fair value measurement has been the release of the smolt into sea cages, but this may change in the future as the onshore phase is being extended.

In the following I will describe two models applied by the Norwegian salmon industry. From 2006 to 2016 the FV model described as the 2006 model below was used by the industry. From 2017 the industry has taken different types of interpolation models into use, one of them described as the 2017 model.[xv] Both models recognise that a contributory asset charge for the licence is necessary, but appraise the inventory directly and use two different approaches to defer the income recognition.

3.2 The 2006 model

From 2006 to 2016 the Norwegian salmon farmers applied a model that could be described as a hybrid model.[xvi]

- For fish below a Lower Threshold (LT) of 1 kg, full cost absorption was assumed to be a reasonable proxy for fair value due to low level of biological transformation.

- For fish between the LT of 1 kg and a Higher Threshold (HT) of 4 kg, full cost absorption plus a linear allocation of farming profit, EBIT, was applied.

- For fish above the HT of 4 kg (mature or harvestable fish), the observed harvesting price for fish of similar weight was applied.

The term 'hybrid model' is used because proceeds from future sales and cost to completion are key value drivers as in a Discounted Cash Flow ('DCF') model, and the output from the model does approach the output from a DCF model as the weight of the fish approaches harvestable size. The model is still a hybrid because in a true DCF model, historic cost would not be relevant and hence full cost cannot be the starting point.

The starting point for the calculation of EBIT or farming profit was the proceeds from harvesting of a 4 kg fish based on the back to farm adjusted price. Farming cost based on a full cost principle and including the cost of smolt was deducted to arrive at farming profit. The farming profit was allocated linearly in weight increase between LT and HT. During the production process both expected proceeds from harvesting and farming cost were updated. As a result farming cost was partly backward looking; that is, realised cost and partly forward looking; that is, estimated cost to completion.

I will first describe the model as it was applied in a simple example without mortality. Later I will extend the example in order to make comparisons with other models.

Let P_T^τ denote the estimated price of a 4 kg fish at time T estimated at time τ. Let C_j^τ be the production cost in period j, 0<j≤T measured at time τ. Thus, if τ ≥ j, C_j^τ is observed. Otherwise, C_j^τ is an expected value.

Let $CI_t^\tau = S_0 + \sum_{j=1}^{t} C_j^\tau$, where CI_t^τ denotes cost incurred until end of period t estimated at time τ and S_0 is the smolt cost. CI_T^τ is the total expected production cost as of time τ.

$$CI_T^\tau - CI_t^\tau = CC_t^\tau$$

CC_t^τ is expected Cost to Completion at t assessed at τ. $CC_t^\tau = \sum_{t+1}^{T} C_j^\tau$

Finally, M_t is weight per fish at time t. Then, estimated Fair Value W_t^τ at time t assessed at τ is,

$$W_t^\tau = \begin{cases} CI_t^\tau;\ if\ \ M_t^\tau \leq LT \\ CI_t^\tau + (P_T^\tau - CI_T^\tau) \times \dfrac{(M_t^\tau - LT)}{(HT - LT)},\ if\ LT < M_t^\tau \leq HT \\ P_t^\tau;\ if\ \ HT < M_t^\tau \end{cases}$$

This means that the value of the option to continue the on growing process beyond HT is disregarded for all weight categories.

The model may be illustrated by a simple numerical example: At time 0, the following data are assessed (superscripts omitted), T =17, P_T =200, $CI_{17} - S_0$=114 and S_0=20. The weight per smolt is 200 g and the cost per kg weight increase is 114/(4.0-0.2)=30. These yields expected farming profit of 200-114-20=66 at T = 17.

The relevant numbers are summarized in the following table:

2006 MODEL – ACCRUAL OF FARMING PROFIT

Time from release – t^*	0.0	9.0	12.9	15.1	16.8	18.0
Weight M_t	0.2	1.0	2.0	3.0	4.0	5.0
Cost CI_t	20.0	44.0	74.0	104.0	134.0	164.0
Farming profit recognized	0.0	0.0	22.0	44.0	66.0^{**}	86.0
Fair value estimate W_t	20.0	44.0	96.0	148.0	200.0	250.0
W_t / M_t	100.0	44.0	48.0	49.3	50.0	50.0

Table 3: *Weight is the observable and time in this table are rounded figures; that is, 4 kg is reached at approximately 16.8 months after release. There is not a fixed relation between time and weight, but this is disregarded for the case of simplicity. **Farming profit is estimated at 4.0 kg (HT).

The 2006 model has two major features, the linear profit accrual and the lower and upper thresholds. The assumption that cost is a good proxy for fair value of fish below 1 kg seems arbitrary. I will later present an amended version of the model where the thresholds are removed, and the farming profit accrued linearly over the full production cycle.

A valuation model must also handle changes in expectations over time and difference between expected and realized values. It is reasonable to impose the restriction that estimated fair value of the fish should not vary too much across populations. It follows that it may be necessary to adjust for excess incurred production cost due to natural causes (biological events) or inefficiency.

We have assumed (or will assume) that at the time the fish is released into sea cages, the fair value of the fish should equal the cost of smolt (chapter 2.1). We have also assumed (or will assume) that at the time of harvesting, fair value of the fish equals the expected sales price. Thus, a change in the expected sales price should have a larger effect on the value of larger fish, and the fair value of the inventory should be increasingly volatile as harvesting weight is approached. The 2006 model does have these attributes, i.e. a linear allocation of EBIT does at least partly resemble a CAC in a DCF model.

We may look at the effect of an unexpected price increase; $\Delta P_T^\tau = P_T^\tau - P_T^{\tau-1} = 20$ shortly after the fish is released into seawater; τ = 1.

$$\frac{\Delta W_t}{M_t} = \frac{(M_t - LT)(\Delta P_T^\tau)}{(HT - LT)\, M_t}$$

2006 MODEL - EFFECT OF PRICE CHANCE

Time from release *	0.0	9.0	12.9	15.1	16.8	18.0
Weight	0.2	1.0	2.0	3.0	4.0	5.0
Cost	20.0	44.0	74.0	104.0	134.0	164.0
Farming profit	0.0	0.0	28.7	57.3	86.0**	111.0
Fair value estimate	20.0	44.0	102.7	161.4	220.0	275.0
W_t/ M_t	100.0	44.0	51.3	53.8	55.0	55.0
$\Delta W_t/M_t$	0	0	3.3	4.5	5.0	5.0

Table 4: *Time in this table are rounded figures; that is, 4 kg is reached at approximately 16.8 months. ** The price increase is 5 per kg. **Farming profit is estimated at 4.0 kg (HT).

We observe that fair value per kg of inventory on hand increases less than the price increase. For a 2.0 kg fish the effect is 3.3. For a 1 kg fish the effect is nil due to LT. When different models are compared, we should not only compare the estimated fair value per kg for different input parameters, but also how an unexpected change in parameters affects the model output.

3.3 The 2017 model

Market based valuation methods are commonly based on rather simple heuristics.[xvii] An underlying theoretical basis will often exist, but in practical use, strict assumptions are commonly forgotten or ignored for example when earnings multiples are used to appraise enterprises. The fair value of harvestable salmon is observable[xviii]. When smolt are released, fair value is observed as well. Large companies will regularly source some of the smolt externally. In any case the barriers to entry have been much lower for production of smolt and data from large market participants show relatively small differences between production cost and external sourcing. Statistics for smolt expenses within the industry is publicly available from Fiskeridirektoratet, but has a time lag. For a large market participant own average production cost is likely to be a good proxy for fair value of smolt[xix].

When the starting and ending point of a price curve is known, although with uncertainty, interpolation may be an attractive alternative for in between appraisals.

We apply the same notation as for the 2006 model. In the 2017 model we do however assume that harvesting takes place at 5 kg, and hence P_T is based on a 5 kg fish. P_T^τ is the expected price of the fish at T estimated at time τ. In this example T is fixed and estimated at τ=0. T is assumed to be 18 months.

CI_T^0 is the estimated cost of growing the fish from smolt to harvestable size. In the 2017 model it is for simplicity assumed that CI_T -S_0 is paid in full at T. S_0 is the cost of smolt paid at t=0. It is important that there is consistency between smolt weight, harvesting weight and production cost CI. As before we use superscript to indicate time of estimation if necessary.

The first step is to determine an internal rate of return -r^0 – using continuous time. No day 1 gain should be recognised when smolt are released.

(1) $$S_0 = (P_T^0 - CI_T^0 - S_0)e^{-r^0 T}$$

Solving this for r^0 we have

(2) $$r^0 = \frac{\mathrm{Log}\left(\frac{P_T^0 - CI_T^0 - S_0}{S_0}\right)}{T}$$

P_T^0 and S_0 are market observations while $CI_T^0 - S_0$ and T are derived from internal production data/plans and should be site and population specific. We do not update S_0 which is expected to be fairly stable.

When fair value of a 2 kg fish at time t is to be assessed at time 0, the estimated fair value is[xx]

(3) $$W_t^0 = (P_T^0 - \frac{(CI_T^0 - S_0)\times(5-2)}{4.8})e^{-r^0(T-t)}$$

The model is illustrated using the same parameters as before.

Example: 1

If $P_T^0 = 250$, $CI_T^0 - S_0 = 144$, $T = 18$, $S_0 = 20$, Weight at harvesting 5 kg and weight of smolt 200 g, we have $r^0 = 0.0927$ (2)

For a fish of 2.0 kg the remaining time to harvesting, T-t, will be 5 months.

$$W_{13}^0 = \frac{250 - \frac{144x(5-2.0)}{4.8}}{e^{5x0.0927}} = 101.52$$ or 49.65 per kg.

2017 MODEL – INTERPOLATION

Time	0.0	9.0	13.0	15.0	17.0	18.0
Weight*	0.2	1.0	2.0	2.9	4.2	5.0
W_t	20.0	56.47	101.52	142.17	205.49	50.0
W_t/M_t	100.0	56.47	49.65	48.62	49.15	50.0

Table 5: * The figures are rounded, with a starting weight of 200 g and a harvesting weight of 5.0 kg 18 month later. The weight after 13 months is not exactly 2.0 kg

If one, P is received and CI is paid at the time of harvesting and, two, there is no economic rent, r will be equal to the cost of capital, i.e. the model is equivalent with a discounted cash flow model where the internal rate of return equals the cost of capital. One is obviously wrong and indeed the model is somewhat inconsistent as CI is assumed to occur at T in (1) and linearly in (3), but may be rectified through a minor adjustment to the formula or accepted for the case of parsimony. Two is also wrong for the time being and in any case the model should allow economic rent to exist. Hence, we should test whether the interpolation results in a valuation and corresponding profit recognition that is sufficiently close to a more complicated discounted cash flow model.

When fair value of a 2 kg fish is to be assessed at time $t = \tau$, the model reassesses the internal rate of return, r^{τ} - based on new estimates for P_T^{τ} and CI_T^{τ}.

The reestimated fair value of a 2 kg fish is

(3) $$W_t^\tau = (P_T^\tau - \frac{(CI_T^\tau - S_0)\times(5-2)}{4.8})e^{-r^\tau(T-t)}$$

The effect of an unexpected price increase depends on the level of abnormal profit as $(W_t^\tau - W_t^{\tau-1}) = (P_T^\tau - P_T^{\tau-1})e^{-r^\tau(T-t)}$. We look at the same price increase as in the former example; that is, $\Delta P_T/Kg = 5.0$

Example: 2

If P_T=250, CI_T-S_0 =144, T=18, S_0=20, Weight at harvesting 5 kg and weight of smolt 200 g, we have $r^0 = 0.0927$ (2)

First we update r for P_T=275

$$r^{13} = \frac{\text{Log}\left(\frac{P_T^{13} - CI_T^{13} - S_0}{S_0}\right)}{T}$$, r^{13}=0.1044

$$W_{13}^{13} = \frac{275 - \frac{144x(5-2.0)}{4.8}}{e^{5x0.1044}} = 110.56$$ or 54.07 per kg.

2017 MODEL – EFFECT OF PRICE INCREASE

Time	0.0	9.0	13.0	15.0	17.0	18.0
Weight*	0.2	1.0	2.0	2.9	4.2	5.0
W_t	20.0	60.6	110.6	155.5	225.6	275.0
W_t/M_t	100.0	60.6	54.1	53.2	54.0	55.0
$\Delta W_t/M_t$	0.0	4.1	4.4	4.6	4.8	5.0

Table 6: * The figures are rounded, with a starting weight of 200 g and a harvesting weight of 5.0 kg 18 month later. The weight after 13 months is not exactly 2.0 kg

3.4 Comparison of the 2006 and 2017 models

Weight is the observable in the 2006 model and in the tables, weight are exact figures while time are rounded figures. In the 2017 model time since release (or remaining time to harvesting) is the observable and weight are rounded figures. In both models weight is a function of a daily growth ratio and the number of days since release. For the sake of parsimony the growth ratio is certain and constant over the production cycle.

Both LT and HT bias the 2006 model downwards. The LT biases downwards because no profit is recognised neither on the capital employed in inventory nor on contributory assets until LT is reached. The HT biases downwards because the option to grow the fish beyond HT is disregarded.

If we move LT to equal the weight at release (0.2 kg) and HT to equal the weight at harvesting (5.0 kg), effectively removing both, we have

2006 R: $$W_t^{\tau} = \mathrm{CI}_t^{\tau} + (\mathrm{P}_\mathrm{T}^{\tau} - \mathrm{CI}_\mathrm{T}^{\tau}) \times \frac{(\mathrm{M}_t^{\tau} - 0.2)}{4.8}$$

Assuming that cost is linear in weight and write M_t=m, our ex ante expectation is that we have

$$(CI_t^0 - S_0) = (CI_T^0 - S_0) \times \frac{(\mathrm{m} - 0.2)}{4.8}$$

2006 R: $$W_t^0 = S_0 \times \frac{(5-m)}{4.8} + P_T^0 \times \frac{(\mathrm{m}-0.2)}{4.8}$$

This means that the value in the revised 2006 model is a convex linear combination of the sales value and the smolt expense using realised and planned future growth as weights. It also follows that W_t^0 is linear in m. It is also possible to show that,

$\frac{W_t^0}{m} > \frac{P_T^0}{5} = 50$

for 0.2 < m < 5.0.

This lower bound does not hold for the 2017 model.

2017 $$W_t^0 = (\mathrm{P}_T^0 - \frac{(\mathrm{CI}_T^0 - S_0) \times (5-\mathrm{m})}{4.8})\mathrm{e}^{-\mathrm{r}^0(\mathrm{T}-\mathrm{t})}$$

If the profitability is very high, i.e. P_T^0 exceeds CI_T^0 by very much, and accordingly, r is high, we may have that $\frac{W_t^0}{m} < \frac{P_T^0}{5}$ for medium sized and large sized fish[xxi]. Although the effect of discounting diminishes as we approach harvesting the impact of discounting on the decreasing cost to completion does not offset the impact of discounting the proceeds from harvesting.

2017 MODEL - CONVEXITY

Weight	0.2	1.0	2.0	2.9	4.2	5.0
W_t/M_t	100.0	56.47	49.65	48.62	49.15	50.0

Table 7: Extract from Table 5. We observe that the estimated fair value per kg falls below 50 for medium / large sized fish

It is hard to compare the 2006 and 2017 models analytically. In the 2006 model W is a linear function of m, but m is a convex function of t. In the 2017 model W is also a convex function of t. Moreover, the 2017 model has a logical inconsistency. The cost to completion is assumed to be paid at T, and at the same time it is assumed to decrease over time as cost is sunk.

INDUSTRY MODELS – COMPARISON OF FV PER KG

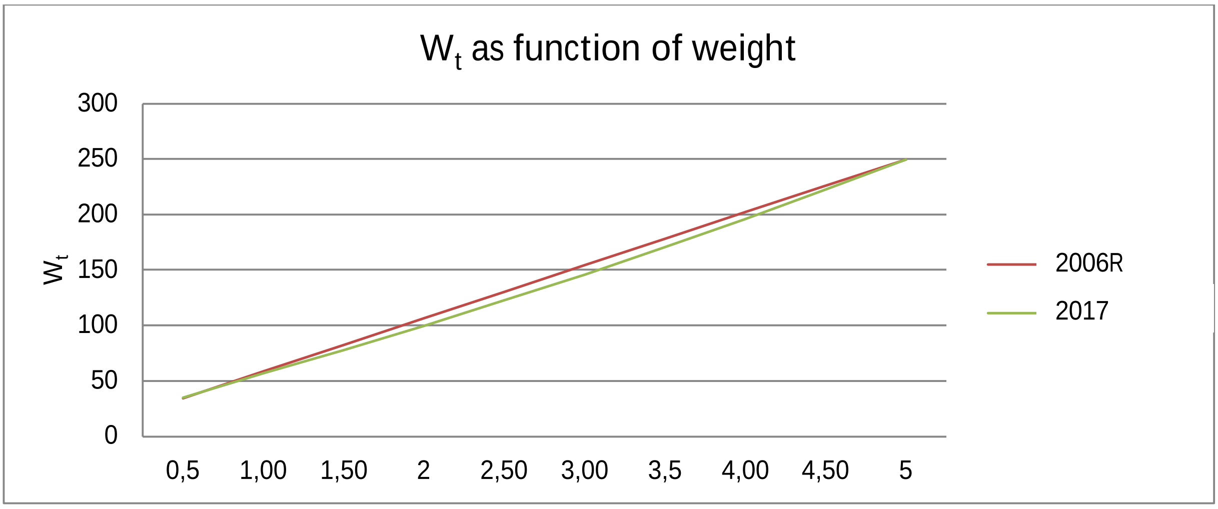

Figure 2: The figure is based on an excel plot of the figures below which are calculated based on the formulas for 2006 revised and for 2017 applying the same assumptions as in Example 1. W_t is close to linear in weight for both for the assumptions applied.

M_t	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
2006 R	34.4	58.3	82.3	106.2	130.2	154.2	178.1	202.1	226.1	250.0
2017	34.9	56.5	77.7	99.5	122.2	145.8	170.4	196.0	222.5	250.0

INDUSTRY MODELS – COMPARISON OF FV DEVELOPMENT

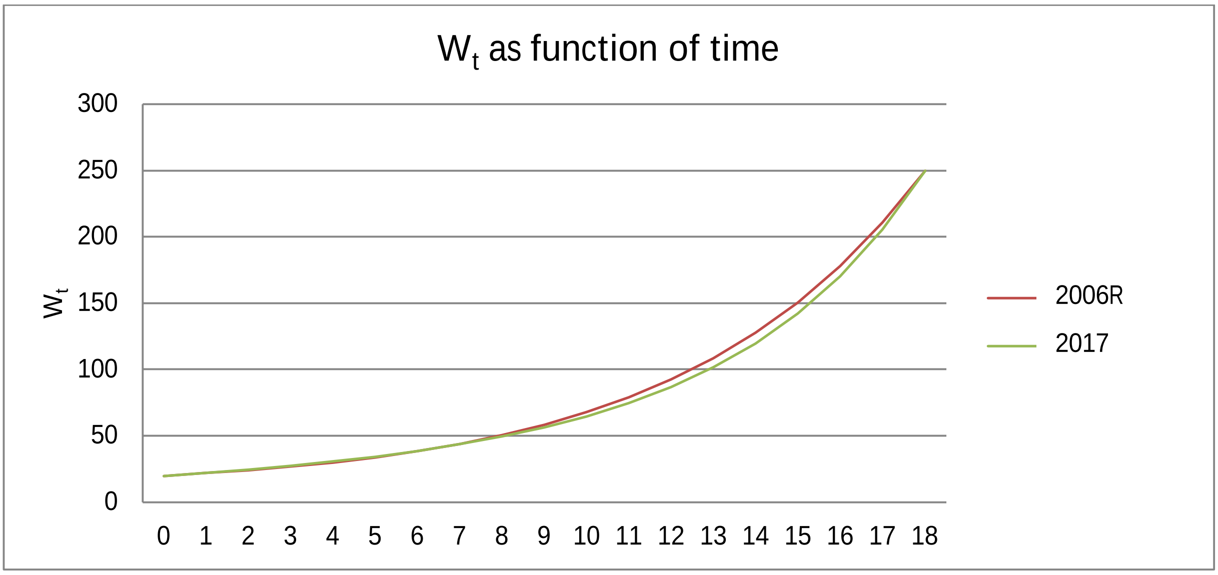

Figure 3: The table is based on an excel plot of the figures below which are calculated based on the formula for 2006 revised and for 2017 applying the same assumptions as in Example 1. Both are convex in time.

Period	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0
2006 R	20.0	24.1	30.0	38.4	50.5	67.7	92.4	127.6	178.0	250.0
2017	20.0	24.7	30.7	38.7	49.5	64.7	86.8	119.7	170.2	250.0

The convexity of the 2006 revised model stems from the daily growth rate; $M_t = M_0 \times e^{\gamma t}$ while the 2017 function is convex because $W_t^0 = (\mathrm{P}_T^0 - \frac{(\mathrm{CI}_T^0 - S_0)\times(5-\mathrm{M}_t)}{4.8})\mathrm{e}^{-\mathrm{r}^0(\mathrm{T}-\mathrm{t})}$. We observe that M_t determines T-t through the daily growth rate.

We further note that the effect of the price revision is larger in the 2017 model compared to the original 2006 model.

INDUSTRY MODELS – COMPARISON EFFECT OF PRICE CHANGES

Time*	0.0	9.0	12.9	15.1	16.8	18.0
Weight M_t	0.2	1.0	2.0	3.0	4.0	5.0
$\Delta W_t/M_t$						
-2006	0.0	0.0	3.3	4.5	5.0	5.0
-2017	0.0	4.1	4.4	4.6	4.8	5.0
-2006 R	0.0	4.2	4.7	4.9	4.9	5.0

Table 8: * The figures are rounded as the weight is not exactly 2.00 kg after 12.9 months. Numerical examples showing the effect of price revisions are provided under ch 3.2 and 3.3.

The large difference between the responses to the price increase at 1.0 kg / 9 months is due to the LT applied in the original 2006 model. A linear allocation over the whole production cycle would result in an increase of 4.2 for 1.0 kg, which is fairly close to and above the corresponding increase for the 2017 model. It should be noted that any bias in value per kilo is much more significant for the larger fish, as fish above 2.0 kg make up a very high portion of the total fair value of inventory. I will present another numerical comparison in chapter 5.

A revised estimate of the production cost CI_T is captured in the same way. Note that CI_T is the sum of realized cost and expected cost to completion. Thus, CI_T will be partially backward looking (incurred cost), and partially forward looking (cost to completion). This is inherently problematic in a valuation model that is supposed to resemble a DCF valuation and, in particular, if cost to completion is independent of realised cost.

3.5 Summary

The differences between the 2006 R and 2017 models are in most cases relatively small, and is not very likely to exceed 10%, though a difference of 5% for fish between 2.0 and 4.0 kg is clearly material from an accounting perspective. A downward bias for large fish is unlikely to be offset by an upward bias for small fish because the large fish constitutes most of the biomass. The difference is driven by profitability as the 2017 function becomes increasingly convex in time as profitability goes up. The level of inventory and also the size distribution is not constant over the year, so even in steady state, model generated volatility will to some extent be dispersed into the profit and loss statement if there are biases.

The 2006 model has a linear approach while the 2017 model has an exponential approach, but the linearity in the 2006 model is based on weight increase, not time. Both the methods described are linking FV increase and thereby income recognition to weight increase. The 2006 method does this explicitly. In the 2017 model the expected cost to completion is related to weight. Relating FV to weight, implies lower increases in FV and hence lower income recognition when the fish is small and growth measured in kilos is low.

Both models are influenced by historic cost. When models are taking sunk cost into consideration, i.e. they are not purely forward looking, the FV estimate will be positively related to extraordinary or unexpected expenses that are sunk. There is no logical relation between a FV increase and extraordinary expenses. Extraordinary expenses have different impact on the FV estimate in the two models. In the 2006 model costs directly influence fair value. On the other hand, increased cost has a negative effect on EBIT, but since EBIT is gradually released, the effect is not neutralised until the fish is harvestable (or reach the 4 kg threshold). In the 2017 model cost to completion is proportional to total expected cost. Increased cost will increase expected cost to completion and hence have a direct, negative effect on FV. On the other hand, r will go down which will have a positive effect on FV. The fact that the models are not purely forward-looking means that both models may require some sort of normalization of incurred cost.

The 2006 model focuses on how much of the expected EBIT that should be charged to profit and loss each period. That may not be a good starting point as IFRS has a balance sheet focus. A further weakness is obviously that the model does not take the time value of money into consideration.

The 1 kg and 4 kg thresholds may give reasonable estimates under some set of assumptions, but are difficult to rationalise.

The alternative 2017 model rectifies the problems related to the 1 and 4 kg thresholds, and it also rectifies the problem with future return on capital employed in inventory although not in the parsimonious model described where all cash flows are attributed to the time of sales.

The models behave differently when an unexpected price change occurs. The estimated fair value of smaller fish is more sensitive to price changes in the 2017 model. The reason is that cost is the dominating input factor until the fish is 1.5-2.0 kg in the 2006 model.

4 The valuation problem / theoretical framework

The fish farming enterprise comprises two assets; the inventory of live fish and the licence that form a CGU and generate a common cash flow. According to IFRS the licence is measured at historic cost (IAS 16) while live biological assets are measured at fair value (IAS 41). In order to assess the fair value of inventory, we have to allocate the cash flow between licence and inventory assuming that both receive market return, irrespectively of the book (historic cost) value of the licence. Hence, we have to assess the fair value of both the inventory and the licence or at least the part of the licence that relates to the current production cycle.

In this chapter I will primarily deal with the valuation problem from a theoretical perspective. Valuation theory is well known from extant textbooks. There are some challenges related to the estimation of input parameters and a more theoretical problem related to a CAC and the allocation issue.

4.1 Inventory - generally about valuation models

Model based valuation should be based on a theory; for example, that investors discount expected future cash flows with a risk adjusted discount rate in order to assess fair value (IFRS 13).

Whenever valuation models are applied to assess fair value, the model assumptions should be calibrated (IFRS 13.64). Valuation models for live salmon suffer from the problem that they cannot be calibrated or back tested based on observed transactions, as the observed value of a 2 kg salmon has limited relevance if normal weight at harvesting is 5 kg. With no calibration opportunities it becomes even more important to ensure the internal validity of the model, i.e. that it produces results that are plausible based on the valuation theory that is applied.

Ideally a valuation model should return unbiased estimates for fair value. An examination of the problem is useful to detect any pitfalls. A valuation model will quite often be particularly sensitive to 2-3 key input factors or value drivers. IFRS 13 requires us to populate our model with expected values or best estimates for input factors. In the absence of observable prices, different valuation experts may not necessarily agree about for example salmon prices 12 months into the future, and they may disagree about both the expected value and the probability distribution. This may also happen even if they have access to exactly the same information. Hence, we are faced with input parameters that are uncertain and that also have an uncertain probability distribution. This is however not unusual, and the uncertainty is unlikely to be higher than for other accounting estimates.

Some of the parameters, for example cost to completion, will be based on information that is entity specific and partly private. We cannot expect a level 3 valuation to be a consensus view of all market participants about future cash flows.

Further the input parameters are unlikely to be statistically independent, but correlations cannot be determined with certainty. Some of the input parameters, for example cost to completion, are likely to have a skewed distribution. We also have to make parsimonious assumptions about for example pace of growth and cost per unit of weight increase.

All these factors contribute to the risk that the valuation model may return biased estimates even if the valuation is based on best estimate input. A valuation based on point estimates, even if such are the expected value of each input parameter, may not give the same result as simulation if the input parameters have skewed distributions and are correlated. There is also a risk that a valuation model exacerbates (or smooth) the underlying uncertainty, i.e. produces a more (or less) volatile output than the underlying market should indicate. A biased model could mean that the model systematically over or undervalues for certain or all size categories and price levels.

As the model cannot be back-tested against market observations, it is not possible to quantify a model fit statistically. Rather a discussion about model fit must be based on valuation theory and how we think a hypothetical buyer or seller may behave. In terms of value most of the inventory consists of large fish, partly because the large fish constitute most of the volume (biomass), but also because the cost is already incurred (sunk). Even if we accept the individual fish as unit of account, we have to consider the absolute impact of potential bias on aggregate inventory value if we have to choose between two models. A model that is unbiased for the larger fish may be preferable to alternatives even if it is very sensitive to input or even proven to be biased for smaller fish.

Both smoothing and model created volatility are non-desirable model properties, but is it possible to make a trade-off between bias and realistic (true) volatility? We could possibly have a situation where a cost-based model returns biased values, but with realistic volatility for small fish while a DCF model returns unbiased values but is too sensitive to uncertain model input.

We have to look upon a model as a tool that is likely to be imperfect. It is unlikely that we should be able to design a model that fulfils all our objectives and that we also are able to prove it.

Obviously, the standard setters have concluded that fair value measurement is worth the effort, although they hardly assessed the practical issues in all industries that may apply IAS 41. Still, we have to apply cost vs benefit considerations both with respect to collection and analysis of information and with respect to model development. It is not obvious that a parsimonious, easy to use model, should be replaced by a complex model, even if the complex model is likely to be less biased. Black & Scholes formula is for example commonly applied for valuation of financial options, also in situations where the underlying assumptions may be violated.[xxii] It is easy to use, and it may not be worth the effort to develop complicated simulation models or binominal trees.

The Norwegian salmon industry has been reluctant to implement a full DCF model because of the uncertainty of the licence value, but probably also because it is demanding to develop and maintain such model and perhaps it requires resources that are not available in-house. Clearly a highly complex model will increase the risk of user mistakes.

Below I will present a formal example of a valuation model based on one production cycle. The purpose is to describe the cash flow allocation problem. I will later show that the fair value of one population does not rely on product prices beyond the production cycle, that is, justify the one production cycle model. Indeed it will be shown that it is better to view the license as a series of rights to farming over time.

4.2 FV Measurement – Formal modelling

4.2.1 Notation (same as in Chapter 3 with some minor modifications)

Variable	Definition
P_T^τ	Price (net of cost to sell) at expected time of harvesting T estimated at time τ
C_t	Cost in period t (Cost of smolt is C_0) I will still use the accounting terminology 'cost' and 'cost to completion', but there is neither any accounts payable nor inventory of feed in the models; that is, cost is paid as incurred.
T	Time of sales / harvesting
V_t	Value of licence to operate for the remaining production cycle starting with smolt at t=0 and ending with harvesting at t=T
W_t	Value of stock of fish at time t
d_t	Charge for use of license (contributory asset charge – CAC) in period t. d could be interpreted as hypothetical fee (also named rent) paid from the fish owner to a third party holder of the licence. From an accounting perspective $d = \{d_1, \ldots, d_T\}$ could also be considered as an allocation scheme
K	Cost of capital
r^t	Internal rate of return remeasured at time t
P_T^τ	Price at time T estimated at time τ
EV_t	Enterprise value: $EV_t = W_t + V_t$

Superscripts are used to indicate time of assessment and are dropped when not needed.

4.2.2 The deterministic model

I will apply a Discounted Cash Flow ('DCF') model to estimate Fair Value. All cash flows refer to end of period. Fair value of the licence refers to the end of the period after cash flows are paid and received. Fair value of the inventory refers to the end of the period after farming costs are paid.

In order to simplify, mortality is implicit (see chapter 2 for explanation). Further $C_t = 0$, for $t \neq 0, T$.

(1A) $V_0 = \frac{P_T - C_T}{(1+k)^T} - C_0$

(1B) $W_0 = C_0$

These relationships are based on the assumptions that fish and licence are separate assets. There exists a market for smolt and hence the value of fish is determined by the market price at time 0 (but not 0 < t < T as no market exists). Any rent is allocated to the licence. For any t, 0<t<T, we can determine $EV_t = W_t + V_t$, but each of W_t and V_t have to be determined based on an ambiguous cash flow allocation.

(2A) $V_T = 0$

(2B) $W_T = P_T$

These relationships are based on the assumption that the licence has no market price at the end of the licence (sub)period.

(1A,B) – (2A,B) imply that value must be transferred from the licence to the fish. This may happen via accounting entries reducing the licence and increasing inventory. The accounting entries will sometimes be interpreted as actual payments of charges from the fish (owner) to the licence (owner). This is an analogy and should never be taken literally.

The periodic payment/allocation scheme may be formulated as follows $\{d_1, \dots, d_T\}$. Initially I place no restrictions on d_t, but I will provide intuition for why a negative d_t is not economically meaningful later. d_t must satisfy, $V_0 = \sum_{t=1}^{T} \frac{d_t}{(1+k)^t}$, the net present value of the payments / allocations must equal the initial value of the licence.

The scheme defines $V_t, W_t \quad t = 1, \dots, T-1$

(3) $V_t = \sum_{\tau=1}^{T-t} \frac{d_{t+\tau}}{(1+k)^\tau}$

(1A,B) and (2A,B) defines W_t, V_t and EV_t for t=0 and T:

(4) $$W_t = \frac{P_T - C_T}{(1+k)^{T-t}} - \sum_{\tau=1}^{T-t} \frac{d_{t+\tau}}{(1+k)^{\tau}}$$

It follows that

(5) $$W_t = W_{t-1}(1+k) + d_t$$

(6) $$V_t = V_{t-1}(1+k) - d_t$$

(7) $$EV_t = V_t + W_t = (V_{t-1} + W_{t-1})(1+k)$$

The allocation problem has no solution without a payment scheme $\{d_t\}$ - a contract. Assume that $\{d_t\}$ exists, thus the value of the licence and the farming is readily determined at any time (as shown above). The simplest allocation method is a linear (annuity) scheme with $d_1 = d_2 = \cdots . = d_T$. Allocation problems of this kind are familiar from historic cost. It is ironic that it is also present in a fair value context. The reason is that fish and licence are considered two separate assets with common cash flows.

Let us propose the following specific scheme

(8) $$d_t = W_{t-1}(r-k), W_0 = C_0$$

Where r is the internal rate of return satisfying

(9) $$\frac{P_T - C_T}{(1+r)^T} - C_0 = 0$$

Let us show that this scheme is feasible. From (8) it is clear that (1B) is satisfied. It must be shown that (1A) holds as well. Using (5) and (8), the present value of (d_1, …, d_T) may be calculated as follows,

(10) $$\widehat{V_0} = \sum_{t=1}^{T} \frac{C_0(1+r)^{t-1}(r-k)}{(1+k)^t}$$

$$= \frac{C_0(r-k)}{(1+r)} \sum_{t=1}^{T} \left(\frac{1+r}{1+k}\right)^t = C_0 \left(\frac{1+r}{1+k}\right)^T - C_0$$

$$= \frac{P_T - C_T}{(1+r)^T} \times \frac{(1+r)^T}{(1+k)^T} - C_0 = \frac{P_T - C_T}{(1+k)^T} - C_0 = V_0$$

It follows that (1A) is also satisfied for this scheme.

The proposed scheme has some convenient properties:

i. ROA=k every period for the farming business (i. e. if d_t is considered an expense)[xxiii]
ii. Growth in assets = r every period
iii. Growth in payment / allocation of charges = r
iv. The licence owner receives the residual (excess) return
v. We do not have to consider the licence / right to start a new production cycle. V_t and W_t, $t \leq T$, are not affected by abnormal return and licence charges beyond the production cycle.

Property ii. is interesting. It shows that the inventory value, W_t is equal to EV_t for all t when there is no economic rent r = k. When there is no economic rent, there is no allocation problem and the fair value of inventory is unambiguous. On the other hand, if r > k, W_t does not depend on the cost of capital k. Some may argue that this is not appropriate as fair values should depend on the cost of capital. However, it is also possible to argue that all economic rent should be allocated to the limiting factor i. e. the licence. In that case inventory should be independent of k.

4.2.3 *Modelling uncertainty*

Assume $\widetilde{P_T}, \widetilde{C_T}$ are random variables. Let P_T^τ, C_T^τ be expected values updated by information received up to time τ. Similar V_t^τ, W_t^τ are updated values. T may also be random, but this issue is ignored here[xxiv]. It follows from 2B that in a parsimonious model with $C_t = 0, \text{for } t \neq 0, T$ we may analyse the effects of changes in P_T leaving C_T unchanged with no loss of generality.

In the deterministic model $d_t^\tau = d_t^{\tau-1}$, d_t does not update based on new information, because there is no new information, per definition. In a stochastic model we have to discuss the effect on d_t of a change in P_T. First, I will explore the alternatives and then relate the alternatives to IFRS.

Using the contracting analogy, the payment might be conditional rather than fixed in advance. Renegotiations are excluded.

The issues considered here are in accounting usually referred to as changes of estimates.

Fixed charges – random return on farming

$\{d_t\}$ is fixed, and hence random price fluctuations result in random return on farming. If payment is fixed, it is easy to see that $V_t^\tau = V_t^0$ for all τ.

(11) $$W_t^t = \frac{P_T^t - C_T^t}{(1+k)^{T-t}} - \sum_{\tau=1}^{T-t} \frac{d_{t+\tau}}{(1+k)^\tau}$$

Where only the first term in W_t^t varies with new information resulting in windfall gains or losses for the farmer.

The effect of a price increase is

$$\Delta W_t = \frac{\Delta P_t}{(1+k)^{T-t}}$$

Save for the effect of discounting the full effect of a price increase is recognised in inventory immediately.

Fixed return on farming (=k) - random charges

The owner of the licence will change the charges such that the farmer always receives a return=k. The adjustment of the charges could either be done with retrospective effect or by changing the charges for the remaining period until harvesting (including the current period); that is, prospective implementation.

Alternative 1: Prospective implementation

(12) $W_\tau^t = W_\tau^{t-1}, \tau < t$

W_τ will never change as a result of subsequent information. In an accounting system W_τ is recognised at τ and subsequent information will not change the recognised amount.

(13) r^t solves $\frac{P_T^t - C_T^t}{(1+r^t)^{T-t+1}} - W_{t-1}^{t-1} = 0$

We "invest" the fair value of beginning inventory before new information and recalculate the internal rate of return.

(14) $W_\tau^t = \frac{P_T - C_T}{(1+r^t)^{T-\tau}}$ $\tau = t, \dots, T$

It follows that $W_t^t = W_t^{t-1} \frac{1+r^t}{1+r^{t-1}}$

Thus, there is an immediate effect of new information on FV of the inventory because d_t is recalculated. We also observe that W_t depends on the information available at t-1 which is not unproblematic and which I will revert to in ch 4.4.

(15) $d_t^t = W_{t-1}^{t-1}(r^t - k),$

This means that d_t is updated based on the information available at t.

Alternative 1 may be referred to as prospective implementation of the change in estimate:

$$W_t^t - W_{t-1}^{t-1} = r^t W_{t-1}^{t-1}$$

Alternative 2: Retrospective implementation

(16) r^t solves $\frac{\mathrm{P_T^t - C_T^t}}{(1+\mathrm{r}^t)^{\mathrm{T}}} - C_0 = 0$

We "invest" the fair value of the inventory at t=0 and recalculate the internal rate of return.

(17) $W_\tau^t = C_0(1 + r^t)^\tau$; $\tau = t, \dots, \mathrm{T}$

The new internal rate of return will affect the charges for subsequent periods, which means that the expected return for owner of the fish will be k for subsequent periods. The adjustment of the charges for previous periods means the fair value of the fish makes a jump as a result of the new information:

(18) $W_t^t - W_t^{t-1} = C_0((1 + r^t)^t - (1 + r^{t-1})^t)$

r^t and r^{t-1} means r updated at t and at t-1 respectively.

(18) implies that there is a catch-up effect in period t. It should be noted that the jump is not a windfall gain for the farmer. When the charge for previous periods is adjusted, it is released to profit and loss. Because of the mixed measurement model (fish at fair value and licence at cost), values are recognized in income when they are moved from licence to fish.

Alternative 2 may be referred to as retrospective implementation of the change in estimate:

$$W_t^t - W_{t-1}^{t-1} = C_0(1 + r^t)^t - C_0(1 + r^{t-1})^{t-1}$$

$$= C_0(1 + r^t)^{t-1}(1 + r^t) - C_0(1 + r^t)^{t-1} + C_0(1 + r^t)^{t-1} - C_0(1 + r^{t-1})^{t-1}$$

$$= C_0(1 + r^t)^{t-1}r^t + C_0((1 + r^t)^{t-1} - (1 + r^{t-1})^{t-1})$$

Here the second term is the catch up effect on the inventory as of t-1.

4.2.4 Implications

First of all, note that the different principles for handling changes in estimates have been described for one particular rule for determining (d_1, …, d_T). The principles may be applied analogously for alternative rules.

In the fixed charge, random returns alternative, the allocation problem is solved. I will later discuss whether the solution is acceptable under IFRS. A fixed charge, random return on farming leads to a highly volatile fair value of inventory as the full impact of a price change, save for the effect of discounting, will hit the inventory immediately.

We may alternatively allocate the effect of changes in future cash flows to the licence. Under Alternative 2 the charges for all periods are adjusted, but since previous accounting entries are fixed, i.e. charges for previous periods are considered paid, there will be a catch-up effect in the current period hitting inventory and profit and loss. Under alternative 1 the effect of a price change is allocated to the licence and the current and future charges are adjusted such that the farmer receives fixed return=k. This means that the catch up effect is not recognized immediately, but is allocated to current and future periods.

4.3 Release of contributory asset charge - A basic numerical example

Compared to the analysis in ch. 4.2 I introduce feed cost every period. We observe that in addition to the release of contributory asset charge, W will also include accumulated feeding expenses and normal return on such. The formal model under ch 4.2 discusses the alternatives

- Fixed charges – Random return on farming
- Return on farming fixed=k

Although the recognition of biological transformation may have been an important argument for the introduction of IAS 41, the standard focuses on FV increase as basis for the recognition of gain. In a case with abnormal return, I will show that gain on biological transformation is return on investment in the licence. We may consider a model with one licence and one population of fish that is harvested at a certain date. The licence is for one production cycle. We should expect net income in period t to be

$(V_{t-1} + W_{t-1})$ x k where V and W denotes the fair value of the Licence and Inventory and k denotes the Weighted Average Cost of Capital, WACC. At t=0 we invest the net present value of abnormal return in the licence and 20 in smolt. We have 4 reporting periods and we feed at the end of each period. The feed expense for 1 kg weight increase is 30. We harvest at 5 kg at the price 50 per kg. The discount factor is $e^{-0.015}$. The growth rate is constant. Linear allocation of licence charges resembles an annuity with return on and off capital similar to a land lease:

LINEAR ALLOCATION OF CHARGE

Period	0	1	2	3	4
Weight	0.20	0.45	1.00	2.24	5.00
Cash flow					
Proceeds from harvesting P_T					250.00
Smolt C_0	-20.00				
Feed C_t		-7.42	-16.58	-37.08	-82.92
Net cash flow (P_t-C_t)	-20.00	-7.42	-16.58	-37.08	167.08
Discount factor	1.00	0.99	0.97	0.96	0.94
Present value	-20.00	-7.31	-16.09	-35.45	157.35
Net value V_0	78.50				
Linear charge - d_t		-20.37	-20.37	-20.37	-20.37
NPV Remaining Cash Flow V_t+W_t	98.50	107.41	125.61	164.59	250.00
$\Delta FV_t= (V_t+W_t)-(V_{t-1}+W_{t-1})$		8.91	18.21	38.98	85.41
C_t		-7.42	-16.58	-37.08	-82.92
Net income (ΔFV_t-C_t)		1.49	1.62	1.90	2.49
Return on assets $(\Delta FV_t-C_t)/(V_{t-1}+W_{t-1})$		0.0151	0.0151	0.0151	0.0151
FV Licence V_t	78.50	59.32	39.84	20.07	
FV Inventory W_t	20.00	48.09	85.77	144.53	250.00

Table 9: The table shows allocation of licence charges based on an annuity. The assumptions applied are not randomly chosen. The are realistic based on an industry average. The observations are not very sensitive to the assumptions made, but the allocation problem is the result of a sizeable residual return.

The linear charge model gives a constant return on assets equal to cost of capital, but a rapid increase in inventory value (income recognition) when the internal rate of return is high.

The model developed under ch 4.2 places the following restrictions on d_t:

$$V_0 = \sum_{t=1}^{T} \frac{d_t}{(1+k)^t} \text{ and } d_t = W_{t-1}(r-k), W_0 = C_0$$

This model is easily generalized to include periodic feed costs where (5) is replaced by,

(9A) $W_t = W_{t-1}(1+k) + W_{t-1}(r-k) + C_t$

Recalculating table 9 with these allocations, we have,

ALLOCATION OF CHARGE BASED ON IRR

Period	0	1	2	3	4
Net cash flow (P_t-C_t)	-20.00	-7.42	-16.58	-37.08	167.08
IRR	35.66%				
FV Inventory W_t	20.00	34.55	63.45	123.16	250.00

Table 10: The table shows recognition gain / fair value increase based on internal rate of return. (20x1.3566+7.42)=34.55

It should be noted that the licence is not depreciated for accounting purposes. Neither will it be impaired. In this one farming cycle model, the fair value of the licence; that is, the abnormal profit for this farming cycle, is transferred from the licence to the inventory. At the same time the enterprise moves closer to the cash flow from future farming cycles. In the financial statements we have

FINANCIAL STATEMENTS IMPACT

Period	0	1	2	3	4
Inventory HC	20.00	27.42	44.00	81.08	164.00
Inventory FV					
Linear Charge	20.00	48.09	85.77	144.53	250.00
FV Gain (income)	0.00	20.67	21.10	21.68	22.55
Inventory FV IRR	20.00	34.55	63.45	123.16	250.00
FV Gain (income)		7.13	12.32	22.63	43.92

Table 11: The table shows the mixed model accounting where inventory is measured at fair value and the licence at historic cost. Above allocation based on annuity and below based on IRR. Income = ∆Inventory FV - ∆Inventory HC

We observe that the recognition of fair value increase is deferred when FV is transferred from the licence to inventory based on IRR compared to a method where the FV is transferred based on an annuity or a land lease. The reason is that more charges are allocated to later periods when the inventory is larger. The expected net present value of all charges at t=0 must add up to the fair value of the licence, and the charge d_t is the abnormal return on the inventory at t-1.

If we look upon the charge from the farmer's (payer's) perspective there are a few allocation patterns that stand out[xxv]. A charge that

1. is constant in time, typically like a land rent (example above)
2. increases in the fair value of the inventory (analysis in 4.2)
3. is based on the expected weight increase

Here 2) and 3) are likely to give a similar progressive allocation pattern. In a DCF analysis we observe only cash flows and time which mean that only 1) and 2) are available. In practical use 3) is clearly preferable to 2) as weight is observable and it is easier to avoid circular references if the model is implemented in a spread-sheet. I will apply allocation based on weight in some later numerical examples.

4.4 IFRS implications

All the models discussed are meant to be alternative interpretations / implementations of IAS 41. The standard does not offer a solution to the allocation problem, but recognises indirectly that it exists, IAS 41.25.

IFRS 13 requires the valuation to be based on 'current market conditions'. This means that the salmon prices (or internal rate of return) as of the time when the fish was released must be irrelevant. Before we accept the fixed charge solution, we have to explore the alternatives. A fixed charge solution implies that the allocation scheme is fixed when the fish is released, similar to a fixed price rental contract for the licence.

It should also be noted that the fixed charge solution has a property that may be considered as undesirable. All price variations will hit the inventory directly, save for the effect of discounting by the cost of capital. This will cause the volatility for fish just released to be very high. A price increase of 5 (10%) per kg for fish harvestable at 5 kg, will cause the fair value of a 200 g smolt to increase by 100%. (In an alternative reasoning we may assume that the rental contract is bundled with the inventory, but in that case we have not solved the problem, but just reformulated it as the contract also must be fair valued.)

Two different populations of equal sized fish that were put into sea at two different days should preferably have the same fair value as this promotes comparability among account producers. In order to achieve this, we should preferably allow all input parameters to be fully updated by information at the valuation date. In a true cash flow based valuation, $P_T^\tau, \tau < t$ must be irrelevant at any valuation date t.

There are 2 alternatives under fixed return on farming.

(1) Under alternative 1 (prospective implementation) a price change in the current period will have a smaller effect on the fair value of the inventory as allocate change in value to future periods. The future charge in a hypothetical rental contract is adjusted such that return on farming activities is kept constant at return=k. This could also be seen as smoothing.

(2) Under alternative 2 (retrospective implementation) the internal rate of return is recalculated for the whole production period. This will cause a larger jump in the fair value of the inventory since the charges for previous periods are considered to be paid. An alternative view is that the future expected return on farming is k, but that the farming activity gets a windfall relating to previous periods. (Whether the farmer actually pays the difference or receive a windfall is of no interest).

Alternative 1 implies that if the estimate for the price at the time of harvesting, P_T - is updated during the production cycle, it matters when we updated our expectations. Assume that P_T was updated at time τ, then W_t^τ will depend on τ for all $\tau<t<T$. If we assume that a fish farm, both the fish and the licence, were acquired at the reporting (measurement) date, a hypothetical acquirer of both the licence and the fish has to allocate the acquisition price to the fish and the licence.

It is unlikely that the expectations about the price at the point of harvesting that existed when the fish was released into sea cages $\tau=0$ or at any other $\tau<t$ would be considered as relevant valuation input. Under IFRS 13 fixed return on farming with retrospective implementation seems preferable, but also this alternative has a (smaller) backward looking element as realised cost will influence the remeasurement of the IRR.

To summarize we have to choose among solutions that all could be criticised on theoretical reasons, and empirical evidence does not exist.

4.5 Contributory Asset Charge – Implications

So far we have discussed a single farming cycle example. The full fair value of the licence will be the net present value of abnormal return on all future production cycles. If we assume that a production cycle is completed in one period, a third party owner of a licence will get

$$V_t = \sum_{t=0}^{\infty} \frac{d_{t+1}}{(1+k)^{t+1}} \text{ or } V_t = \frac{V_{t+1}+d_{t+1}}{(1+k)}$$

The 3. party owner will get the rent for the period plus the expected changes in fair value. The rent for period t+1; that is, the contributory asset charge, is the abnormal profit (cash flow) for period t+1. The change in fair value $\Delta V = V_{t+1} - V_t$, does not affect the cash flow attributable to inventory in period t+1 and hence not the fair value of the fish; W_{t+1}. If the conclusion is that the CAC to the licence simply is the positive residual cash flow, we do not need know the fair value of the licence.

The contributory asset charge is the positive residual income from the farming operation. A hypothetical 3. party owner of the licence will receive the positive residual cash flow as rent. If the residual cash flow is negative, he does not receive (have to pay) a negative rent. The reason from an accounting perspective is that a negative residual income is a future loss that must hit the inventory and cannot result in negative fair value of the licence. From a financial perspective the producer invest the current inventory plus cost to completion and receive the proceeds from harvesting. A negative residual income means that this investment has negative net present value.

If the residual income is negative before the fish is released, there should be no production in the current farming cycle (there may obviously be large costs associated with an interuption). d_0=0 and the fair value of the right to start the current cycle is also nil. The net present value of proceeds from harvesting less the net present value of cost to completion, both discounted by cost of capital, should be the upper limit for fair value of the inventory. Even if we stick to the assumption that it is not possible to harvest fish below 5 kg, it is unlikely that the FV of the inventory should become negative due to high initial investments in smolt.

5 The different valuation models - Description

In this chapter I will describe a full discounted cash flow model where also mortality is taken into consideration. We place ourselves at the start of the production cycle and assess how the fair value estimates develop over the production cycle given that our initial assumptions are realised. The discounted cash flow model helps us to estimate the combined fair value of the licence and the inventory, but not how FV should be allocated. Hence, the purpose of developing a full-fledged cash flow model is partly to understand the implications of the allocation problem, but also to compare the output with the output from the 2 industry models described. I will show numerical examples of different allocation methods. Then apply I will apply the same assumptions in the 2017 model and the amended 2006 model.

Even if the model has to take some real life problems into consideration, this particular model is still built for the purpose of gaining insight into the valuation issues addressed in the article. The model is not built for the purpose of solving any practical problem that may arise in practical use.

In ch 4.5 I have shown that we do not need to assess the residual cash flow beyond the production cycle. Hence, the model focuses on one production cycle. The principles of DCF valuations are well known from extant valuation literature, and although there may be technical challenges pertaining to different industries, the challenges are mainly related to the task of setting unbiased and internally consistent assumptions. I will first present some common assumption before I present a standard pre-tax valuation model with an explicit forecast period equal to one production cycle and no continuing value.

5.1 Common assumptions

In all previous examples there has been one fish and mortality has been disregarded or implicit. In this example we release Q_0=1200 smolt into sea cages. The cost per smolt C_0=20, the weight is M_0=200 g and we expect to harvest fish weighting M_T=5 kg 18 months later; T=18, hence the daily growth rate is $\gamma = \frac{log\left(\frac{5}{0.2}\right)}{30x18}$. We expect to harvest Q_T=1000 fish, hence the daily mortality rate is $\mu = \frac{log\left(\frac{1000}{1200}\right)}{30x18}$. The cost of achieving 1 kg of weight increase is 28.15. How we arrive at the cost of achieving 1 kg increase in harvestable biomass can best be explained by an example. During period 1 the weigh increases from 0.200 kg to 0.20 kg x $e^{30\gamma}$=0.24 kg. The number of fish at the start of the period is 1200 and the farming cost incurred is (0.24 - 0.20) x 1200 x 28.15 = 1323. The number of fish at the end of the period is 1200 x $e^{30\mu}$ =1188. The increase in biomass is 0.24 kg x 1188 – 0.20 kg x 1200 = 44.1 kg. The farming cost incurred 1323 divided by the increase in biomass 44.1 is 30.00. We observe that we assume that we feed all the fish that is alive at the start of the period for the whole period and divide by the increase in biomass after the mortality is taken into consideration. This is a modelling adaption. 28.15 is the input variable, not 30.00. The difference 30.00 – 28.15 = 1.85 is the cost of feeding fish, which subsequently dies per kg fish which survives.

The observed price for 4 kg gutted fish is 71.25 and the back to farm adjusted price is (71.25x0.8-7)=50 where 0.8 is remaining weight after harvesting loss and 7 is harvesting cost per kg live fish. We discount monthly cash flows by $1/e^{0.06x(\frac{t}{12})}$. Other operating costs such as labor and depreciation are ignored.

5.2 *The discounted cash flow model*

The discounted cash flow model helps us to estimate the combined fair value of the licence and the inventory, but not how FV should be allocated. The table below shows the development of estimated FV of inventory based on different models for allocation of licence charge.

DCF MODEL – DIFFERENT ALLOCATIONS OF LICENCE CHARGE

Period	0	1	2	---------9	--------16	--------18
Observed Weight; M_t	0.20	0.24	0.29	1.00	3.50	5.000
Number of fish; Q_t	1200	1188	1176	1095	1020	1000
Biomass kg; $B_t = Q_t \times M_t$	240	284	336	1095	3568	5000
Cost per kg increase biomass		-30.00	-30.00	-30.00	-30.00	-30.00
Income $P_T \times B_T$						250 000
Farming cost*	-24 000	-1 323	-1 566	-5 101	-16 615	-23 282
Discount factor	1	0.995	0.990	0.956	0.923	0.914
PV Farming cost	-157 515	-1 316	-1 550	-4 876	-15 337	-21 278
PV Income	228 483					
NPV = V_0	70 968					
Allocation Licence cost						
-Annuity (d_t)		-4 133	-4 133	-4 133	-4 133	-4 133
-Weight (d_t)		-703	-832	-2 711	-8 831	-12 375
Cash Flow annuity	-24 000	-5 456	-5 699	-9 234	-20 748	222 585
W_t	24 000	29 576	35 424	89 096	196 687	250 000
W_t/kg	100.00	104.10	105.33	81.33	55.12	50.00
Cash Flow Weight	-24 000	-2 026	-2 398	-7 812	-25 446	214 342
W_t	24 000	26 146	28 676	64 984	182 237	250 000
W_t/kg	100.00	92.03	85.27	59.32	51.07	50.00

Table 12: Farming cost for t=0 is $C_0 \times Q_0$. For subsequent periods farming cost is $(M_t – M_{t-1}) \times Q_{t-1} \times 28.15$ which means that the mortality does not occur continuously. The 30.00 cost per kg increase biomass is an output rather than an input.

Accumulated cost at the time of harvesting is 166 781 or 33.36 per kg.[xxvi] Hence, the FV adjustment is sizeable. The table illustrates the difference between an allocation of charges for the licence based on an annuity; that is a constant per period, and allocation based on weight. Due to the accumulating volume of inventory the difference in W_t is more important than W_t/kg from an accounting perspective. We observe a 37% difference in W_9.

The allocation based on weight is based on the increase in biomass each period as a percentage of the total expected increase in biomass, solving the following set of equations with respect to θ.

$$d_t = \theta \times \frac{(M_t - M_{t-1})}{(M_T - M_0)} \text{ and } V_0 = \sum_{t=1}^{T} \frac{d_t}{e^{kt}}$$

Here the rent d_t will not depend directly on W_{t-1}. Biological transformation in the salmon industry is weight increase, which is purely a result of feeding the fish. Weight is also the observable and remaining time to harvesting is updated based on observed weight. If a 200 g fish is released into sea-water and is growing by 0.6% per day (continuous growth), the weight increase the first month is $200\text{g} \times (e^{0.006 \times 30} - 1) \approx 39\text{g}$.[xxvii] After 17 months the weight is 4.182 kg and after 18 months the weight is 5.000 kg; that is, a weight increase 21 times that of the first month. Save for the effect of mortality, which is significant, the amount of inventory has increased by the weight increase of each individual fish.

5.3 2006 Revised Model

In the revised 2006 model (2006 R), the Lower and Higher Thresholds, which lack a logical justification, are removed to test whether an allocation on farming margin linearly in weight increase may return a reasonable output. This also means that the farming margin is estimated based on harvesting at 5 kg in the following example.

2006 R MODEL

Period	0	1	2	--------9	------16	------18
Observed Weight M_t	0.20	0.24	0.29	1.00	3.50	5.000
Number of fish Q_t	1200	1188	1176	1095	1020	1000
Biomass kg B_t	240	284	336	1095	3568	5000
Cost per kg increase biomass		-30.00	-30.00	-30.00	-30.00	-30.00
Income P_T x B_T						250 000
Farming cost	-24 000	-1 323	-1 566	-5 101	-16 615	-23 282
Cost incurred (accum)	24 000	25 323	26 889	49 660	123 831	166 781
Allocation (d_t)		679	1 491	13 870	57 153	83 219
W_t	24 000	26 002	28 380	63 530	180 985	250 000
W_t / kg	100.00	91.52	84.39	57.99	50.72	50.00

Table 13: Farming margin in allocated linearly in weight. W_t=Cost incurred plus allocated farming margin. Farming cost for t=0 is C_0 x Q_0. For subsequent periods farming cost is (M_t – M_{t-1}) x Q_{t-1} x 28.15 which means that the mortality does not occur continuously. The 30.00 cost per kg increase biomass is an output rather than an input.

In the 2006 R model the rent is linear in weight increase with no discounting. A closer comparison will be made in ch. 6, but we observe W_9=63 530 compared to 64 984 based on weight increase in Table 12. A notable difference is that there is no discounting in the 2006 R model and that the linear allocation of farming profit does not allow for a return on capital employed in inventory.

5.4 2017 Model

The 2017 model also allocates based on weight increase, but remaining time to harvesting, not weight, is the observable.

2017 MODEL

Period	0	1	2	------9	------16	------18
Observed Weight M_t	0.20	0.24	0.29	1.00	3.50	5.000
Number of fish Q_t	1200	1188	1176	1095	1020	1000
Biomass kg B_t	240	284	336	1095	3568	5000
Cost per kg increase biomass		-30.00	-30.00	-30.00	-30.00	-30.00
Income P_T x B_T						250 000
Farming cost	-24 000	-1 323	-1 566	-5 101	-16 615	-23 282
Cost incurred (accum)	24 000	25 323	26 889	49 660	123 831	166 781
Allocation (d_t)		1 080	2 217	13 207	51 495	83 219
W_t	24 000	26 403	29 106	62 867	175 326	250 000
W_t / kg	100.00	92.93	86.55	57.39	49.14	50.00

Table 14: The interpolation factor is estimated as described under ch 3.3 Farming cost for t=0 is C_0 x Q_0. For subsequent periods farming cost is (M_t – M_{t-1}) x Q_{t-1} x 28.15 which means that the mortality does not occur continuously. The 30.00 cost per kg increase biomass is an output rather than an input.

A closer comparison will be made in ch. 6, but we observe that the W_1 is above the 2006 R model while W_9 is below the 2006 R model. These observations are not independent of the assumptions made. Increasing profitability will increase the convexity of the interpolation function thereby the tendency to fall below the 2006 model for larger fish.

As the interpolation is based on point of release and point of harvesting, the allocation will come close to allocation based on weight (or IRR) if the pace of growth and cost per unit of weight increase are constant. This is by assumption true as the purpose of the analyses are to illustrate the allocation problem and to compare the methods in a parsimonious example. Departure from these assumptions may command a more complex model or produce various artefacts in the different models.

The 2006 R model is less sensitive to departures from the constant growth and constant cost per unit of weight assumptions, but may on the other hand show less desirable properties when price and cost assumptions change over the production cycle.

6 Comparison of models

6.1 Valuation axioms

As it is not possible to back test any model against observable prices, the reasonableness of the models will be evaluated based on a set of axioms:

(1) Cost is a reasonable proxy for fair value when the smolt are released into sea cages (or there is an observable market price), i.e. there should be no day 1 profit upon release; that is, $W_0=C_0$.

(2) There is no allocation problem at the estimated point of harvesting as 100% of the cash flow is allocated to inventory; that is, $V_T=0$ and $W_T=P_T$

(3) The allocation of cash flows should be based on updated expectations at the time of valuation. W_τ^t should be a function C_τ^t $t<\tau\leq T$ and P_T^t

(4) Fish of same size should have same fair value across locations (licences), save that both have $r\geq k$.

(5) The model should report fair value when there is no economic rent and hence; $d_t = 0$ for all r.

Axiom (1) implies that all residual profit is attributable to the licence at this point of time. It is not critical to our discussion of the allocation problem or choice of model that $W_0=C_0$. An observable fair value different from cost is no problem, but it is of course important that we do not have an allocation issue at t=0.

Axiom (2) follows if we accept that the licence is a series of options to start a production cycle. The sub-licence has expired and the fair value is transferred to the inventory.

Axiom (3) is less obvious and discussed in more detail under ch 4.4. The fair value in period t should not be influenced by the price expectations in any previous period as this would violate the current market condition valuation premise. The price a hypothetical buyer of the fish is willing to pay cannot be path dependent. (14) and (15) implies that a prospective implementation of changes in estimates will violate this axiom. To see this note that W_τ^t not only depends on P_T^t, but also on the value of inventory (W) when the change in estimate took place. This is not the case for retrospective implementation. We observe in (16) and (17) that W_τ^t depends on C_0, but that does not matter as long as C_0 is assumed to be constant.

Axiom (4) follows from IFRS and the valuation premise that fair value should be market, not entity specific. All farmers are assumed to realise the same P_T. Firstly, axiom (4) will rule out 'cost-plus' models that load on entity specific sunk cost. This could be a problem with the 2006 model, in particular if there is no normalisation of cost. All models investigated do to some extent rely on sunk cost to update farming profit, internal rate of return or an interpolation functions. Ideally only future cash flows should be considered.

Secondly, the differences[xxviii] in fair value between licences are mainly caused by differences in farming conditions; for simplicity cost per unit of weight increase. If the charge for licence is based in time, the release of the charge for the licence will follow a different pattern than the cost savings, which is associated with the weight increase. In other words, the residual cash flow we discount to arrive at the fair value of the licence has time profile that differs from allocation based on time. This will cause fish of the same weight to be appraised differently depending on the quality of the location. This is not reasonable because the sum of cost to completion and residual cash flow should be the same. Hence, axiom 4 points against allocation based on time in this case.

Axiom (5) implies that growth in book value should include return(=k) on capital employed in working capital (W) and requires future cash flows to be discounted.

If a 'gold standard' is unachievable, we may have to seek a second best solution, which does not satisfy every axiom perfectly

6.2 Development of the fair value estimates over the production cycle

In the examples provided in chapter 5, we look at the development of the fair value estimates with similar assumptions and under certainty. By comparing the outputs we may observe that models have more or less desirable properties, but we also have to discuss other aspects.

INVENTORY VALUE / COST PER KG AS A FUNCTION OF TIME

Period	0	1	2	------9	------16	------18
Observed Weight	0.20	0.24	0.29	1.00	3.50	5.00
DCF Annuity	100.00	104.10	105.33	81.33	55.12	50.00
DCF Weight *	100.00	92.03	85.27	59.32	51.07	50.00
2006 R	100.00	91.52	84.39	57.99	50.72	50.00
2017	100.00	92.93	86.55	57.39	49.14	50.00
DCF IRR	100.00	93.78	88.23	63.09	51.86	50.00
Historic cost	100.00	89.13	79.95	45.33	34.70	33.36

Table 15: * Weight is considered as a proxy for fair value of the inventory. The table shows W_t / M_t (estimated fair value per kg). The figures are extracted from tables 12-14 except for historic cost which is included to indicate the size of the fair value adjustment. The difference between any of the allocation methods and historic cost is the amount recognized in income per kg

ALL ALLOCATION MODELS COMPARED

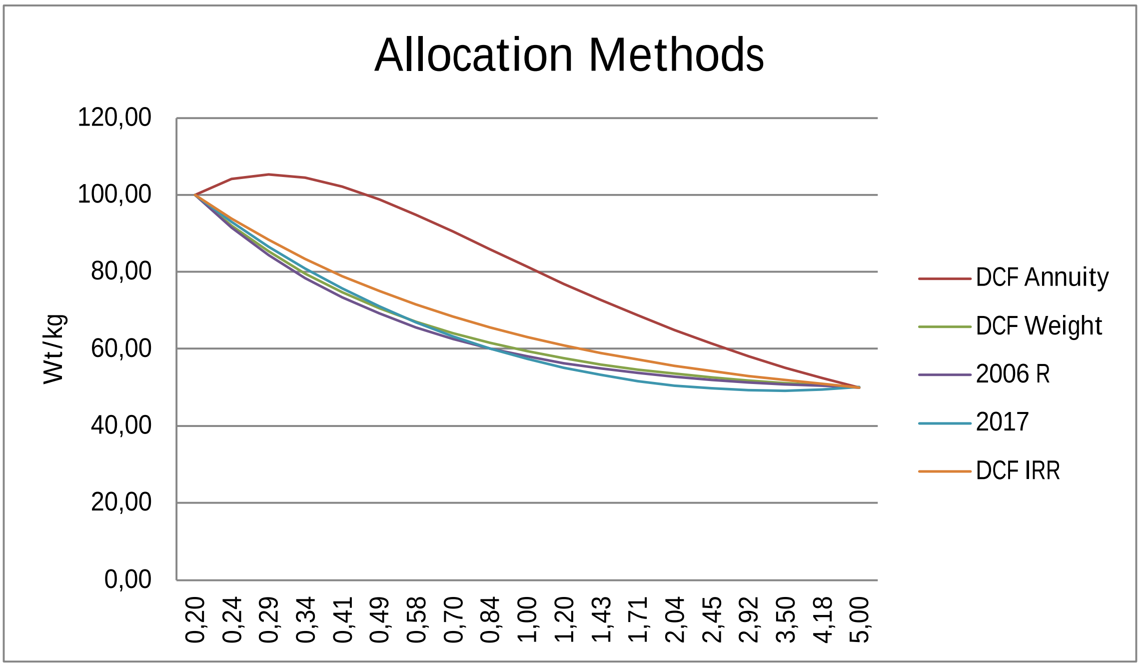

Figure 4: Note the non-linear X-axis. The X-axis gives a reasonable representation of time as 1 kg is reached approximately halfway in the production process, while the labels are weight. The figure is based on Table 15.

The remarkably similar profiles are due to common assumptions and model constructions, and the differences between the models are not very sensitive to changes in assumptions (not reported). Due to the long production cycle and large balances of inventory, the differences between W_{16} for the different models are, however, clearly material from an accounting perspective, but we have to bear in mind the inherent uncertainty of the input parameter to the valuation model. The users of the financial statements are likely to consider the fair value of inventory as an uncertain accounting estimate. In this perspective the models come in remarkably close.

Firstly, we observe that axiom (1) and (2) are fulfilled for all alternatives (Historic Cost is presented just for reference). All the models are also by construction made such that they are updated based on new information about all valuation parameters, axiom (3), but models with prospective implementation have a particular problem with path dependency. The analytical model under ch 4.2 does assume $C_t=0$ for $t \neq 0,T$. When we relax this assumption and introduce feeding cost (operational expenses), all models will violate axiom 3 because all models will update IRR, interpolation factor or farming profit based on realised cost. This raises a question about normalization. The cost impact is particularly strong for the 2006R model. The allocation problem is, however, insolvable if we only observe the expected cost to completion and expected proceeds from sales. Axiom (4) will disqualify allocation based on an annuity, if differences in the FV of licences is caused by differences in operational efficiency, but not to the extent all licences have positive FV. The 2006R model also violates axiom 4 because realised cost weights heavily for smaller fish. The 2006R model also violates axiom 5 because there is no discounting.

The DCF annuity model stands out with a much earlier income recognition than the other models. The reason is that the charge for the licence is based on time, not on weight or value of the inventory. If we look at the inventory, allocation based on an annuity gives a fair value increase, defined as $\left(\frac{W_t - C_t - W_{t-1}}{W_{t-1}}\right) - 1$, which is much higher than the internal rate of return early in the production cycle, dropping below towards the end. This as opposed to allocation based on weight (proxy for fair value)[xxix], which shows a fairly stable return more in line with the internal rate of return:

RETURN ON INVESTMENT FOR DIFFERENT ALLOCATIONS

Period	0	1	2	------9	------16	------18
Cash flow	-24 000	-1 323	-1 566	-5 101	-16 615	226 718
IRR	5.50%					
FV Inventory (Annuity)	24 000	29 576	35 424	89 096	196 687	250 000
$((W_t-C_t-W_{t-1})/W_{t-1})-1$	-	17.7%	14.5%	5.7%	2.9%	2.4%
FV Inventory (Weight)	24 000	26 141	28 670	64 979	182 236	250 000
$((W_t-C_t-W_{t-1})/W_{t-1})-1$	-	3.4%	3.7%	5.3%	6.2%	6.3%
FV Inventory (IRR)	24 000	26 643	29 674	69 113	185 057	250 000
$((W_t-C_t-W_{t-1})/W_{t-1})-1$		5.50%	5.50%	5.50%	5.50%	5.50%

Table 16: The table shows the difference between allocation based on annuity, weight (as a proxy for fair value) and internal rate of return.

The reason why allocation based on weight leads to slower income recognition than IRR, is that although the rate of growth is constant, only a very low portion of the total weight increase is realised during the first months. The fair value increase on inventory is, in the DCF models, partly a return on capital employed in the inventory. The IRR method will, unlike the weight model, provide return on the relatively high early investment in smolt.

Different patterns of release result in different patterns of fair value increase. As a consequence of different patterns of fair value release, the annuity (linear) method fails to fulfil axiom (4); ceteris paribus the fish on the best location will get the highest fair value estimate. To see that consider that most of the farming cost is closely related to weight increase. High fair value on licence is associated with low farming cost as the fair value on the licence is NPV of the residual cash flow. The earlier transfer of fair value, disconnected from weight increase, in the annuity method, means that fair value is transferred to inventory before the farming cost is incurred. We do not achieve the effect that lower production cost is offset by higher licence charges in the same period to the extent we do in the alternative models. Under the annuity approach the estimated fair value of inventory will increase earlier for the producers with the best locations.

The DCF weight model does not differ much from the 2006R model (linear allocation of farming margin) when the profitability is high, the discount rate is low and the production period is 18 months. We may say that the models are conceptually different, but the output is not very different, given the assumptions chosen.

The 2017 model suffers from a convexity problem when the profitability is very high, and the output tends to fall somewhat below the other models between 3.5 and 4.5 kg the reason being the inconsistent treatment of cost incurred. Assuming that the real option to choose the optimal time of harvesting still has a positive value, the fair value per kg should not fall below the sales price per kg if we assume that the proceeds from harvesting is linear in weight.

6.3 Changes in estimates

The models analysed do not behave significantly differently when changes are made to the input parameters; at least not sufficiently different to hold it in favour or against any of the models. The sensitivities; that is, the changes in estimated FV per kg for a unit change in the most important value drivers, are not very different. The analyses are performed, but not tabulated.

6.4 Discussion

From an economic perspective the enterprise value; that is, the combined fair value of the licence and the inventory should increase by the cost of capital (plus any incurred operational expenses) over the production cycle. This does not answer the question about when fair value should be transferred from the licence to the inventory. This is an accounting (allocation issue) and IFRS 13 offers no solution to that problem. The requirements for initial recognition in IAS 41.10 may prevent the apple farmer from recognising an inventory in February, which means that we will have an unrecognised fair value increase on the apple trees instead. Valuation of inventory of fish does not have to consider the issue of first time recognition; that is, when it is meaningful to separate the apple from the apple tree, but there is a similarity in the very low levels of biological transformation (growth) in an early phase. Transfer of fair value from the licence to the inventory based on an annuity leads to very high fair value estimates for the small fish and aggressive income recognition. Perhaps weight increase is a better allocation key than time alone?

The benefit of applying weight as observable is that it is related to biological transformation and that it from a modelling perspective is impractical to use value as input. We know that weight and internal rate of return to a large extent share characteristics, but that IRR may lead to a somewhat more rapid income recognition, although both lead to a pronounced slower income recognition than the annuity model.

The 2006 R model has been criticised because an unexpected expense will increase the fair value estimate. It will also cause the least efficient producer to come up with the highest fair value estimate early in the production cycle. The model forces us into a practice of cost normalisation, which may not actually promote comparability between producers because it introduces a new layer of discretion. The experiences from Norway, although with a different model, the 2006 model with thresholds, are not in favour of the model.

The advantage of the 2017 model over any DCF model is that it is easier to implement over a large number of populations in a spread-sheet because it ignores the timing of cash outflows. It is also easy to replicate by external analysts.

The 2017 model is not completely cured from artefacts caused by the effect of incurred cost on the interpolation factor (estimated rate of return). In practical use, several populations in different weight categories will form an interpolation curve similar to the curve established when we predict the development of a specific population and outliers will be adjusted. With very high levels of abnormal profit, the model suffers from a convexity problem; that is, W_t/m may fall below $P_T/5$ for fish close to harvestable size which should not be possible if the option to grow further has positive value. The reason is that the interpolation factor exceeds the true internal rate of return because all farming cost are assumed to be incurred at the end of the farming cycle.

In Norway the licence is for a maximum amount of biomass; that is, the biomass should never exceed a limit. As the capacity constraint decides the number of fish to be released and may be effective for significant periods, allocation based on weight seems to have some merit.

6.5 Robustness

Figure 4 shows relatively small differences between the 4 models; IRR, DCF Weight, 2006R and 2017. An interesting question is whether this is simply due to choice of assumptions. Unreported simulations show that value relations do depend on assumptions and how expectations develop over the production cycle. Changes in assumptions can change the differences between the models for a certain weight category, but still figure 4 depicts the most important characteristics for each of the models based on assumptions that are realistic.

Under the assumptions chosen, the IRR model gives the highest estimates (fastest income recognition) of those four models. The reason is that the inventory grows with return on the expensive smolt.

- The 2017 model gives the lowest estimates for larger fish and will become increasingly convex as profitability increases. The tendency to fall below the other alternatives for large fish increases in profitability. The reason is the inconsistent treatment of cost incurred.
- The 2006R model gives the lowest estimates for the smallest fish because of the linear allocation in weight increase and no discounting. The increasing capital employed in inventory is not taken into consideration. This makes the model increasingly conservative when the

profitability increases. When the profitability falls below normal cost of capital, the model will be upward biased.

- The NPV Weight allocates the charge for the licence based on the portion of the total weight increase achieved during the period. This also results in conservative estimates for the smallest fish. The charge for the licences is lower in an early phase compared to the IRR model mainly because IRR method allows for a return on the initial investment in smolt. The early phase difference between allocation based on weight and IRR increases in profitability.

The 2006R, the 2017 and the NPV Weight are all returning fair value estimates below the IRR model, and this tendency will increase in profitability for all, but in a varying degree. A higher profitability than assumed in the examples, cannot be ruled out for shorter periods or for very high performing populations, but the examples show a profitability in line with the average achieved by Mowi, the largest producer over the 2015-2019 period.

7 Summary and conclusions

IFRS 41 requires inventory of live biological assets to be measured at fair value. Fish farming operations commonly need a licence to operate and such a licence may become a valuable (intangible) Contributory Asset to the farming operation. When two or more assets interacts within a CGU to generate a common cash flow, the valuation of the individual assets requires the cash flow to be allocated between the assets. If more than one asset have unobservable market price, the allocation schedule becomes ambiguous. Allocation issues are well known in accounting from the choice of amortisation plans and split of operational cost between activities, and ambiguous solutions are not unknown (Thomas 1975).

Valuation of assets that do not have a separate independent income stream is addressed in IAS 36, Impairment, and also under PPA in IFRS 3. IAS 36 recognises that there is no simple solution to the allocation problem and does not require assets to be tested for impairment individually within a CGU.

While live biological assets are measured at fair value, the licence is measured at historic cost according to IAS 38. A revaluation option exists in IAS 38, but it is generally not used within the fish farming industry, and in any case the revaluation effect should be reported under OCI and will accordingly not remedy the effect of any allocation problems in net income.

This mixed model does not cause the allocation issue, but it does not help us out either. The CAC should be based on fair value which implies that the amount reported in profit and loss as a fair value change on inventory may partly be due to hidden reserves or the effect of a fair value shock on the licence being released during the reporting period.

Unless a fish farmer allocates the NPV of abnormal return to the licence, the NPV of abnormal profit from the farming cycle just started will be recognised in income upon the initial recognition of an inventory. In the hypothetical case where the licence is measured at fair value (just acquired), the booked value of the licence has to be reduced accordingly (impairment). Contrary to popular belief, we do, however, not have to appraise the licence in order to appraise the fish, but we need to allocate a portion of the cash flow from the current farming cycle to the currently used right to farm. This observation greatly simplifies the problem, because uncertainty about product prices beyond the current farming cycle does not affect the allocation problem. In a two assets model, we may allocate 100% of the NPV of the next farming cycle to the licence at $t=0$ and 100% to the inventory at $t=T$; that is, at harvesting. During the farming cycle we have to charge the farming operation (inventory) for the use of the licence, which means that we transfer fair value from the licence to the inventory. The allocation problems are about the choice of allocation pattern and about how we should deal with new information (updated cash flow estimates).

If we only observe the net present value of proceeds from harvesting and the net present value of cost to completion; that is, we have a purely forward looking perspective, we are unable to determine whether a change in net present value should be allocated to the inventory or the licence. An allocation pattern raises questions about whether charges for the use of the licence should be updated retrospectively or prospectively when information changes, but also how we should treat sunk cost when we update our estimates. Transaction in live immature salmon does not occur outside business combinations, and it is not possible to back test a valuation model empirically. As we also are unable to solve the allocation problem theoretically; that is, there is no unique solution or "gold standard", we may to limit the set of feasible models based on a set of axioms:

(1) All residual profit is attributable to the licence when smolt is released into sea-water; that is, there is no day 1 profit
(2) The cash flow from harvesting is allocated to inventory at the point of harvesting
(3) The allocation of cash flows should only be based on updated expectations about future cash flows at the time of valuation.
(4) Fish of similar size should have similar fair value across locations with different farming conditions,
(5) The model should report fair value when there is no economic rent

(1) and (2) are easily explained in a model with only two assets; the inventory and the licence, where the starting point is when the fish is released into sea water and

the ending point is the harvesting. (3) The fair value of the inventory in period t should not be influenced by the price expectations in any previous period as this would violate the current market condition valuation premise in IFRS 13. A prospective implementation of changes in estimates will violate this axiom because it then matters when the price expectations where last updated. All models update their allocation parameter based on an updated assessment of the profitability over the farming cycle. This raises the question about a normalisation of sunk cost. Models that load on entity specific sunk cost will violate axiom (4). Also models with allocation based on an annuity will violate axiom (4). Finally models where return on capital employed in inventory is disregarded, i.e. time value of money, will violate axiom (5).

In a DCF, fair value of the inventory will increase as a function of time; that is, because we are approaching the positive cash flow from harvesting. Of course, growth or biological transformation is the underlying value driver; without biological transformation we will not approach harvesting, but in the DCF model we only observe time and cash flows. Biological transformation or growth may follow a different pattern. An allocation pattern where a CAC for the licence is based on an annuity; that is, disconnected from biological transformation, will cause fish of the same size and quality to be appraised differently on different farming locations because different locations offer different farming conditions and different profitability. Allocation based on an annuity will also lead to a declining return on investments in working capital. An alternative allocation based on weight, provides a much more uniform return on capital employed and does also come much closer to an equal fair value estimate for fish of same weight and quality irrespectively of farming condition.

An allocation pattern based on weight and retrospective implementation come closest to the valuation axioms. An internal rate of return that updates based on sunk cost is not ideal, and may bring about a discussion about normalisation.

The farming industry has suggested different solutions to the allocation problem; both a linear allocation of farming profit based on weight and also an interpolation function where the allocation indirectly is linked to weight through a growth function. I show that both the models come fairly close to a DCF model where a charge for the licence is a function of weight, but also that the industry models have certain model artefacts that may result in measurement biases and violations of the axioms. The major reason for leaving the 2006 model is that it loads too heavily on entity specific historic cost early in the farming cycle. The 2017 model suffers from a potential downward bias for the large fish when the profitability is very high. The industry models both benefit from easier implementation than a DCF model.

Overall this example from the fish farming industry shows that fair value measurement is not free from allocation problems, and they may be more sever than standard setters have realized. On the other hand the industry may have overplayed the difficulties based on the belief that a full valuation of the licence is required to estimate the fair value of the inventory. The alternative models suggested by the industry, both come fairly close to a DCF model, but the results are not insensitive to the assumptions chosen and some model artefacts exist.

Further, the choice of valuation model should also take other attributes into consideration, for example how the effect of new information is implemented.

--

The allocation problem (RQ 1) can neither be solved theoretically nor empirically, but we can find models that reasonably well fulfil our valuation axioms.

We observe (RQ 2) that simplified practical models based on linear (in weight) accretion or interpolation come fairly close to models based on NPV under plausible assumptions. This is due to the design of the models rather than choice of assumptions and the conclusion is robust, but we cannot conclude that the 2006 model is closer to our valuation axioms than the 2017 model under all plausible assumptions or vice versa.

Fair value measurement in a mixed model makes the fair value adjustment reported in the profit and loss statement hard to interpret. The amount comprises an accretion effect, a revaluation effect of the inventory, but also a possible revaluation effect and release of hidden reserves associated with the licence. Ideally analysts should be able to extract information about management's expectations from the fair value reporting, but to make corroborative calculations requires supplementary disclosures beyond those offered under IFRS.

---

[i] I will use the terms 'abnormal' and 'residual' interchangeable

[ii] Contributory Assets, for the apple farm the trees and the land require a return in every period, but the gain resulting from the release of a Contributory Asset Charge can only be recognised together with the initial recognition. The accounting treatment seems unclear, see for example PwC (2015)

[iii] I will not problematize further whether it is legally permissible to separate the fish and the licence nor any interpretational consequences in relation to IFRS.

[iv] The estimated fair value of the licence; that is, the contributory asset, will by nature be a Value in Use and hence capture the effect of the owners operational efficiency. We cannot rule out the possibility that other intangible assets or goodwill exists. This may be important if the licence were the primary subject of the valuation. For the purpose of appraising the inventory, it may not be important to distinguish between the quality of the licence and the operational efficiency of the producer.

[v] Clearly there may be other intangible assets, for example assembled work force and know how. There may also be accounting biases; that is, deviations from fair value accounting, pertaining to other assets and liabilities

[vi] When the salmon has reached the planned harvesting weight, the site is normally close to a capacity constraint, physically or regulatory. Further, the farmer has to harvest one generation and redirect the production resources to next generation. The large producers are complex logistics operations that need to consider delivery commitments, utilisation of harvesting plants and transportation. Hence the room for opportunistic harvesting is limited.

[vii] A salmon returns to the river where it was born to spawn. The eggs and the fingerlings cannot live in seawater. Smolt is a juvenile that has gone through a transformation where it adapts to seawater.

[viii] Although each fish is a unit of account, see 5.3, materiality is considered on account basis. Large producers will benefit from significant diversification effects. It is not likely that more complex models, which perhaps may have a better fit on population level, but not on aggregate level, will pass a cost benefit test.

[ix] For practical reasons information from integrated production planning and accounting systems will be utilised, but all producers are performing the valuation as a closing the book procedure. The time of harvesting for accounting purposes is set at a point where the fair value of the option to delay harvesting is negligible. Practical modelling requires a point estimate for the date of harvesting.

[x] Incurred But Not Reported; an issue that relates to an event prior to the reporting date should be provide for if information were available or provisions could be made based on statistical methods.

[xi] Ref IFRS 13.62

[xii] Ref IAS 41.24

[xiii] The case may be compared to a pension obligation. In period t we pay pensions to those being alive at t-1. Persons that die in period t, result in a gain at t because the obligation lapses, while persons that survive period t result in a loss at t because their expected lifetime, conditioned on survival of period t, has increased.

[xiv] Ref IAS 41.15

[xv] The model was implemented by Marine Harvest as of 31 December 2017.

[xvi] The industry is currently in the process of replacing the model used since 2006

[xvii] Nine out of fourteen sell side equity analysts following the salmon industry neither made references to a DCF analysis nor long term equilibrium prices, ref own work. Bradshaw

2004 suggests that analysts' stock recommendations are more closely related to with heuristic valuation models than with present value models.

[xviii] This assertion is debatable; there is an observable forward price in a derivative market, though not highly liquid. Further there may be systematic differences between contracts for physical delivery and financial settlement. It is also necessary to make adjustments to move from FV of a harvested fish to FV of a live fish. Fish farmers will also use other sources of information to estimate future sales price.

[xix] This may be about to change as the industry is extending the on-shore production period.

[xx] The model, as applied by the industry, has a logical inconsistency. Cost to completion is ex ante assumed to be paid at T, but when the fair value of a 2 kg fish is assessed, cost already incurred is considered to be paid

[xxi] when the production process continue, the current inventory is invested into the future production. $\frac{W_t^0}{m} < \frac{P_T^0}{5}$ cannot hold if this investment has positive net present value.

[xxii] B&S is for example commonly applied to appraise employee stock options even if the underlying stock are highly illiquid or the put / call parity is not fulfilled.

[xxiii] This statement implies fair value and actual transfers. If licence is accounted for at historical cost (=0 for simplicity), the fish ROA=r and licence ROA=0 as the hidden reserves on the licence is recognised in inventory over time.

[xxiv] Valuation under uncertainty is complicated, but this is not really the issue here. Random T raises many separate issues, not least non-linearity. T is a function of current weight and excepted growth rate. CT and PT may also be functions of T.

[xxv] In principle an infinite number of allocation patterns exists, but a discussion of allocation based on the patterns mentioned is sufficient to shed light on the problem

[xxvi] For those who try to recalculate; Accumulated cost divided by biomass is 166 781 / 5 000 = 33.356 which is total cost per kg harvested. The cost of observed increase in biomass per kg is (166 781 – 24 000) / (5000 – 240) = 29.996. The cost of observed increase in biomass per kg plus the smolt cost divided by survivors is 29.996 x 4.8 + 24 = 167.981. 167.981 / 5 = 33.596 which does not reconcile to 33.356. The reconciliation difference 167.981 – 166.781 = 1.2. 1.2 times 1000 survivors = 1200 which is equal to 30 x 40 which is the cost of acquiring 1 kg of harvestable biomass times the weight of the smolt that eventually perished.

[xxvii] Constant pace of growth over the production cycle is not realistic, but the issue is still valid. The exact figure applied is 0.005961

[xxviii] All licences (locations) that continued will have an expected positive rent

[xxix] Weight is a fairly good approximation for fair value partly because farming cost is closely related to weight increase. Further, the pace of growth is fairly constant and the proceeds

from sales is close to linear in weight for harbestable fish. It should be noted that this does not necessariliy hold for other live biological assets.

References

Botosan, C. A. and Huffman A. A. (2015) Decision-Useful Asset Measurement from a Business Valuation Perspective. Accounting Horizons Volume 29, No. 4, 757-776.

Fiskeridirektoratet, lønnsomhetsundersøkelse; http://www.fiskeridir.no/Akvakultur/Statistikk-akvakultur/Statistiske-publikasjoner/Loennsomhetsundersoekelser-for-laks-og-regnbueoerret

Gassen, J. and Schwedler K. (2010) The Decision Usefulness of Financial Accounting Measurement Concepts: Evidence from an Online Survey of Professional Investors and their Advisors. European Accounting Review Volume 19, No. 3, 495-509

Goncalves, R., Lopes, P. and Craig, R. (2017) Value Relevance of Biological Assets under IFRS. Journal of International Accounting, Auditing and Taxation Volume 29, 118-126.

Hitz, J-M. (2007) The Decision Usefulness of Fair Value Accounting – A Theoretical Perspective. European Accounting Review, Vol. 16, No. 2, 323-362

Hodder, L., Hopkins, P. and Schipper, K. (2013) Fair Value Measurement in Financial Reporting. Foundations and Trends in Accounting Volume 8, Nos. 3-4, 143-270

IASB (2012) Staff Paper Emerging Economies Group 28-29 May

Marine Harvest (2018) Salmon Farming Industry Handbook

Mowi ASA (2019) (former Marine Harvest ASA) Annual Financial Statements

Ohlson, J. A. (1995) Earnings, book values, and dividends in equity valuation. Contemporary accounting research, 11(2), 661-687.

PwC (2015), Agriculture In Depth. A look at current financial reporting issues

Reilly, R. F. and Schweihs, R. P, (1998) Valuing Intangible Assets, McGraw-Hill ISBN 0-7863-1065-0

Silva, R. M. and Nardi, P. C. C. (2018) The (in) Difference Between Historical Cost And Fair Value for Biological Assets: a Cross-Country Study. Annual Meeting of the American Accounting Association, At Washington, DC.

Thomas, A. L. The FASB and the Allocation Fallacy. Journal of Accountancy. November 1975 Vol. 140 Issue 5 pp 65-68

WHO (2021): Bulletin of the World Health Organization, Volume 99, No. 2, February 2021, 77-168

IV Paper 2

Is Fair Value Measurement of Inventory in a Production Company Value Relevant? Evidence from Norwegian Fish Farming

Is Fair Value Measurement of Inventory in a Production Company Value Relevant? Evidence from Norwegian Fish Farming

Bjarne Møller

Department of Accounting Auditing and Law, Norwegian School of Economics, Bergen, Norway

bjarne.moller@nhh.no

Is Fair Value Measurement of Inventory in a Production Company Value Relevant? Evidence from Norwegian Fish Farming

This paper studies the value relevance of fair value measurement of inventory in a production company. Although a biological transformation takes place, salmon farming is the industrial production of food with an extensive human involvement. Norwegian salmon producers have sufficient levels of inventory reported at fair value, which together with high profitability and volatile salmon prices, gives sizable fair value adjustments. A dual reporting practice of transaction based historic cost and fair value provides a unique opportunity for a 'within company, within period' study. The reporting practice for this industry offers the opportunity to study both the difference in value relevance between historic cost and fair value measurement and the incremental value relevance of the fair value adjustments.

The study has significance because both IAS 41 is controversial and value relevance is observable in a new context where net operating profit is based partly on fair value and partly on historic cost measurement. The study distinguishes itself from research on fair value measurement of financial assets in that inventory is not readily available for sale and there is no separate, independent cash flow attributable to inventory.

The study demonstrates that fair value measurement of inventory is value relevant and the fair value adjustments convey little information above product prices.

Keywords: value relevance, fair value, inventory, IAS 41

1 Introduction

The primary objective of financial reporting is to provide information that is useful in making decisions relating to providing resources to the entity (IASB 2018). A positive association between accounting information and share prices, value relevance, indicates how well accounting reports reflect information used by equity investors (Barth, Beaver and Landsman 2001). Using well-accepted valuation models, value relevance research attempts to assess the relevance and the reliability of accounting amounts (Barth et al 2001).

According to IFRS Conceptual Framework 6.2 (IASB 2018) 'consideration of the qualitative characteristics of useful financial information and the cost constraint is likely to result in the selection of different measurement bases for different assets, liabilities, income and expenses'. This has motivated the research into the value relevance of fair value measurement of inventory in a production company.

Numerous prior studies examine the value relevance of fair value reporting. (See Barth 2000; Beaver 2002; and Beisland 2008, for overviews of value relevance research.) Much early value relevance research focused on financial instruments (Barth, Beaver and Landsman 1996). A heated debate about fair value accounting developed in the aftermath of the financial crisis (Laux and Leuz 2010a; Laux and Leuz 2010b), a debate primarily related to fair value accounting in the financial industry. This debate, however, did not focus attention on the financial reports of production companies or on whether fair value accounting might be useful in such reporting.

In addition, standard setters have not paid much attention to this concern either. The only accounting standard that commands fair value reporting for an operational asset in a production company is IAS 41.[i] This standard requires fair value measurement of live biological assets. (Under US GAAP, historic cost is applied for live biological assets.) The implementation of IAS 41 has been controversial in Canada, Brazil, Indonesia and Norway. Account preparers have objected to the standard on the grounds of relevance, reliability and cost/benefit, but mostly critics have cited it for lack of relevance.[ii] By this, accountants maintain the use of fair value measurement here adds too much noise to the profit and loss statement. They expand their critique by pointing out that sell side equity analysts rely on historic cost (not fair value measurement) for predictive purposes. Even given these criticisms, use of fair value measurement might be appropriate for a wider application to production companies. The fair value information may have information content even if noisy. Evidence may show that value relevance, as defined by Francis and Schipper (1999), disproves the lack of reliability argument (Palea 2014). Reliability does not warrant relevance (capacity to make difference to decisions), but relevance requires a certain degree of reliability because low reliability means a low content of information.

In the extreme case of an investment company or fund, the balance sheet (according to fair value) may provide sufficient information to assess the fair value of the enterprise. For a company that arbitrages between the prices of finished products and input resources and must execute a business plan, fair value measurement eliminates hidden reserves for recognised assets. Even with this benefit, however, because of other assets measured at historic cost, unrecognised assets, and other factors including (but not limited to) interaction between assets, the gap between booked value and enterprise value will only be partly eliminated. In such circumstances, the balance sheet alone does not provide sufficient information to assess the fair value of the enterprise (Hitz 2007).

When information stated on the balance sheet is insufficient for valuation purposes, investors must revert to the profit and loss statement for cash flow prediction.

Most empirical studies of value relevance have focused on fair value disclosures (Hitz 2007) and pay little attention to income measures. In the agricultural industry, there typically is a stock of biological assets measured at fair value and significant contributory assets measured at historic cost. These two types of assets interact to generate a common cash flow; thus, valuations of individual assets (and liabilities) are based on an allocation of expected future cash flow.

Even in a case with a single asset with a definite remaining useful life, the fair value adjustment in the profit and loss statement requires decomposition to be useful for the purposes of cash flow prediction. (Hitz 2007; Hodder, Hopkins and Schipper 2013) The research of the present study will explore whether the combination of historic cost and fair value measurement in a production company is value relevant. The accounting issues pertinent to a production company differ from those of the financial industry where separate and independent cash flows may be attributed to most individual assets and liabilities and where the assets are held in exchange.

The fair value of inventory increases whenever the fish prices increase, moving the net assets closer to the share price. Because of this, we expect that fair value accounting makes the balance sheet more value relevant. The change in the fair value adjustment charged to profit and loss, however, does not necessarily bring earnings closer to recurring earnings. In particular, this is due to high levels of inventory. The incentives of management and cash flow allocation issues may add additional noise to the profit and loss statement and thereby hinder the capability of cash flow prediction. In such a case, the value relevance of the profit and loss statement is likely to be somewhat ambiguous.

The Norwegian fish farming industry has a long production cycle and relatively high levels of inventory in progress. This makes the fair value adjustments significant to earnings from operations and to net assets. Interim financial data for the eight companies are hand-collected for each quarter for the periods from the fourth quarter 2006 through the fourth quarter 2015, giving approximately 240 data points. The dual reporting--historic cost and fair value--provides a unique opportunity for a 'within company within period' study.

A particularly interesting question is whether to control for salmon prices. The purpose of fair value accounting is to make the accounting information more relevant by capturing information about the assets from the outside world. Given this, to control for salmon prices may defeat the purpose of the test. Yet in this context, it would be interesting to know whether the fair value adjustments convey any significant information beyond just the prices of salmon. The fair value measurement requires significant efforts from the preparers, and if the process renders no additional significant information, the salmon prices could be obtained in a more timely fashion with less risk of bias and without confounding factors from sources other than the financial statements.[iii] I will offer different approaches to control for salmon prices.

The main observation of the present study is that fair value information is proven to be value relevant; that is, the study rejects the null hypothesis that there is no value relevance.

	Fair value increment. value relevant		Fair value more value relevant	
	Balance Sheet	Profit and Loss	Balance Sheet	Profit and Loss
Full sample				
-Price Specification	No	No	More	Less
-Return Specification	NA	Yes	NA	More*)
Sub sample				
-Price Specification	Yes	Yes	Not tested	Not tested
-Return specification	NA	Not tested	NA	Not tested

Table 4: Summary of results, *) Only weekly significant.

Although some of the specifications generate highly significant coefficients, these results are not very strong; that is, it is questionable whether the fair value adjustments convey significant information above the salmon prices. It should be noted that while ‘no’ means ‘nothing found’, that is, the nil hypothesis could not be rejected, ‘less’ means that historic cost is proven more value relevant in a two-way test.

The results should be interesting for standard setters, for equity analysts, and for the industry that previously has argued that increased volatility and a high level of transitory items in the profit and loss statement reduce the relevance of the financial information. The results disprove the claims that the fair value adjustments lack relevance, at least when presented together with historic cost information.[iv]

The remaining article is organised as follows: First, I review relevant literature before I explain the institutional background. Then hypotheses are developed, and I present the empirical results. Finally, I discuss the results and make concluding remarks.

2 Literature

The article positions itself in the category of value relevance research that focuses on measurement and classification issues, but it distinguishes itself from previous literature about financial instruments in the feature that the items of inventory (unfinished goods) are not available for sale, but they have to undergo a production process before realised. The study is also distinctive for its dimension that inventory does not generate separate independent cash flows but is appraised based on allocated cash flows. Fish farming is different from forest-oriented production because the production cycle is shorter and the level of human involvement much higher. In this regard, fish farming is similar to production companies.

Some studies of value relevance have focused on time series; that is, have financial statements been more or less relevant over time? (Collins, Maydew and Weiss

1997) Research has also been conducted on the value relevance of disaggregated information (Ohlson and Penman 1992) and about the location of information. Such studies address information recognised directly in the balance sheet and profit and loss statement, in contrast to disclosures and Other Comprehensive Income (OCI) (Jones and Smith 2011; Yu 2013). The implementation of IFRS triggered extensive research about the benefit of IFRS over local accounting standards (Barth, Landsman and Lang 2008), and research is also conducted on the value relevance of US GAAP reconciliations (Amir, Harris and Venuti 1993). Finally, value relevance research has been conducted on earnings and book values (Francis and Schipper 1999) and on accruals and cash flows (Sloan 1996; Pfeiffer and Elgers 1999).

The value relevance research on fair value measurement initially focused on financial instruments held by financial institutions (Landsman 2007). Financial instruments are characterised by independent separable cash flows and are generally readily available for sale. In the case of listed instruments, the valuation uncertainty is relatively low.

Investment property is also characterised by separate cash flows and has limited interaction between assets. Studies have been made about the reliability of the fair value assessment of investment property in IFRS accounts (Dietrich, Harris and Muller 2000; Nellessen and Zuelch 2011), but these papers have a greater focus on estimation bias (Dietrich, Harris and Muller 2000) and the gap between market value and net asset value (Nellessen and Zuelch 2011). Danbolt and Rees (2008) compares fair value measurement for investment property funds and investment funds. The study found that fair value measurement is more relevant than historic cost for both investment property and investment funds and that fair value measurement explains less of the changes in the share prices of real estate funds compared to investment funds. This is probably due to less reliable fair value estimates. Lourenco and Curto (2008) concludes that investors distinguish between recognised fair value and fair value disclosure for investment property. Investment property, with an exception for development projects, is readily available for sale, and a real estate company is closer to an investment company than to a production company. Investment property and production companies have the common characteristic that fair value measurement implies mark to model, rather than mark to market. For our purposes, it is important to note that Gassen and Schwedler (2010) shows that professional investors rank 'mark to model' fair value measurement as the least decision-useful measurement category. It is difficult to see that any inferences from these studies could shape an examination of reporting on inventory and production companies.

Two studies examine whether there is a difference in value relevance between level 1 and 2 and level 3 valuations (Danbolt and Rees 2008; Song, Thomas and Yi 2010). Both studies conclude that level 3 valuations may be less relevant. This may be of particular interest when I look at an asset that is appraised by level 3 and has to undergo a production process that means that the earliest possible realisation is months or even a year ahead. By contrast to these two studies, Altamuro and Zhang (2013) found that level 3 valuations may benefit from management's private information in a way that outweighs potential problems with bias whenever infrequently traded assets are appraised. Research on the differences in usefulness of fair value reporting between the different levels in the fair value hierarchy has been criticised for lack of control for true underlying differences in the assets measured; for example, differences in liquidity (Hodder et al. 2013).

In the case of operational assets, the rationale for fair value reporting is less obvious. Penman (2007) is highly critical against the use of exit prices for assets held by an enterprise that does not speculate in fluctuation in asset prices, but realises value from holding assets and executing a business plan. Fair value is meaningless if there is no link between shareholder value and exit prices. Sellhorn and Stier (2017) reviews research evidence on long-lived operating assets. Except for real estate, accountants rarely use fair value for PP&E and intangible assets. Easton, Eddey and Harris (1993) and Aboody, Barth and Kasznik, R. (1999) conducted studies on revaluation reserves on PP&E, and both studies found a positive association with stock prices.

Argilés, Blandon and Monllau (2011) looked at the differences in short term cash predictive capacity between fair value and historical cost accounting in Spanish agriculture. They found no differences between historic cost and fair value measurement with respect to cash flow prediction.

Argilés-Bosch, Miarons, Garcia-Blandon, Benavente and Ravenda (2018) studied the usefulness of fair value measurement for cash flow prediction by comparing companies that use either historic cost or fair value measurement in a broader context and found that it becomes increasingly difficult to predict cash flows when the portion of biological assets to total assets goes up, but the studies demonstrated that this effect is mitigated, but not necessarily offset, by the use of fair value measurement.

Huffman (2014) matches measurement to asset use in an IAS 41 setting and finds that companies that are matching asset use to measurement; that is, those that apply fair value for in exchange assets and historic cost for assets in use, provide more value relevant information. Apparently, the distinction between in use and in exchange assets is the distinction between bearer plants and biological assets produced to be harvested and sold. It may take 20 years or more to grow a bearer plant, and meanwhile there will normally be no observable market price. Even when the bearer plants start to produce a crop, it may not be an observable market price for the bearer plant, and a fair value estimate may be highly uncertain. By contrast, the production cycle for most agricultural produce is less than two years; thus, it is difficult to make any inferences with respect to whether the effect observed relates to valuation issues and whether the assets are held for use or in exchange. The distinction between assets held in use and those held in exchange does not fit very well for the stock of biological assets. While held in use may fit for juveniles of salmon that are input to a production process, harvestable fish is best be described as a commodity ready for market. The distinction of ‘fixed assets versus inventory’ seems more relevant for our purposes. Given this, bearer plants have been scoped out of IAS 41 and made an IAS 16 asset because historic cost provides information that is more relevant.

Botosan and Huffman (2015) concludes that fair value is more decision useful for assets expected to be realised in exchange while historic cost is more decision useful for in use assets and cash flow prediction. Their work makes use of accounting theory as well as valuation theory and practice. The concept of decision usefulness is itself problematic; standard setters, scholars and practitioners have not yet agreed on an undisputed measure of decision usefulness (Gassen and Schwedeler 2010).

Goncalves, Lopes and Craig (2017) tests the value relevance of biological assets with no comparison to historic cost, i.e. whether biological assets have a significant coefficient when partitioned out from net assets. The study finds a significant coefficient, but it also concludes that no more of the variability in share prices is explained. Filho, Machado and Machado (2013) found historic cost more value relevant than fair value when studying 25 listed Brazilian firms between 2008 and 2009. Silva and Nardi (2018) also applies the method of partitioning biological assets out of net assets in a in a cross-country study and concludes that measurement method is irrelevant to investors.

Lyngtun and Welo (2012) first addressed the issue of value relevance of fair value measurement in the salmon industry.[v] In 2017, Misund tested the value relevance of fair value measurement in the salmon industry by comparing R squared in a price specification when share price is regressed against profit and loss measures inclusive and exclusive the fair value adjustment, and the study concludes that historic cost is more value relevant than fair value. Extending beyond the Lyngtun and Welo (2012) research, this study applies a larger data set and a broader set of tests, as well as different econometrics.

3 Institutional Background

3.1 Salmon farming

Worldwide and in Norway, fish farming is a fast growing industry. According to the Food and Agriculture Organization of the United Nations, the estimated value of the world's aquaculture production in 2013 was USD 157 billion. Ninety percent of the world's population of wild fish stocks are considered overfished, and in the future, most of any increase in consumption of seafood (considered to have positive health effects) will have to come from fish farming. The seven listed salmon farmers on the Oslo Stock Exchange had a market capitalisation of NOK 162 (EUR 18) billions, and as of December 12, 2016, these companies constituted 7.6% of all assets on the Oslo Stock Exchange.

The salmon farming industry is characterised by a production cycle of 2.5 to 3 years. In a normal production cycle, the mature salmon spawn in late fall and the fertilised eggs hatch after 3-4 months. The juvenile salmons or fingerlings are grown onshore in freshwater tubs for 12-14 months until May of the following year, when they have reached a weight of 70 g to 100 g. At this stage, the fish adapt to seawater, become smolt[vi] and are released into sea cages. Recently, the industry has begun to stretch the on-shore period as a response to disease problems and to produce smolt of 150 g and even 200 g. The industry is able to manipulate the natural seasonal variation and sometimes release smolt in the fall.

Most of the large salmon farmers are vertically integrated; that is, they produce their own smolt. In 2016, smolt cost constituted less than 10% of production cost for harvested salmon

	Salmon	Smolt
Smolt (eggs in smolt column)	9.4 %	17.5 %
Feed	43.0 %	18.1 %
Salary	6.7 %	20.2 %
Depreciations	5.3 %	8.7 %
Other operating expenses	25.7 %	35.5 %
Harvesting including freight	9.6 %	
Total production cost	100 %	100 %

Table 5: Cost Structure 2016, Source: Fiskeridirektoratet

For salmon production, other operating expenses include cost related to prevention and fighting sea lice, which are substantial. For smolt, for example, other operating expenses include vaccination, electricity and water treatment. The smolt develops in sea cages to harvestable salmon of approximately 5 kg over a 16-20 month period. Due to the long production cycle, a substantial amount of inventory is built up. The number of inventory days (Inventory x 365 / Cost of goods sold) based on inventory measured at fair value varies due to seasonal variations in quantity and volatile prices, but this number was approximately 400 days during 2015 and rarely below 300 days or above 500 days during the observation period from 2006 to 2015.

Biological assets reported at fair value constituted 30 % - 50 % of the fish farmers' total assets. The fair value adjustment of inventory on the balance sheet is in the range of 5% of Enterprise Value based on market value of the equity,[vii] but this could be larger or smaller (and even negative), as companies have been taking losses.

The industry has been very profitable as evidenced by high market capitalisation compared to net asset values (Figure 2) and high prices on licences to operate. The industry is regulated through a licence regime partly to control environmental effects and partly to control spill over effects between producers, in particular the spread of diseases. A side effect of the licence regime is substantial barriers to entry.

Figure 2 uses unadjusted accounting figures, which are the same figures that are used in regression models. Because the companies have acquired concessions at very different prices, the different P/B multiples in Figure 2 do not necessarily reflect differences in profitability and growth opportunities. In Table 6 below, Price / Book is based on Market Capitalisation plus Net Interest Bearing Debt (P) / Net Operating Tangible Assets (B). Both share prices and book values are as of 31.12.15.

	Marine Harvest	Salmar	Grieg	Bakkafrost	Lerøy	NRS	SSC
P/B	3.9	4.8	2.1	4.1	3.8	4.9	1.2

Table 6: Price / Book as of December 31, 2015. Sources; Share prices are closing prices on the Oslo Stock Exchange. Accounts with reporting currency other than NOK are translated by foreign exchange rates obtained from Norges Bank (the Central Bank of Norway); both rates are as of the date nearest to 31.12.15.

During the period from December 21, 2015 to December 31, 2016, the Oslo Stock Exchange Seafood Index (not dividend adjusted) increased from 618 to 974, by 58%; the P/B has increased further since December 31, 2015. In the same period (2016), salmon prices increased from NOK 46 per kg to NOK 74 per kg. Figure 3 shows that although highly volatile, the prices reached a historically high level in late 2015. The low prices in 2011 caused several producers to take losses and sent the P/B ratio towards 1 (Figure 2). Relatively low salmon prices combined with generally low asset prices during the finance crisis also resulted in low P/B ratios in late 2008 and in early 2009.

Salmon is close to a commodity. Differences in quality exist and will affect prices, but it is difficult for a producer to establish a position as high quality producer. The producers are to large extent price takers in a fluctuating commodity market and are forced to be active players in a cost cutting game.

Fresh salmon and frozen salmon are not perfect substitutes for one another, harvesting can only be delayed for shorter periods and shortage in current supply cannot be covered by future production. Accordingly, it is not reasonable to assume that spot salmon prices will follow a random walk. Analysts assume that future short-term supply fluctuations will cause price fluctuations and try to predict them. The futures price in the derivative market, which is likely to influence the valuation of current inventory, may come closer to a random walk in an efficient market.

Furthermore, it is important to consider some seasonal patterns. Although juveniles may be released into seawater at any time, they are typically released in April or May, which is the natural biological cycle. Their growth is influenced by light and temperature. Although the pace of growth is fastest when the fish are small, the total accumulation of biomass is fastest in quarter three when a large stock of fish, normally two generations, approaches harvestable size and there exist good farming conditions.[viii] The natural biological cycle, regulatory factors, production planning, and demand govern harvesting. If we look at the biggest producer, Marine Harvest, harvesting in quarter four exceeds the annual average by 12% during the observation period.[ix] Volumes in stock, however, do not drop significantly during quarter four. At the same time, salmon prices exceed the annual average by 11% in quarter four. For Marine Harvest, gross margin based on transaction based historic cost for quarter four exceeds annual average by 16%.[x] If prices are systematically lower in quarters one and two, we should expect a negative fair value adjustment in the fourth quarter because we are moving closer to low prices. For some reason, this is not the case. During the fourth quarter, the volume of harvestable fish may decrease, but so does the volume of small fish due to growth. The average size of the fish increases. The fair value adjustment is very small for juveniles because any residual earnings are attributable to the concession.[xi] In total, the effect of the fair value adjustment exacerbates the seasonal variations in inventory rather than smoothing them.

3.2 IAS 41 has been controversial

IAS 41 covers a variety of biological assets, from chickens with a production cycle of 9 weeks and substantial human involvement in the production process to forests that may grow for 80-90 years with little or no human involvement. IAS 41 has been controversial since the standard was issued (Bernhoft and Fardal 2007; IASB 2012). One issue has been biological assets where no biological transformation goes on, for example, bearer plants, and the question of when to recognise a biological asset that grows on a bearer plant. Other concerns are related to questions of reliable measurement, for example, the problem of uncertain and unobservable valuation parameters. In Norway, the ability to measure reliably and the issue of usefulness have been debated. Several authors draw lines between usefulness and relevance (Francis and Schipper 1999; Barth et al. 2001). Francis and Schipper (1999) define value relevance as a statistical association between accounting information and market values or returns, 'Value relevance is measured by the ability of financial information to capture or summarize information, regardless of source, that affect share values'. Under such a definition, no claims are made with respect to timeliness or expectation formation. Alternative interpretations for value relevance, still according to Francis and

Schipper (1999), include the view that financial statement information capture information about intrinsic share value, contain variables applied in valuation models or that assist in predicting such or are forming expectations.

When IAS 41 was introduced, it presupposed the principle that fair value is the best, or, in some cases, the only, accounting tool available to represent biological transformation (IASB 2012). Despite this, no convincing evidence has yet been presented with respect to whether fair value is the most value relevant measurement method for inventory that has to go through a production process, where significant contributory assets are involved, where the window of optimal harvesting is rather narrow, and the prices highly volatile. So far, no one has presented convincing evidence for the issue of usefulness. In such circumstances, it is interesting to note that US GAAP applies historic cost.

Some of the controversies have to do with the differing views about the relative importance of the balance sheet and the profit and loss statement. In the balance sheet, fair value measurement of the inventory captures information about size and timing of future cash flows, but only for the period until the producers harvest the current stock of inventory. It cannot be applied directly as input on a valuation model in the same way as can the fair value of non-operational assets, and it does not solve the problem of predicting volumes, prices and production cost beyond that point of time any better than does historic cost measurement.

Given these concerns, analysts may have to revert to the profit and loss statement for predictive purposes. In a situation where production volumes are close to constant and where harvesting equals regeneration, changes in fair value are predominantly due to price fluctuations. Yet even though salmon prices clearly are a relevant input to a valuation model for a fish farming company, changes in fair value reported to profit and loss may not be relevant. In this context, relevance, according to SFAC No 5 (FASB 1984), ‘refers to the ability of the item to make a difference to decisions of financial statements users.’ IFRS Conceptual Framework has a similar definition (IASB 2018)

Research on value relevance is unlikely to end the discussion about usefulness. What is more, for those who focus on the profit and loss statement, fair value measurement in the balance sheet will render profit and loss effects due to price fluctuations with questionable predictive value. Depending on the levels of inventory and whether the price change occurs early or late in the reporting period, the effect of fluctuating prices may move net income for the period away from its recurring level.

Some of the research on value relevance may be germane for our purposes, because evidence of value relevance may have some bearing on the discussion of reliability. Following Francis and Schipper (1999) and Palea (2014), fair value reporting is value relevant, and the fair value estimates are reliable, if share price movement and stock market return are better described by fair value accounting than by historic cost accounting. According to Francis, LaFond, Olsson and Schipper (2004), value relevance captures combined relevance and reliability.

3.3 IFRS reporting of farmed fish in Norway

Norwegian salmon producers report transaction based sales and cost of goods sold on a historic cost and matching basis. The fair value adjustment in the profit and loss statement is reported separately. The reported figure on the balance sheet is fair value, but the disclosures present reconciliation to historic cost. For practical purposes, the present study will occasionally refer to the ‘fair value adjustment in the balance sheet.’ It will use the term ‘ΔFV_t’ for the fair value adjustment in the profit and loss statement in period t and ‘FV_t’ the fair value adjustment to the balance sheet ending period t.

$$\Delta FV_t = FV_t - FV_{t-1}$$

Net assets and aggregate profit and loss measures may be reported according to historic cost or fair value. This is specified; B(HC) refers for example to net assets based on Historic Cost. The fair value adjustment creates a temporary difference under Norwegian tax legislation. Tax adjustments are applied to ensure consistency between pre-tax and post-tax accounting figures. This is also specified whenever relevant.

The production cycle is long, resulting in a substantial amount of inventory of immature fish. This is an important feature when one wants to examine the association between inventory measurement and share price. Furthermore, the final product is best described as a commodity with an observable market price. This presents an excellent opportunity to compare historic cost and fair value reporting within year and within firm.

Fair value measurement of inventory has two implications. Most important is that weight gain is recognised as income; income recognition moved from when the fish is handed over to the buyer, transaction based, to when the fish gains weight. This was labelled ‘accretion accounting’ by Philips in 1963, and the effect may be called ‘the accretion effect’. The other implication is that inventory at the beginning of the period that is still on the balance sheet is remeasured. This may be named ‘the price effect’.

The fair value adjustment in the profit and loss statement ΔFV_t consists of three elements:

(1) The value above cost of the weight gain during the period measured at closing balance prices. This is always positive as long as the margin is positive (unless mortality causes a reduction in aggregate biomass).

(2) The impact of price changes on the part of the opening balance (time t-1) of inventory that is still on the closing balance (time t).

(3) A release of the fair value adjustment on harvested fish (a correction to cost of goods sold that is reported at historic cost).

Many producers report 1-3 as one figure with no further specifications or have at least done so during a part of the observation period.

The fair value estimates could potentially convey information in excess of salmon prices; for example, about size distribution, health status and cost to completion, and other factors, but lack of transparency makes this information difficult to extract. Detailed information may also be available through guidance and other auxiliary information. Historically, the industry has not disclosed sufficient information to allow analysts to make corroborative calculations of fair value. In particular, information about size distribution has been too coarse.

Generally fair value measurement has been considered more susceptible to manipulation; in particular, if valuations are model based (level 3, IFRS 13.72). The fair value measurement of inventory has an ambiguous impact on management's ability to manage results. Fair value measurement introduces estimates that may be manipulated. The two most important assumptions are expected price at the time of sales and cost to completion. By contrast, the timing of harvest will have little or no impact on reported results under fair value measurement (accretion accounting), in contrast to transaction based historic cost, because the income is already recognised. In this case, earnings cannot be manipulated either through timing or through selection of population to be harvested (Different population may have different production costs). Fair value measurement also eliminates the effect of different principles for cost allocation and different treatment of mortality.[xii] Improved knowledge about and control over biomass may also improve the guidance proffered for future harvesting; therefore, equity investors may benefit from fair value measurement even if they do not use the information provided.

Ideally, the fair value adjustment in the profit and loss statement should only encompass the three elements described above, but it is likely to express any effect of management bias. Of course, management bias could include some form of deliberate manipulation, but such bias might also be the effect of estimation uncertainty and result from the use of imperfect valuation models. Accordingly, ΔFV_t encompasses any estimation error made in period t and estimation errors made in previous periods that are released in period t. Potentially, this makes ΔFV_t noisy.

3.4 Data

Eight fish farming companies have been listed on the Oslo Stock Exchange during the period under investigation. One company, Lighthouse Caledonia, which was listed for a shorter period, is excluded. Austevoll, which has a controlling interest in Lerøy, is excluded because the only inventory reported at fair value is the inventory held by Lerøy. Although there are some differences in level of geographical diversification, size and vertical integration, the sample could be defined as ‘pure play’ competitors (or peers). Even so, significant company fixed effects should be expected. Similarly, there may be time fixed effects. In particular, the pricing in the stock market will vary, for example, due to variations in the risk-adjusted discount rate. The companies are to varying degrees affected by shifting foreign exchange rates, among other things. Company and time effects that also capture different levels of salmon prices will be taken into consideration, partly, by the use of panel data with fixed effects.

The analysis is based on hand-collected data from interim financial statements for each quarter for the period fourth quarter 2006 through the fourth quarter 2015. The tests for incremental value relevance are performed on unbalanced panel data. This gives 243 (235) data points for a price (return) specification. The tests for relative value relevance are based on ordinary multiple regression analyses on the full data set with no identification of company or period, where fair value and historic cost are considered to be independent samples, thereby giving 486 (470) data points in a price (return) specification. The hypotheses are tested with both price and return specifications. The tests will mainly be based on the significance of regression coefficients, but in one occasion, the differences between R squared are tested for significance.

4 Hypothesis Development

4.1 Logical model

Balance sheet

The share price is affected by expected cash flows beyond the current production cycle; thus, at best the fair value of inventory may only partly explain share prices. There is a clear logical link between expected future salmon prices and share prices through a valuation model based on discounted cash flows. There is also a clear logical link between expected salmon prices for the next 0-18 months and the fair value adjustment in the balance sheet. This is also evident through a bivariate correlation of 0.54 between the fair value of inventory and the current salmon (spot) price. The effect of accretion accounting should also contribute to a closer association between share price and net assets measured at fair value.

Changes in the salmon prices, based on general valuation theory, will influence the share prices not only because the companies hold a stock of inventory but also because the estimated level of future earnings are updated. A spike in the salmon prices that is expected to last for a relatively short period may not impact share prices above the direct impact on inventory value.

Profit and loss statement

If we assume a 0-growth steady state production and constant inventory, we may consider a permanent price shift that either takes place in the beginning of the reporting period or at its end, but before the books are closed; that is, before the valuation of inventory is carried out. If the permanent price shift takes place in the beginning, it will have a full impact on the historic cost earnings, and the fair value adjustment of inventory will move earnings measured at fair value away from recurring profit, depending on the size of the inventory. If, however, the price shift takes place in the end of the reporting period, the fair value adjustment may be more informative. In particular, if the number of inventory days is close to the duration of the reporting period. With reporting periods of 90 days and 400 inventory days, I expect fair value measurement to be noisier than historic cost.

If the level on inventory shows large variation, fair value measurement has the desirable feature of disentangling net income from random differences between harvesting and regeneration. Transaction based historic cost accounting tells little about the value added in forestry.[xiii]

Predictable earnings variations, for example, seasonality, may have little impact on share prices. Fair value measurement may both smooth and exacerbate seasonality depending on whether seasonality affects regeneration, sales (harvesting) or product prices. Given this, the value relevance of fair value measurement may be ambiguous.

A fair value adjustment could be a predictable result of volume changes, changes in size distribution, or moving along the price curve. It could also be the result of new information. Only in the latter case, should we expect an association with changes in share price. Even though the fair value adjustments are based on expected prices at the point of harvesting, the stock market may be able to foresee price movements in the salmon market before there is an impact on the financial statements; thus, movements in share prices may precede the fair value adjustments.[xiv] To summarize, many factors influence on $\Delta FV_{t,}$ and these factors may interact; therefore, it is difficult to predict an association between ΔFV_t and (changes in) share prices.

4.2 Relative vs incremental value relevance

The fair value adjustments in the financial statements are incrementally value relevant if there is information content; that is, if a prediction of share price or return based on historic cost information may be improved by information about fair value, and there are good reasons to expect this. The assertion about incremental value relevance is not very strong. The assertion about more value relevance; that is, that fair value information has stronger predictive power than historic cost (or vice versa) is much stronger. In particular, for the fair value adjustment in the profit and loss statement, ΔFV_t, the expectations are neutral. We do have a theoretical model suggesting that fair value is more relevant in the balance sheet, but not so for the profit and loss statement. In the profit and loss statement, value relevance depends on which effects dominate.

4.3 Valuation model

In a linear model, it is common to regress share price against current book value and earnings (Collins et al 1997; Francis and Schipper 1999; Gjerde, Knivsflaa and Saettem 2007). Ohlson (1995) and Feltham and Ohlson (1995) show that it is meaningful under certain conditions. One such condition is clean surplus accounting. It is normal (Clarkson, Hanna, Richardson and Thompson 2011) to assume clean surplus accounting or that the expected value of dirty surplus is nil. OCI is not included in the Net Income definition. OCI for the companies in the dataset mainly consists of translation effects related to foreign subsidiaries, pensions and employee options. Although it cannot be precluded that the expected value of future OCI is not nil, OCI does not encompass inventory related items.

When share prices at time t are regressed against net assets at time t-1, transactions with the owners during the measurement period is a problem. For Net Assets I apply the definition

$$B_{t-1} \equiv B_t - NI_t$$

Even if share issues or buyback programs are carried out at fair value (they are not dilutive), they will affect analyses carried out on share level; for example, when accounting measures are divided by the issued number of shares. No attempt is made to adjust for such effects. The ‘within period, within company’ design of the test should mitigate any effects of dirty surplus or share issues/buybacks.

Expectations about changes in salmon prices affect future earnings expectations and thereby share prices. Expected changes in salmon prices do not affect historic cost measurement except for rare lower cost market adjustments. Fair value measurement in the financial statements will presumably convey information about the salmon prices. I develop tests to see if the fair value adjustments are incrementally value relevant and whether fair value measurement is more value relevant than historic cost measurement.

4.4 Hypothesis 1

Hypothesis 1 tests incremental value relevance:

- $H0_{1A}$: The fair value adjustment recognised in the balance sheet is not incrementally value relevant when historic cost is the basis.

- $H0_{1B}$: The change in the fair value adjustment recognised in the profit and loss statement is not incrementally value relevant when historic cost is the basis.

4.5 Hypothesis 2

Hypothesis 2 tests whether historic cost or fair value measurement is the more value relevant.

- $H0_{2A}$: Net assets reported according to historic cost is more value relevant than net assets reported according to fair value.
- $H0_{2B}$: Profit reported according to historic cost is more value relevant than profit reported according to fair value.

The aspect of more or less value relevant is examined through a two-way test.

5 Empirical Analysis

5.1 Research Design

The value relevance of accounting information may be assessed by using price, return and abnormal return regressions (Barth et al. 2001). This paper focuses on price and return regressions. Both the significance of regression coefficients and differences in R squared will be tested.

First, I apply regression models to investigate whether the share prices or stock market return best can be explained by the historic cost accounts or whether the explanatory power of the model could be improved by adding the fair value adjustments to the right hand side. Hypothesis 1 takes historic cost as a base and looks at the marginal benefit of having access to information about fair value (Amir, Harris and Venuti 1993).

The price level is tested under the following:

(1) $V_{i,t} = \alpha + \beta_1 NI_{i,t} + \beta_2 \Delta FV_{i,t} + \beta_3 B_{i,t-1} + \beta_4 FV_{i,t-1} + \beta_5 C_{i,t} + \epsilon_{i,t}$

V=Share Price, NI=Net Income, FV=Fair Value Adjustment, ΔFV= Change in FV Adjustment, B=Booked Equity (Net Assets), C=Control Variable (may be more than one). The numeral i denotes company i while t denotes period t. All accounting figures on the right hand side are normalised by the number of issued shares at the balance sheet date.[xv]

As $B_t = B_{t-1} + NI_t$,[xvi] I do not use B_t which comprises NI_t on the right hand side. Similarly, $FV_t = FV_{t-1} + \Delta FV_t$. If the salmon price increases in period t, the effect will hit both the independent variables FV_t and ΔFV_t. $B_{t-1} + FV_{t-1}$ together represent net assets based on fair value t-1 while $NI_t + \Delta FV_t$ together represent the result based on fair value t. It should be noted that B_{t-1} and FV_{t-1} are not directly affected by the salmon price at t (this price is not known). C is any control variable.

I expect positive coefficients for $\beta_1 - \beta_4$. The primary test of the pricing hypothesis would be to compare

$$H0_{1A}: \beta_4 > 0$$

$$H0_{1B1}: \beta_2 > 0$$

for balance sheet and profit and loss, respectively.

The change in fair value adjustment in the profit and loss statement can be tested based on a return specification with stock market return on the left hand side. On the right hand side, the independent variables are normalised with share prices.

(2) $\quad R_{i,t} = \alpha + \beta_1 \frac{NI_{i,t}}{V_{i,t-1}} + \beta_2 \frac{\Delta FV_{i,t}}{V_{i,t-1}} + \beta_3 C_{i,t} + \varepsilon_{i,t}$

R_t is return for company i in period t.

$$R_t = \frac{V_t + D_t}{V_{t-1}} - 1, \quad D_t = \text{Distribution}$$

The primary test is

$$H0_{1B2}: \beta_2 > 0$$

In both the price and the return specifications, NI is split in 'Noplat' and 'Financial' based on the method described under data sources and manipulation. This reduces the amount of noise and the coefficients for Noplat and ΔFV are easier to compare than NI and ΔFV. The formal test is the same.

In hypothesis two, I test whether fair value is more value relevant than historic cost by considering the two reporting regimes as independent samples (Biddle, Seow and Siegel 1995). Let $B_j = B(HC) - B(HC)I_j + B(FV)I_j$ and $NI_j = NI(HC) - NI(HC)I_j + NI(FV)I_j$. I_j=0 for J=1 and I_j=1 for J=2. These expressions allows B_j=B(HC) when j=1 and B_j=B(FV) when j=2. Similarly for NI_j

(3) $\quad V_{i,t,j} = \alpha + \beta_1 B_{i,t-1,j} + \beta_2 NI_{i,t,j} + \beta_3 I_{i,t,j} + \beta_4 B_{i,t-1,j} * I_{i,t-1,j} + \beta_5 NI_{i,t,j} * I_{i,t,j} + \beta_6 C_{i,t,j} + \varepsilon_{i,t,j}$

i=1,….8, t=1,…37, j=1,2.

Here B and NI will appear both based on Historic Cost and Fair Value. I expect positive coefficients for $\beta_1, \beta_2, \beta_4$ *and* β_5. The hypothesis will be tested for the balance sheet by analysing β_4.

$$H_{2A}: \beta_4 > 0$$

The corresponding test for the profit and loss statement will be

$$H0_{2B1}: \beta_5 > 0$$

The profit and loss statement can be tested based on a return specification

(4) $$R_{i,t,j} = \alpha + \beta_1 \frac{NI_{i,t,j}}{V_{i,t-1,j}} + \beta_2 I_{i,t,j} + \beta_3 \frac{NI_{i,t}}{V_{i,t-1}} I_{i,t,j} + \beta_4 C_{i,t,j} + \varepsilon_{i,t,j}$$

I is still an indicator, and NI will appear both based on Historic Cost and Fair Value. Here NI is split in Noplat and Financial; thus, Noplat appears on historic cost and fair value format. The formal test is on Noplat, while Financial may be considered as a control variable.

The formal test is

$$H0_{2B2}: \beta_3 > 0$$

An alternative test is to compare R squared based on separate regressions. Fair value measurement is more value relevant than historic cost measurement if a significantly higher part of the volatility in stock market return is explained.

5.2 Expectations

The coefficients for B, FV, ΔFV, and Noplat should all be positive. Financial is on average close to nil, and the sign is uncertain.

I expect the coefficient for ΔFV to be lower than the coefficient for Noplat due to lower earnings persistency (Ramakrishnan and Thomas 1998). As the ΔFV is the difference between two valuations, I expect it also to be more susceptible to measurement errors and to correlating variables that are omitted.

5.3 Econometric Challenges

Measurement errors

The difference between booked equity and share price will reflect accounting conservatism and measurement error as established within the accounting rules (I refer to the requirement that financial statements should be free of material misstatements). A specification problem will occur if systematic measurement problems or biases related to the fair value adjustment in the balance sheet directly affect the fair value adjustment to the profit and loss statement in the subsequent period. If, however, the fair value adjustment is systematically too low by 30%, this could be interpreted as if only 70% of the inventory is subject to fair value adjustment, and there will no dependency between the adjustments in the balance sheet and the adjustment in the subsequent profit and loss statement. It becomes more complicated if the measurement error varies in price level. If present, this problem will reduce the value relevance of fair value accounting.

Causal relations

If a producer holds large quantities of harvestable inventory, the effect on the share price of a change in product prices should be close to that of a change in fair value of a financial item. For inventory of not yet harvestable fish, changes in product prices may reflect cost changes that hit the entire industry; thus, this will have little impact on the fair value of the inventory (and share prices).

Changes in the salmon prices could also affect the expectations about salmon prices and production volumes in the future and might even affect expectations about the long-term equilibrium price. In this case, there could also be effects on the share price that are not reflected in the financial statements. The expectations about the persistency of a price change may depend on the current level of the price.

According to Francis and Schipper (1999), value relevance describes an association, not a causal relation. In an investment fund, there is a causal relation between the net asset value and the fair value of underlying portfolio companies although the fair value of the underlying companies changes for a reason.

The association between an increase in the price of operational assets and share price is far more complicated in a production company; therefore, I expect the association to be weaker, that there will be lower value relevance. The discussion about controlling for salmon prices shows that more control variables are unlikely to solve this problem

Control for salmon prices

The tests that are listed above demonstrate that fair value is (incrementally) more value relevant if it better explains share prices or stock market return. Collectively, they constitute a test of the association between the fair value adjustments and share prices or stock market return.

In this context, it may be interesting to control for salmon prices both in order to establish whether the fair value adjustment conveys other relevant information than the salmon price and to control for the possible impact on the share prices that may not be explained by the fair value adjustments in the accounts. By contrast, the purpose of fair value accounting is to render the accounting information more relevant by capturing information about the assets from the outside world. Given this, to control for salmon prices may defeat the purpose of the test. I want to test whether the share prices are better explained by fair value information; yet by introducing a control variable that correlates with both the share price and the fair value information, I may introduce a multicollinearity problem.

Controlling for the observed spot salmon price at t has a dramatic impact on both the levels and significance of the coefficients for the fair value adjustments, and they may assume levels that are counterintuitive and change sign (Table 2.2). Testing whether the fair value adjustments convey information other than the salmon prices could be important, but controlling for observed salmon prices at t does not seem to be the econometric solution.

I will offer an alternative two-stage approach to control for the effect of salmon prices. For each company, FV is regressed against salmon prices and ΔFV is regressed against salmon prices and changes in salmon prices.

(5a) $FV_{i,t} = \alpha_i + \beta_{i,1}\text{Salmon Price}_t + \epsilon_{i,t}$

(5b) $\Delta FV_{i,t} = \alpha_i + \beta_{i,1}\text{Salmon Price}_t + \beta_{i,2}\Delta\text{Salmon Price}_t + \epsilon_{i,t}$

The residuals, observed minus predicted, for each of the two regressions replace FV and ΔFV in specification 1 and 2. These residuals are independent of salmon prices, and changes in salmon prices and salmon prices are introduced as control variables.

Share price

Another crucial question is the matter of when the share price should be collected. The valuation model is on the format

$$V_t = \alpha + \beta_1 B_{t-1} + \beta_2 NI_t + \beta_3 C_t + \varepsilon_t$$

where C_t could be any control variable, for example, salmon price.

Lang, Raedy and Yetman (2003) suggests measuring share price six months subsequent to the fiscal period end when using annual data. The reasons for this is that financial statement information is presumably not known until the accounts are released and because share prices may not reflect the new information immediately. Aboody, Hughes and Liu (2002) suggests adjusting the model for market inefficiencies.

The salmon prices are highly volatile and have a high impact on share prices; a correlation of 0.31. In order to avoid the effect of subsequent changes in salmon prices on the share price, I collect the share price as of the end of the reporting period, at time t. This departs from normal practice where an observation lag of 3-6 months is normal. When the financial statements are released, most of the new information is common for historic cost and fair value accounting. As the companies are guiding on future harvesting and biomass development, it may be reasonable to assume that a semi-efficient stock market is able to predict the fair market value adjustments and that the share prices already reflect the fair value adjustments to be reported at time t. The IASB Conceptual Framework presupposes a semi-efficient stock market. Due to the 'within company within period' design, new information that is common for historic cost and fair value accounting is in any case irrelevant. In such a circumstance, even if the financial statements present information that is unknown to the market when the share price is collected, it is assumed that this information does not affect the study of relative differences in value relevance between historic cost and fair value measurement. Furthermore, the potential effect of collecting the share price prior to the release of the accounting information likely would be to underestimate the value relevance of both the historic cost accounts and the fair value adjustment. The problems relating to controlling for salmon prices are likely to be exacerbated if share prices are collected subsequent to the reporting date.

We cannot preclude that ΔFV comprises information in addition to the (change in) salmon price, information previously unknown to the stock market and not reflected under the historic cost measurement. The analysis in Table 2.2 is also replicated for the sub-sample with share prices collected 90 days subsequently to the balance sheet date. At that time, the interim financial statements would have been released, but dividends not yet paid. The regression explains less of the variations in the share price 90 days subsequent to the balance sheet date, and the P tests become weaker for all the independent variables. By collecting share prices before the accounts are released, the analysis may become biased against finding value relevance, but noise due to the effect on share prices of subsequent changes in product prices, is avoided.

Foreign Exchange

Fluctuations between the NOK and the EUR have contributed to large fluctuations in salmon prices denominated in NOK. The reason for this is that most of the salmon is consumed within the EU and the demand is driven by the EUR denominated price. An investor maximizing EUR wealth is not better off whenever the fair value of harvestable inventory, measured in NOK, increases because the EUR appreciates against the NOK (harvestable inventory is close to a monetary item). By contrast, the investor does benefit because the cost base of salmon farmers with large operations in Norway is partly denominated in NOK. However, this is a more indirect effect related to future cash flows, but not to holding inventory.

A Norwegian investor will benefit from holding a large balance of harvestable inventory. Shareholders who are likely to maximize their NOK wealth control some of the companies: Salmar, Grieg and Leroy. Foreign investors control other companies. Because of this, we may assume that the companies may take different approaches to FX risk hedging.

The different effects of FX changes to each of the companies caused by true differences in their business models are dealt with by using panel data. The effect, if any, on value relevance from hedging activities should only be that FX changes introduce noise to the financial reporting that the stock market disregards; that is, in reduced value relevance.

Correlated Omitted Variables

In addition to the analytical problems caused by FX, we raise the question of whether FX causes a correlated omitted variable problem, giving rise to the question of whether to control for the NOK/EUR exchange rate. The concerns are the same as whether to control for salmon prices; this may defeat the purpose of the test. The bivariate Pearson correlation between share price and exchange rate is 0.16, and the correlation between salmon price and exchange rate is 0.39 (both significant). These correlations indicate that the salmon and share prices denominated in NOK increase whenever the NOK depreciates against the EUR.

In the same way as controlling for salmon prices, controlling for the NOK/EURO exchange rate has a dramatic impact on the level and significance of the regression coefficients, but this does not change the conclusions.

Economic rent

Due to public regulation and a challenging biological situation (in particular, problems with sea lice), the supply has been constrained, and this has caused favourable prices. Producers in other countries (Chile, in particular) have also experienced problems of supply. Furthermore, the effect of a depreciation of the NOK against the EUR has caused the prices to be even more favourable measured in NOK. Although the challenging biological situation has some negative cost implications, the industry is very profitable, and the Price / Book (P/B) factor is high, figure 3. Given all these eventualities, it is likely that the long-term equilibrium price for salmon is below the present level (Penman 1991.) Large variations in P/B between the companies are partly due to differences in profitability, but the variations are also due to differences in the historic acquisition price of licenses. Large variations in residual income might change the relative importance of net assets and income in pricing models, but company fixed effects when panel data is applied, should alleviate the effect.

Competing information sources

Competing information sources are always available. Because value relevance merely claims that there is an association between stock price and accounting information, it does not matter from where the stock market information comes in a price specification. A return specification that does not include net assets as an independent variable is likely to be more sensitive to expectation formation. If the stock market anticipates changes in salmon prices before such changes affect financial information, return may come in one period and income in following periods.

OLS assumptions

When measuring value relevance by return specifications, value relevance could be tested both by the significance of coefficients and by looking at the marginal change in adjusted R squared by including the fair value adjustment.

Price regressions on accounting data are unlikely to satisfy all OLS-regression assumptions. Scale effects exist because larger firms generally have larger market capitalizations, larger book values, and larger earnings when compared to smaller firms (Barth and Kallapur 1996; Brown, Lo and Lys 1999; Easton and Sommers 2003). Scale effects are dealt with partly by using panel data and by using data that are deflated by market capitalisation whenever feasible. The within firm design will also alleviate the scale problems present when R squared is compared between samples in level models.

R-squared might then be be overstated, but the effect should be similar for historic cost and fair value figures because they stem from the same sample. Supplementary use of return specifications will also reduce the problem because the return regressions are deflated by prior period share price.

Applying robust standard errors reduces the problem of heteroskedasticity.

5.4 Data sources and data manipulation

Accounting data are derived from publicly available interim financial statements. All companies except Bakkafrost (DKK) and SSC (GBP) apply the NOK as the functional and reporting currency. Both the balance sheet and the profit and loss statement of these companies are converted to NOK based on the exchange rate of the balance sheet date. Share prices are daily closing prices on the Oslo Stock Exchange (denominated in NOK), and salmon prices are the average export prices for fresh salmon for the week ending at the reporting date obtained from Statistics Norway (also nominated in NOK). Foreign exchange rates are obtained from Norges Bank (the Central Bank of Norway). Salmon forward prices are the daily closing prices obtained from Fish Pool.

Share prices, salmon prices and FX rates are obtained electronically while accounting data are collected manually.[xvii] All data are compared at reporting (balance sheet / closing) date or as of the nearest possible date.

For the accounting data, no adjustments are made for items asserted to be unusual or non-recurring. No other manual adjustments or transformations are made except for those described below and under the definition of variables.

Net Income and Noplat

Net Income, NI, is split in ‘Noplat’ and ‘Financial’. Noplat will be based on either historic cost (HC) or fair value (FV). NI = Noplat(HC) + ΔFV + Financial.

Tax

All tax is treated in accordance with IAS 12 and the nominal method, which implies that temporary differences are multiplied by a nominal tax rate and there is no discounting. The companies are located in various countries with different tax rates, but 25% is assumed a sufficiently accurate estimate for the average tax rate.

Net Income and Net Assets are both post-tax figures. To be consistent, all pre-tax figures in the financial statements are tax adjusted based on the template tax rate. In the profit and loss statement, the actual tax expense must be allocated between EBIT (in order to arrive at Noplat), the fair value adjustment (in order to arrive at ΔFV), and Financial. The template tax rate is applied to arrive at Noplat and ΔFV; therefore, the residual is allocated to Financial.[xviii] Accordingly, the differences between actual tax and template tax on EBIT and ΔFV will be allocated to Financial.

If there are systematic differences between template and actual taxes on EBIT, we should expect such differences to cause a correlation between Noplat(HC) and Financial. There is an insignificant correlation of 0.06 between Noplat(HC) and Financial.

Fair value adjustments; FV and ΔFV

The independent variables FV and ΔFV are tax-adjusted figures, not the figures reported directly in the financial statements.

We have in principle the relations

$$(1\text{-}s)(\text{Inventory(FV)}_t - \text{Inventory(HC)}_t) = FV_t$$

$$\Delta FV_t = FV_t - FV_{t-1}$$

$$\text{Noplat(HC)t} + \Delta\text{FVt} = \text{Noplat(FV)t}$$

$$B(HC)_t + FV_t = B(FV)_t$$

ΔFV is not a part of taxable income; therefore, there is a temporary difference associated with the difference between inventory reported at fair value and historic cost. Net assets based on fair value B(FV), as reported in the financial statements, is net of deferred tax. B(HC) is derived by deducting FV, from B(FV).

The fair value adjustments do not always reconcile, that is

$$FV_{t-1} + \Delta FV_t = FV_t.$$

does not always hold. The data set does not allow a detailed analysis, but occasionally fair value adjustments on derivatives are grouped with ΔFV, but not with FV.[xix] In addition, mergers and acquisitions can cause changes in FV that are not reflected in ΔFV. Low reporting quality might also be a possible explanation. No attempt is made to adjust or control for reconciliation differences.

Return on shares

When calculating return on the shares, corrections are made for distributions, capital increases, changes in treasury shares and corporate actions (splits, reverse splits, and others).

5.5 Sample selection

The data set consists of eight companies during the fourth quarter 2006 through the fourth quarter 2015, 37 periods of price and accounting data and 36 periods of return data. Not all companies were listed throughout the period.

Company	Total Assets* NOK Billions	CAGR** Total Assets	From	To	Periods of Price data
Marine Harvest	40.2	4.4%	4q2006	4q2015	37
Cermaq	9.0	4.9%	4q2006	3q2014	32
Salmar	10.9	19.4%	2q2007	4q2015	35
Grieg	6.0	9.0%	2q2007	4q2015	35
Bakkafrost	5.1	26.9%	3q2010	4q2015	24
Lerøy	16.0	12.7%	4q2006	4q2015	37
NRS	2.9	15.5%	3q2011	4q2015	20
SSC	2.1	7.4%	2q2010	4q2015	23

Table 7: NRS=Norwegian Royal Salmon; SSC=the Scottish Salmon Company. *Total Assets as of the fourth quarter of 2015 except for Cermaq, which is as of the third quarter 2014. **Compound Annual Growth Rate is calculated for the periods included.

The data set consists of salmon producers listed on the Oslo Stock Exchange during the observation period except for one company Lighthouse Caledonia that was listed for a shorter period.

The reason why the fourth quarter 2006 is selected as starting point is that the industry collectively adopted a new interpretation of IAS 41 issued by the Financial Statements Oversights Board.

Several of the analyses have been tested on a dataset generated after the financial crisis. The conclusions based on these analyses remain the same as those based on the longer period.

5.6 Descriptive statistics

The total number of data points is 243 for share price and accounting data and 235 for return data. Due to differences in geographic location, vertical integration, and acquisition price for licenses, there are company specific effects. Because all the companies are affected by general price fluctuations in the stock market, beta risk, there will also be time effects. An analysis of the Price / Book ratio (Share Price / Net Assets measured at Historic Cost) shows both company specific effects, that companies are systematically priced at higher or lower Price / Book ratio and time effects for example, there is a significant drop during the financial crisis and an increase starting in the first quarter 2012. These effects are shown in figures 1 and 2. These findings support that an analysis on panel data should be analysed for fixed effects. This is affirmed by a Hausman test. The hypothesis, ‘Random effect is appropriate’ is falsified at prob>chi2 = 0.0000.

Figure 4 shows the development on the Oslo Stock Exchange main index and salmon prices since the second quarter 2011. The increasing Price / Book factor within the salmon farming industry that starts August 2011 may be explained both by increasing salmon prices and a general price increase in the stock market.

Data characteristics are summarised in Table 1.1

We observe that all the independent variables have some extreme outliers and that they are not normally distributed.

The correlations between the analysed variables before normalising by share price, that is, the input to the price specifications are presented in Table 1.2 Panel A.

The negative correlation between FV_{t-1} and ΔFV_t may be caused by salmon prices that are negatively series correlated and through the release of fair value adjustment through harvesting; that is, volume effects. The negative correlation between ΔFV and Financial may be the result of the successful hedging of FX-risk. When the analyses are performed across all the companies, the high correlations between Noplat and B and FV are partly a size effect.

The correlation of 0.98 between $B(HC)_{t-1}$ and $B(FV)_{t-1}$ could indicate that the discussion about value relevance is trivial. First, a huge common volume component, causes them to correlate heavily. Second, the fair value adjustment itself depends on both volume and price. With low volumes, the FV adjustment cannot be very high even if prices are sky high. Finally, during periods of relatively stable prices, the difference between B(HC) and B(FV) is primarily that of level. The difference between $B(HC)_{t-1}$ and $B(FV)_{t-1}$, (which is FV_{t-1}) correlates 0.62 with $B(HC)_{t-1}$. Considering that the fair value adjustment of inventory on the balance sheet is in the range of 5 % of Enterprise Value, the adjustment could clearly have information content. $B(HC)_{t-1}$ and $B(FV)_{t-1}$ never occur together on the right hand side of a regression.

The correlations for the independent variables, normalised by share prices, are presented in Table 1.2 panel B.

The share prices go up when the salmon prices go up. Out of 235 periods, the salmon prices increased in 143 periods, and out of the 143 periods with a price increase, in 104 periods (73%), the quarterly return exceeded 1.5 %.

The size of the companies observed measured by total assets as of December 31, 2015, varies from NOK 2 billion (the Scottish Salmon Company) to NOK 40 billion (Marine Harvest).

5.7 Empirical results

Stata14 is applied for all statistical analyses. All regressions, except when panel data are applied, have been tested for size effects both by including a control variable for size and by inspecting the interaction between the control variable for size and the fair value adjustment. All regressions are conducted with robust standard errors.

Is the fair value adjustment incrementally value relevant?

Table 2.1 shows separate regressions based on historic cost and fair value. It indicates that a regression on historic cost (in particular, if controlled for salmon prices) may explain share prices at least as well as a regression based of fair value. Although the sub-sample has somewhat higher R-squared, we observe the same. The small differences in R-squared indicate, in any case, that we are looking for quite small overall effects. We note a significantly higher coefficient for Noplat in the historic cost regression, which might indicate a higher relative importance, that the profit and loss statement is more important whenever predictions are based on historic cost accounts.

The relatively much lower coefficient for Noplat in the fair value regression confirms our expectations about more transitory elements, i.e. lower earnings persistency, but it might also signal that net assets are closer to fair value; that is, Noplat has lower relative importance. The companies in the sub sample have by average more data points and the R squared between may indicated that they are more homogeneous.

Table 2.2 presents the regressions relating to specification 1. The fair value adjustments are not incrementally value relevant for the full sample. The analysis reveals that controlling for salmon prices results in counterintuitive negative (non significant) coefficient for the fair value adjustment in the profit and loss statement and the balance sheet. The coefficients for Finance and Salmon Prices are significant, but they contribute little to R squared.

For a sub-sample comprising Marine Harvest, Cermaq, Salmar, Grieg and Lerøy, I find the fair value adjustments incrementally value relevant. These five companies are the largest of the producers, and they have the longest observation record.

Table 2.3 presents the return specification 2. I observe that the fair value adjustment in the profit and loss statement makes a significant contribution to explain return. A R squared of approximately 0.3 is quite normal or even high for a return specification. (Collins, Kothari, Shanken and Sloan 1994; Easton, Harris and Ohlson1992).

Alternative control for salmon prices

I have previously argued that to control for salmon prices may defeat the purpose of the test. When controlling for salmon prices, regression 1 returns counterintuitive coefficients for the fair value adjustments.

However, the salmon price may affect the share price in a way that is not picked up through a regression based on accounting data. Such an effect may influence the coefficients of independent variables that correlate with the salmon price. Furthermore, it may be interesting to explore whether the fair value adjustments convey any information in addition to salmon prices.

The specifications (5a) and (5b) are run for each company. The explanatory power of the regressions above varies (see Table 2.4). When FV and ΔFV in specification 1 and 2 are replaced by residuals and salmon prices are controlled for, this demonstrates an attempt to separate any information content of the fair value adjustments from salmon prices that are known outside the financial statements.

The regressions (not tabulated) did not produce significant coefficients for FV-residual and ΔFV-residual at 90% level, and the impact on R squared by omitting them is negligible. This indicates that the information content, if any, is low. This implies that there is little information in the fair value adjustments beyond product prices.

Cross sectional differences in reporting practice

Differences in value relevance may not only be attributed to differences in reporting practice, but also to differences in business model. There are differences in the level of vertical integration, and there are differences in geographical diversification. Differences in analysts' coverage may also be an alternative explanation, but the small number of subjects does not allow a further split into sub-groups.

Differences in the stage 1 regressions under the alternative control for salmon prices above (Table 2.4) cannot be explained by business model (geographical diversification may play a role) or analyst coverage, but this could indicate differences in reporting quality. We note that a high R2 does not necessarily signal the highest reporting quality, because the use of raw salmon prices for all size categories for reporting purposes would maximise R2 in the regression. The price per kilogram for a harvestable fish may not be the best estimate of the fair value of smaller fish. Large differences in coefficients indicate that changes in salmon prices impact inventory values differently (and this is difficult to explain).

Differences in observation periods and profitability may be alternative explanations. Differences in profitability will cause varying sensitivities to changes in salmon prices; for example, the less profitable will be more sensitive. Finally, differences in the classification of gain and loss on derivative contacts may affect ΔFV; these are less likely to affect FV.

Based my own observations and on the Financial Statements Oversight Board's review of the industry's reporting practice (Finanstilsynet 2015), there are clear indications of systematic differences between the subjects with respect to valuation models and the quality of the fair value estimates.

Summary on incremental value relevance

The price specification does not show incremental value relevance based on the full sample. Incremental value relevance is, however, demonstrated based on the return specification. Incremental value relevance is also demonstrated based the price specification in a sub-sample of the five companies with the longest listing history. I conclude that the fair value adjustments are incrementally value relevant. It is questionable though whether the fair value adjustments convey information beyond the salmon prices.

Is fair value accounting more value relevant than historic cost accounting?

If we move back to the separate regression analyses based on historic cost and fair value, Table 2.1, we observe that both explain approximately the same portion of the variation in share price, expressed as an R squared of 0.751 (0.765) and of 0.730, respectively.

By entering both historic cost and fair value figures for the same periods into the same regression with an indicator variable that tells whether the information is based on historic cost or fair value, we may test whether fair value is more value relevant than historic cost, according to specification 3. The intuition is that the coefficients for the interaction terms are the differences in slope between the historic cost and the fair value figures.

We observe in Table 3.1 that the coefficients for the interaction terms for B(FV) is positive and significant in the right column. This suggests that the balance sheet is more value relevant based on fair value than based on historic cost. When controls are introduced (left column) the interaction terms for B(FV) is no longer significant.

The coefficient for the interaction term for Noplat is negative, suggesting that Noplat is more value relevant based on historic cost. A lower coefficient is consistent with Noplat being more volatile when measured at fair value.

A similar analysis as the price specification (3) is carried out based on a return specification (4). We have previously concluded that fair value accounting is incrementally relevant based on a return specification (2), but we cannot conclude, based on the return specification 4, that fair value accounting is more value relevant than historic cost accounting. The P value of the coefficient in front of the interaction term is 0.152 (not tabulated).

Running separate regressions for historic cost and fair value based on the specifications

(6a) $\text{Return}_{it} = \propto + \beta \frac{\text{Noplat(HC)}_{i,t}}{\text{Shareprice}_{i,t-1}} + \varepsilon_{i,t}$

(6b) $\text{Return}_{i,t} = \propto + \beta \frac{\text{Noplat(FV)}_{i,t}}{\text{Shareprice}_{i,t-1}} + \varepsilon_{i,t}$

Returns an R-squared of 0.204 and of 0.297, respectively. Based on a bootstrapping procedure with 10,000 replications, we have that the difference of 0.094 (0.297-0.204) is significant at 10% level, $P>|z|=0.076$ (Table 2.5) This affirms that fair value reporting is significantly more value relevant than historic cost, although the level of significance is not very high.

Summary of difference in value relevance

The null hypothesis $H0_{2B2}$ could not be falsified based on the return specification 4, but based on an alternative test of R squared based on separate regressions, fair value measurement explains more of stock market return than does historic cost measurement. The level of significance is though not very high.

A positive and significant interaction term in the price specification 3 indicates that fair value is more value relevant than historic cost in the balance sheet, but the significance disappears when controlling for salmon prices. In the profit and loss statement the interaction term is negative. To control for salmon prices may, however, be questionable; the correlation between salmon price and the FV adjustment in the balance sheet is 0.54. Value relevance is about the association between share price and accounting measures. The possibility that FV measurement simply bring the salmon prices into the financial statements, does not disproof value relevance. When financial instruments are measured at fair value, we also simply bring market observations into the financial statements.

We should, however, also recall that the differences in R squared for separate regressions on historic cost 0.751 and fair value 0.730 (Table 2.1 full sample) was not very large. The conclusion is that FV measurement is more value relevant than historic cost in the balance sheet, but the effect is small.

6 Discussion

6.1 Value relevance

The overall picture is mixed. There is a strong logical case for the value relevance of FV measurement in the balance sheet, and we find empirical support for incremental value relevance in a sub sample (Table 2.2(2)) and also for FV being more value relevant (Table 3.1(2)).

The case for value relevance is weaker in the profit and loss statement, in particular in a price specification, and indeed, we cannot reject the null hypotheses about historic cost being more value relevant (Table 3.1(2)). The weaker assertion about incremental value relevance is, however, supported in a sub sample (Table 2.2(2)) and also in a return specification (Table 2.3(2)). We also find weak support for FV being more value relevance in the supplementary analysis in Table 2.5.

Both the difference in value relevance between the total sample and a sub-sample (Table 2.2) and the alternative control for salmon prices (Table 2.4) indicate that reporting quality may be an issue. The companies excluded from the sub-sample are those with the shortest observation period, but they are also the smallest of the companies examined. Size of the company may matter both because large companies may have more resources, but also because diversification may reduce the impact of local variations in farming conditions and special events, including biological incidents.

The case for value relevance in the balance sheet rests on the fact that both the share price and the fair value of inventory are associated with the salmon price. The much weaker case for value relevance in the profit and loss statement rests on the fact that high levels of inventory may result in fair value adjustments that move net income away from its recurring level; that is, the effect is highly transitory.

The fact that there may be little information content other than salmon prices is not an argument against fair value measurement, because one of the key roles of the financial statements should be parsimoniously to aggregate relevant information (Beaver 2002). If information about the salmon prices is relevant, it may well be incorporated in the accounts. This does raise interesting questions from a cost benefit perspective, but most of the information required to produce the fair value estimates are likely to be available in a well-controlled company because such information is also required for operational purposes.

We may safely conclude that the fair value estimates are not completely unreliable and they must carry some information.

Failure to reject the null hypothesis of no incremental value relevance in the balance sheet on the full sample when fair value reporting is proven more relevant than historic cost is puzzling, but this may be attributed to higher statistical strength in the test of specification 3 and the supplementary specification 5. The significance observed in the sub-sample may indicate that low significance might be explainable by the strength of the test combined with more noisy data for some of the smaller companies with a shorter listing history.

6.2 *Comparison to other studies*

Only Filho et al. 2013 compares fair value and historic cost measurement and finds historic cost more relevant by comparing R-squared for a dataset of 25 Brazilian companies between 2008 and 2009. Both Goncalves et al. (2017) and Silva and Nardi (2018) partition biological assets out of net assets and test the separate regression coefficient. Assuming that both biological assets measured at fair value and the share prices are positively correlated with product prices, there should be a strong logical case for value relevance. In this set-up, lack of value relevance mainly indicates low reliability, low quality fair value estimates. Goncalves et al. (2017) finds fair value measurement value relevant and reports an adjusted R-squared of 0.835 for the base model. No comparison is made to historic cost. Silva and Nardi (2018) reports an R-squared of 0.21 in the base model. Of the 375 analysed companies, 84 were located in OECD-countries, 24 of the companies reported cost exclusively, 152 of the companies reported fair value exclusively, and 22 of the companies reported both historic cost and fair value while 175 did not disclose the measurement method.[xx] Generally, low reporting quality, low quality of the dataset, and underdeveloped financial markets could be reasons why value relevance is not identified.

Norwegian salmon shares are fairly liquid. Except for SSC, the annual turnovers of the shares are in the range of 50-100%. Furthermore, there is a strong supervisory authority and all except Bakkafrost and SSC have Big Four audits. My study shows that for a sample of companies operating under the same legal environment, listed on the same stock exchange, and operating in the same industry, fair value measurement appears to be more relevant than historic cost. This has not been shown previously.

6.3 The controversies about IAS 41

The controversies about IAS 41 have comprised unwanted volatility, lack of reliability and relevance. The argument that the accounts become more volatile is obviously right, but not necessarily unwanted from a standard setting perspective. In addition, other accounting standards requiring fair value will have this effect. Considering that the fair value adjustments are level 3 estimates, significant coefficients for the fair value adjustment in several regressions do not support a total lack of reliability. Value relevance must warrant a certain level of reliability (Palea 2014).

It should be noted that volatility that stems from sources other than the true volatility of the underlying market is, in fact, unwanted. Because the inventory valuation is a level 3 valuation, volatility could be affected by both unintentional valuation errors and manipulation. Furthermore, failure to recognise the fair value impact of changing prices on contributory assets measured at historic cost could lead to misstated contributory asset charges and exacerbate the measurement problems related to inventory [Paper 1].

Value relevance tells us nothing about the effort required to produce the information; neither does it prove usefulness for financial analysts. Analysts may obtain information from other sources, information may not be timely, and value relevance does not preclude that valuation models predominantly based on historic cost have the same or even better predictive capacity. In these circumstances, we cannot conclude that the effort to produce the information is worthwhile. Even though analysts may not benefit directly from the fair value information, we do not preclude the possibility that both historic cost accounts and guiding are improved because fair value reporting requires better internal control.

[i] By ‘operational assets’, I mean assets that are acquired for the use in the conduct of the operations and that are necessary to generate revenue. Operational assets do normally not generate separate independent cash flows, but such assets contribute to generate operating result or EBIT. Operational assets cannot be disposed of, except as a part of executing the business plan, without negative consequences for the operation.

[ii] In this context the lack of reliability argument is likely to comprise both measurement uncertainty and the risk of manipulation.

[iii] Historically, the salmon prices applied for valuation purposes have not been separately disclosed.

[iv] IAS 41 does not require that historic cost is disclosed.

[v] Lyngtun and Welo 2012 is a master thesis from NHH. The researchers test whether fair value accounting is incrementally relevant compared to historical cost accounting and find a significant relation between the fair value adjustment in the profit and loss statement and the stock market return. In their study of whether fair value accounting is more value relevant than historic cost accounting, they did not get any significant results. A negative coefficient, although not significantly different from nil, for the fair value adjustment in the balance sheet in the study of incremental value relevance, is contra intuitive and could indicate weaknesses with the data set or a specification problem. Their sample is on annual data and encompasses only 38 data points.

[vi] Smolt is a juvenile salmon adapted to sea water

[vii] Salmar, Interim financial reporting September 30, 2015.

[viii] In quarter three, there will be two generations of fish. The newly released smolt and the fish that were released the year before.

[ix] Subsequently changed name to Mowi. Marine Harvest is chosen as example because it is the largest company and it has the longest observation period and the strongest geographical diversification. A similar pattern is shown by the other sample companies.

[x] The increase in gross margin may intuitively appear to be small. It should be noted, however, that Marine Harvest sells large quantities on delivery contracts and may not be fully exposed to a volatile spot price. Furthermore, there are expenses hitting gross margin that also may have a seasonal component; for example, mortality.

The figures for seasonal variations are not tested for statistical significance, because the purpose of the test is to indicate that seasonality may be a factor but not to determine the impact of the factor.

[xi] Fair value of a fish is expected to be proceeds from sales less cost to bring the fish to the market (but not cost of sales). The cost should include a contributory asset change for the

site. Fair value of the small fish is virtually insensitive to the salmon price. A price increase will cause the concession value to increase, thus, the contributory asset charge will increase.

[xii] Under historic cost measurement, the cost of mortality may be considered as a normal production cost and capitalized on inventory or expensed.

[xiii] As biological transformation requires that the fish be fed, ordinary accrual accounting is more informative about value creation in fish farming.

[xiv] The forward market may have limited trading volumes and because frozen and fresh salmon are perceived as different products (although close substitutes), all information is not necessarily reflected in the forward market.

[xv] The number of issued shares is adjusted for treasury shares, but not for potential future dilution

[xvi] Here I assume zero dividend.

[xvii] Logical tests and manual reconciliations are applied to verify correct entries.

[xviii] This allocation is contrary to the normal textbook approach where the tax expense on financial items is calculated as accurately as possible and taxes on operational items become the residual. The more simplistic method is chosen because I want the same tax rate applied on EBIT, ΔFV and FV.

[xix] Accumulated gain/loss on financial contracts will be classified as receivable/payable while contracts for physical delivery will be provided for—if they are onerous. The provision should be classified as short-term debt, not as a reduction of inventory.

[xx] The number of companies is not consistently reported.

References

Aboody, D., Barth, M. E., and Kasznik, R. (1999) Revaluation of fixed assets and future firm performance: Evidence from the UK. Journal of Accounting and Economics, Volume 26, Issues 1-3, 149-178.

Aboody, D., Hughes, J. and Liu, J. (2002) Measuring Value Relevance in a (Possibly) Inefficient Market. Journal of Accounting and Economics, Volume 40, Issue 4, 965-986.

Altamuro, J. and Zhang, H. (2012) The financial reporting of fair value based on managerial inputs versus market inputs: evidence from mortgage servicing rights. SSRN: https://ssrn.com/abstract=1832606.

Amir, E., Harris, T. S. and Venuti, E. K. (1993) A comparison of the Value-Relevance of U.S. Versus Non-U.S. GAAP Accounting Measures Using Form 20-F Reconciliations. Journal of Accounting Research Vol. 31, Studies on International Accounting, 230-264

Argilés-Bosch, J. M., Miarons, M., J. Garcia-Blandon, C. Benavente, and D. Ravenda. (2018) Usefulness of Fair Valuation of Biological Assets for Cash Flow Prediction. Spanish Journal of Finance and Accounting / Revista Española de Financiación y Contabilidad 47 (2), 157-180

Argilés, J. M. Garcia-Blandon, J. and Monllau, T. (2011) Fair value versus historical cost-based valuation for biological assets: predictability of financial information. Revista de Contabilidad-Spanish Accounting Review Vol. 14, No. 2, 87-113.

Barth, M. E. (2000) Valuation-based accounting research: Implications for financial reporting and opportunities for future research. Accounting and Finance Volume 40, Issue 1, 7-31.

Barth, M. E., Beaver, W. H. and Landsman, W. R. (1996) Value Relevance of Bank's Fair Value Disclosures under SFAS No. 107. The Accounting Review Vol. 71 No. 4, 513-537.

Barth, M. E., Beaver, W. H. and Landsman, W. R. (2001) The relevance of the value relevance literature for financial accounting standard setting: another view. Journal of Accounting and Economics Volume 31, Issues 1-3, (September), 77-104.

Barth, M. E. and Kallapur, S. (1996) The Effects of Cross-Sectional Scale Differences on regression Results in Empirical Accounting Research. Contemporary Accounting Research. Vol. 13, Issue 2 (Fall), 527-567

Barth, M., Landsman, W. R. and Lang, M. H. (2008) International Accounting Standards and Accounting Quality. Journal of Accounting Research Volume 46, Issue 3, (June), 467-498.

Beaver, W. H. (2002) Perspectives on Recent Capital Market Research. The Accounting Review. Volume 77, No. 2. (April), 453-474.

Beisland, L. A. (2008) Essays on the Value Relevance of Accounting Information. PhD dissertation NHH.

Bernhoft, A. C. and Fardal, A. (2007) IFRS and Fish Farming, Magma 6, 49-58.

Biddle, G. C., Seow G. S. and Siegel, A. F. (1995) Relative versus Incremental Information Content. Contemporary Accounting Research Volume 12, Issue 1, (Fall), 1-23.

Botosan, C. A. and Huffman A. A. (2015) Decision-Useful Asset Measurement from a Business Valuation Perspective. Accounting Horizons Volume 29, No. 4, 757-776.

Brown, S., Lo, K. and Lys, T. (1999) Use of R^2 in accounting research: measuring changes in value relevance over the last four decades. Journal of Accounting and Economics Volume 28, Issue 2, (December), 83-115

Clarkson, P., Hanna, J. D., Richardson G. D. and Thompson R. (2011) The impact of IFRS adoption on the value relevance of book value and earnings. Journal of Contemporary Accounting & Economics Volume 7, Issue 1, (June), 1–17.

Collins, D. W., Kothari, S. P., Shanken, J. and Sloan R. G. (1994) Lack of timeliness and noise as explanations for the low contemporaneous return-earnings association. Journal of Accounting and Economics Volume 18, Issue 3, (November), 289-324.

Collins, D. W., Maydew, E. L. and Weiss, I. S. (1997) Changes in the Value-Relevance of Earnings and Book Values over the Past Forty Years. Journal of Accounting and Economics Volume 24, Issue 1, (December), 39-67.

Danbolt, J. and Rees, W. (2008) An Experiment in Fair Value Accounting: UK Investment Vehicles. European Accounting Review Volume 17, Issue 2, 271-303.

Dietrich, J. R., Harris, M. S. and Muller, K. A. (2000) The reliability of investment property fair value estimates. Journal of Accounting and Economics Volume 30, Issue 2, (October), 125-158.

Easton, P. D., Eddey, P. H. and Harris, T. S. (1993) An investigation of revaluation of tangible long-lived assets. Journal of Accounting Research Volume 31 (Studies on International Accounting), 1-38.

Easton, P. D., Harris, T. S. and Ohlson, J. A. (1992) Aggregate Accounting Earnings can Explain most of Security Returns. Journal of Accounting and Economics Volume 15, Issues 2-3, (June-September), 119-142.

Easton, P. D. and Sommers, G. A. (2003) Scale and the Scale Effect in Market-based Accounting Research. Journal of Business Finance and Accounting Volume 30, Issue 1-2 (January), 25-56

FASB, Financial Accounting Standards Board. (1984) Statement of Financial Accounting Concepts No. 5

Feltham, G. A. and Ohlson, J. A. (1995) Valuation and Clean Surplus Accounting for Operational and Financial Activities. Contemporary Accounting Research Volume 11, No. 2 (Spring), 689-731.

Filho, A. C. da C. S., Machado, M. A. V. and Machado, M. R. (2013) Historical cost X fair value: Which information is more relevant on the measurement of biological assets? Custos e Agronegocio, 9(2), 27-50.

Financial Statements Oversights Board's (Finanstilsynet), 2015, Rapport fra Tematilsyn Oppdrettsforetak. Available at https://www.finanstilsynet.no/contentassets/2c0a3597734849b5a5ff98b07f891739/tematilsyn-oppdrettsforetak-11-2015.pdf

Fiskeridirektoratet. Profitability study. Available at: https://www.fiskeridir.no/Akvakultur/Statistikk-akvakultur/Loennsomhetsundersoekelse-for-laks-og-regnbueoerret/Matfiskproduksjon-laks-og-regnbueoerret

Francis, J. LaFond, R. Olsson, P. and Schipper, K. (2004) Cost of Capital and Earnings Attributes. The Accounting Review Volume 79, No. 4, (October), 967-1010.

Francis J. and Schipper, K. (1999) Have Financial Statements Lost Their Relevance? Journal of Accounting Research Volume 37, No. 2, (Autumn), 319-352.

Gassen, J. and Schwedler K. (2010) The Decision Usefulness of Financial Accounting Measurement Concepts: Evidence from an Online Survey of Professional

Investors and their Advisors. European Accounting Review Volume 19, No. 3, 495-509

Gjerde, O, Knifsflaa, K. and Saettem, F. (2008) The value-relevance of adopting IFRS: Evidence from 145 NGAAP Restatements. Journal of International Accounting Auditing and Taxation Volume 17, Issue 2, 92-112.

Goncalves, R., Lopes, P. and Craig, R. (2017) Value Relevance of Biological Assets under IFRS. Journal of International Accounting, Auditing and Taxation Volume 29, 118-126.

Hitz, J-M. (2007) The Decision Usefulness of Fair Value Accounting – A Theoretical Perspective. European Accounting Review Volume 16, No. 2, 323-362

Hodder, L., Hopkins, P. and Schipper, K. (2013) Fair Value Measurement in Financial Reporting. Foundations and Trends in Accounting Volume 8, Nos. 3-4, 143-270

Huffman, A. A. (2014) Matching Measurement to Asset Use: Evidence from IAS 41. Working Paper.

IASB, International Accounting Standard Board. Staff Paper Emerging Economies Group 28-29 May, 2012

IASB, International Accounting Standard Board. Conceptual Framework for Financial Reporting March, 2018

Jones, D. A. and Smith, K. J. (2011) Comparing the Value Relevance, Predictive Value, and Persistence of Other Comprehensive Income and Special Items. The Accounting Review Volume 86, Issue 6, (November), 2047-2073.

Landsman, W. R. (2007) Is Fair Value Accounting Information Relevant and Reliable? Evidence from Capital Market Research, Accounting and Business Research, Special Issue: International Accounting Policy Forum, 19-30.

Lang, M., Raedy, J. S. and Yetman, Y. (2003) How Representative Are Firms That Are Cross Listed in the United States? An Analysis of Accounting Quality. Journal of Accounting Research Volume 41, Issue 2, (May), 363-386.

Laux, C. and Leuz, C. (2010a) Did Fair-Value Accounting Contribute to the Financial Crisis. Journal of Economic Perspectives Volume 24, No. 1, (Winter), 93-118.

Laux, C. and Leuz, C. (2010b) The Crisis of Fair-Value Accounting: Making Sense of the Recent Debate. Accounting, Organizations and Society Volume 34, Issues 6-7, (August-October), 826-834.

Lourenço, I. C. and Curto, J. D. (2008) The Value Relevance of Investment Property Fair Values. Available from URL: http://ssrn.com/abstract=1301683.

Lyngtun, C. and Welo, J. (2012) Does the use of fair value in accordance with IAS 41 give more value relevant information compared to traditional historic cost values? Master Thesis, Norwegian School of Economics.

Misund, B. (2017) Valuation of salmon farmers. Available at: http://dx.doi.org/10.1080/13657305.2016.1228712

Nellessen, T. and Zuelch H. (2001) The reliability of investment property fair values under IFRS. Journal of Property Investment and Finance Volume 29, No. 1, 59-73.

Ohlson, J. (1995) Earnings, book values and dividends in security valuation. Contemporary Accounting Research Volume 11, Issue 2, (Spring), 661-687.

Ohlson, J. A. and Penman, S. H. (1992) Disaggregated Accounting Data as Explanatory Variables for Returns. Journal of Accounting, Auditing and Finance, Volume 7, Issue 4, 553-573.

Palea, Vera. (2014) Fair value accounting and its usefulness to financial statement users. Journal of Financial Reporting and Accounting Volume 12, No. 2, 102-116.

Penman, S. (1991) An Evaluation of Accounting Rate-of-return. Journal of Accounting Volume 6, No. 2, (April), 233-255.

Penman, S. (2007) Financial Reporting Quality: Is Fair Value a Plus or Minus? Accounting and Business Research, Special Issue: International Accounting Policy Forum, 33-44.

Pfeiffer, R. J. and Elgers, P. T. (1999) Controlling for Lagged Stock Price Responses in Pricing Regressions: An Application to the Pricing of Cash Flows and Accriuals. Journal of Accounting Research 37(1)

Philips, G. E. (1963) The Accretion Concept of Income. The Accounting Review Volume 38, No. 1 (January), 14-25.

Ramakrishnan, R. T. S. and Thomas, J. K. (1998) Valuation of Permanent, Transitory, and Price-Irrelevant Components of Reported Earnings. Journal of Accounting, Auditing and Finance Volume 13, Issue 3, 301-336.

Sellhorn, T. and Stier, C. (2017) Fair Value Measurement for Long-Lived Operating Assets: Research Evidence. Available at SSRN: http://ssrn.com/abstract=2991997

Silva, R. M. and Nardi, P. C. C. (2018) The (in) Difference Between Historical Cost and Fair Value for Biological Assets: a Cross-Country Study. Conference Paper, Annual Meeting of the American Accounting Association, At Washington, DC.

Sloan, R. G. (1996). Do Stock Prices Fully Reflect Information in Accruals and Cash Flows About Future Earnings? Accounting Review Volume 71, No. 3, (July), 289-315.

Song, C. J., Thomas, W. B. and Yi, H. (2010) Value Relevance of FAS 157 Fair Value Hierarchy Information and the Impact of Corporate Governance Mechanisms. Accounting Review Volume 85, No. 4, (July), 1375-1410.

Yu, K. (2013) Does Recognition versus Disclosure Affect Value Relevance? Evidence from Pension Accounting. The Accounting Review, Volume 88, Issue 3, (May), 1095-1128

Appendix 1: Variable definitions

Variable	Definition
Dependent variables	
R_t	Return in period t, i.e. the change in share price. $R_t = \frac{V_t + D_t}{V_{t-1}} - 1$, D_t = Distribution
V_t	Share Price in period t.
Independent variables	
B_t	I Net Assets or Equity in period t. Net Assets could be based on historic cost or fair value. This is highlighted when relevant; B(HC) and B(FV) respectively.
B_{t-1}	B_t=B_t-NI_t. Equity or Net Assets t-1 is not observed in the financial statement for period t-1, but is rather Equity for period t less Net Income in period t; NI_t. This avoids the need to adjust for transactions with the owners, OCI items and other dirty surplus.
NI_t	Net Income in period t.
FV_t	The fair value adjustment in the balance sheet in period t adjusted for deferred tax by 25%. Inventory is reported at fair value in the balance sheet and FV is only available in the disclosures and without tax adjustment. FV is also the difference between Net Assets based on historic cost and fair value; B(HC) and B(FV).
$Noplat_t$	NI_t=$Noplat_t$+$Financial_t$. Net Operating Profit Less Adjusted Tax or Earnings Before Interest and Tax adjusted for 25% tax. Noplat could be based on historic cost or fair value; Noplat(HC) and Noplat(FV). This is highlighted when relevant. The reason why Noplat is used instead of EBIT is to avoid that tax on EBIT is included in Financial and hereby creating a dependency between the two variables.
ΔFV_t	The fair value adjustment in the Profit and Loss statement in period t adjusted for deferred tax by 25%. The difference between Noplat based on historic cost and based on fair value. $Noplat(HC)_t$+ΔFV_t=$Noplat(FV)_t$
$Financial_t$	NI_t=$Noplat_t$+$Financial_t$. Financial comprises net financial items less tax on such in period t. Hence, Finance will not comprise OCI items or dirty surplus. Any difference between the 25% tax applied in Noplat and actual taxes on Net Operating Profit will be included in Financial.
$LN(Asssets)_t$	The natural logarithm of Total Assets in period t
IntEquity	Interaction between Indicator variable and Equity
IntNoplat	Interaction between Indicator variable and Noplat
Indicator	In regressions were historic cost observations and fair value observations occur as independent variables for the same company and for the same period Indicator=0 signals historic cost and Indicator=1 signals fair value.
Salmon $Price_t$	The average export price for the week ending at the reporting date for fresh salmon reported by Statistics Norway in NOK.

Appendix 2: Tables and Figures

TABLE 1.1 Panel A

Sample distribution and descriptive statistics

Raw variables

	N	Mean	S.D.	5%	Min	95%	Max	Skew	Kurt
Share Price	243	65.28	59.79	4.08	2.13	177.00	330.00	1.723	6.576
FV	243	2.497	2.275	0.08	-0.40	6.24	15.36	2.023	9.422
B(HC)	243	33.833	27.668	3.40	2.71	93.28	126.23	1.359	4.381
ΔFV	243	0.095	1.701	-2.15	-7.51	2.08	10.83	1.401	16.417
Noplat(HC)	243	1.527	1.774	-0.33	-3.15	5.19	8.58	1.368	5.407
Financial	243	0.030	1.882	-1.41	-3.41	1.24	26.91	12.018	172.931

For variable definitions see Appendix 1

TABLE 1.1 Panel B

Sample distribution and descriptive statistics

The variables are normalised by share price

	N	Mean	S.D.	5%	Min	95%	Max	Skew	Kurt
FV	243	0.052	0.052	0.008	-0.074	0.137	0.492	3.784	8.009
B(HC)	243	0.705	0.513	0.258	0.188	1.469	4.697	3.584	22.543
ΔFV	243	0.002	0.041	-0.048	-0.263	0.049	0.296	0.158	21.855
Noplat(HC)	243	0.018	0.055	-0.017	-0.741	0.060	0.099	-11.209	155.999
Financial	243	-0.004	0.043	-0.026	-0.534	0.190	0.249	-7.374	101.375

For variable definitions see Appendix 1

TABLE 1.2 Panel A

Correlations

Raw values

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) V_t	**1.00**								
(2) FV_t	**0.71**	**1.00**							
(3) $Noplat(HC)_t$	**0.80**	**0.85**	**1.00**						
(4) ΔFV_t	0.10	**0.45**	**0.22**	**1.00**					
(5) $B(FV)_{t-1}$	**0.85**	**0.69**	**0.75**	0.09	**1.00**				
(6) $B(HC)_{t-1}$	**0.83**	**0.63**	**0.69**	0.06	**0.99**	**1.00**			
(7) $Financial_t$	**0.04**	0.00	0.06	-0.18	0.09	0.03	**1.00**		
(8) FV_{t-1}	**0.66**	**0.70**	**0.72**	**-0.32**	**0.66**	**0.62**	0.17	**1.00**	
(9) Salmon $price_t$	**0.31**	**0.54**	**0.39**	**0.31**	0.12	0.06	0.09	**0.32**	**1.00**

The table shows correlations between the analysed variables. Bold figures signal significance at 5% level in a two-tailed test. The significance level is adjusted for number of correlations.

TABLE 1.2 Panel B

Correlations

The variables are normalised by share price

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) FV_t	**1.00**						
(2) $Noplat(HC)_t$	-0.06	**1.00**					
(3) ΔFV_t	**0.51**	0.19	**1.00**				
(4) $B(FV)_{t-1}$	**0.30**	**-0.55**	0.04	**1.00**			
(5) $B(HC)_{t-1}$	**0.39**	**-0.41**	0.11	**0.98**	**1.00**		
(6) $Financial_t$	**-0.36**	**0.70**	-0.13	**-0.52**	**-0.42**	**1.00**	
(7) FV_{t-1}	**0.66**	**-0.23**	**-0.30**	**0.29**	**0.33**	**-0.27**	**1.00**

The table shows correlations between the analysed variables. Bold figures signal significance at 5% level in a two-tailed test. The significance level is adjusted for number of correlations.

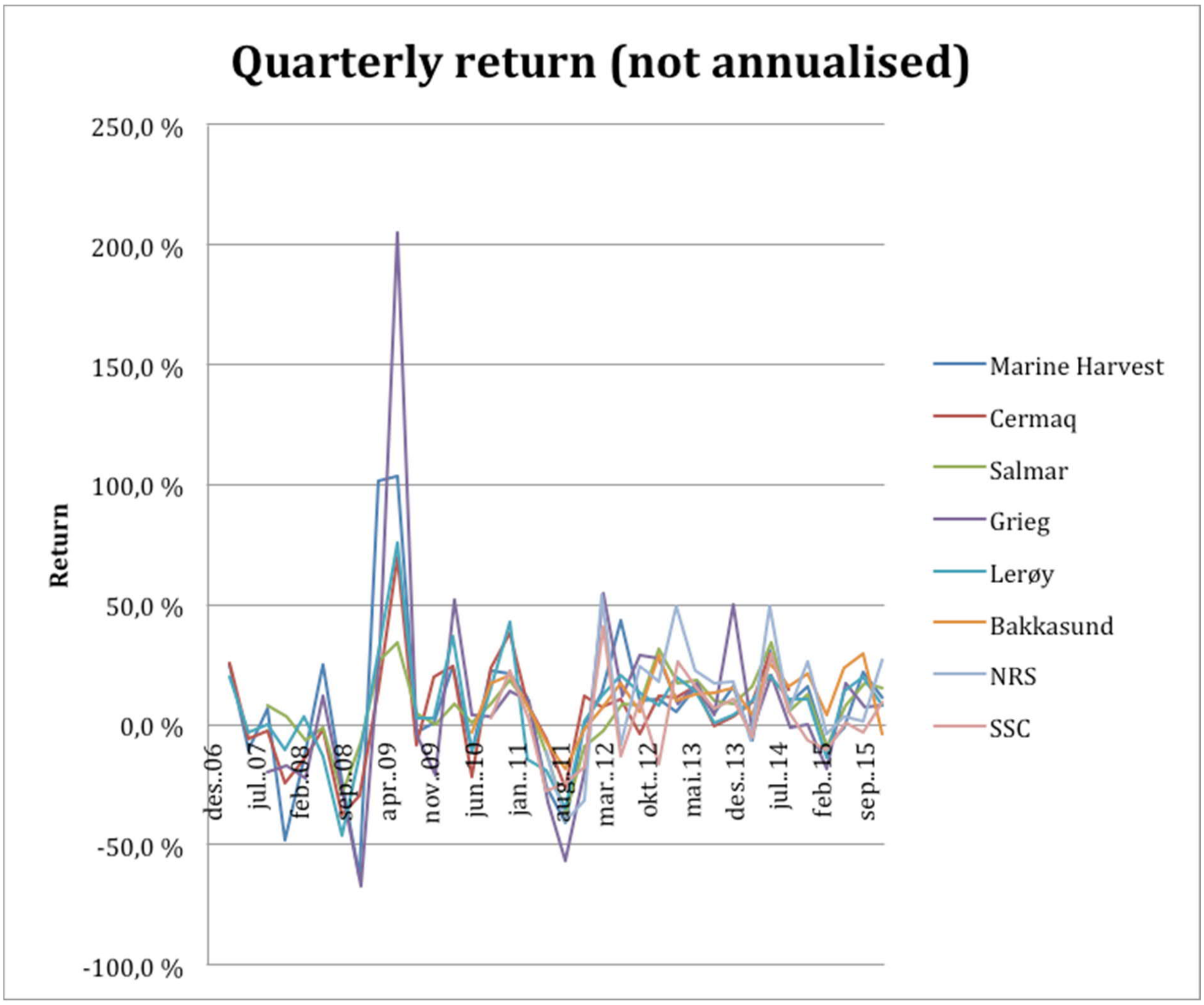

Figure 1 Quarterly return is based on $(V_{t+1} + D_{t+1})/V_t$ where information about distributions are derived from the financial statements. The distribution is assumed to take place the last day in the reporting period.

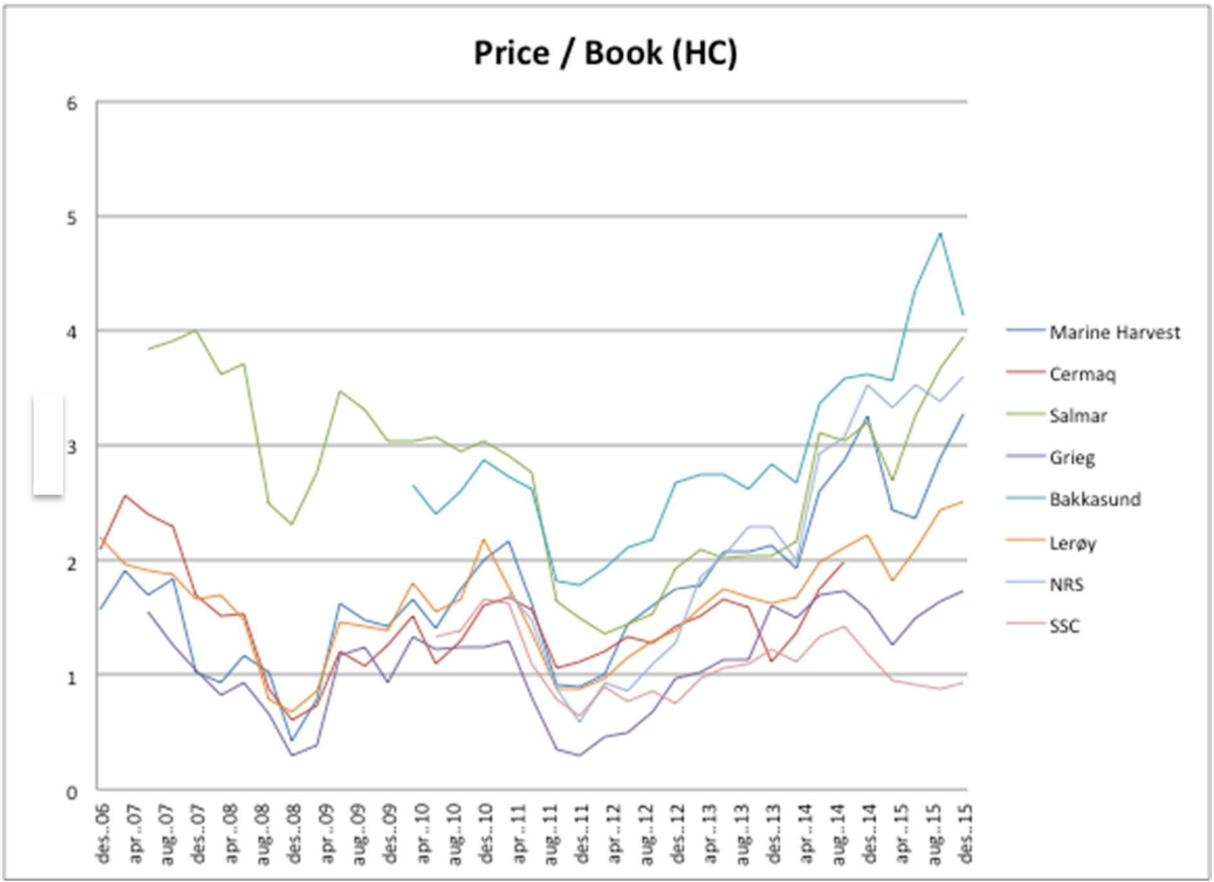

Figure 2 Price / Book is stock price divided by net assets per share based on historic cost. The number of shares is adjusted for treasury shares, but no attempt is made to adjust for outstanding options or other dilution.

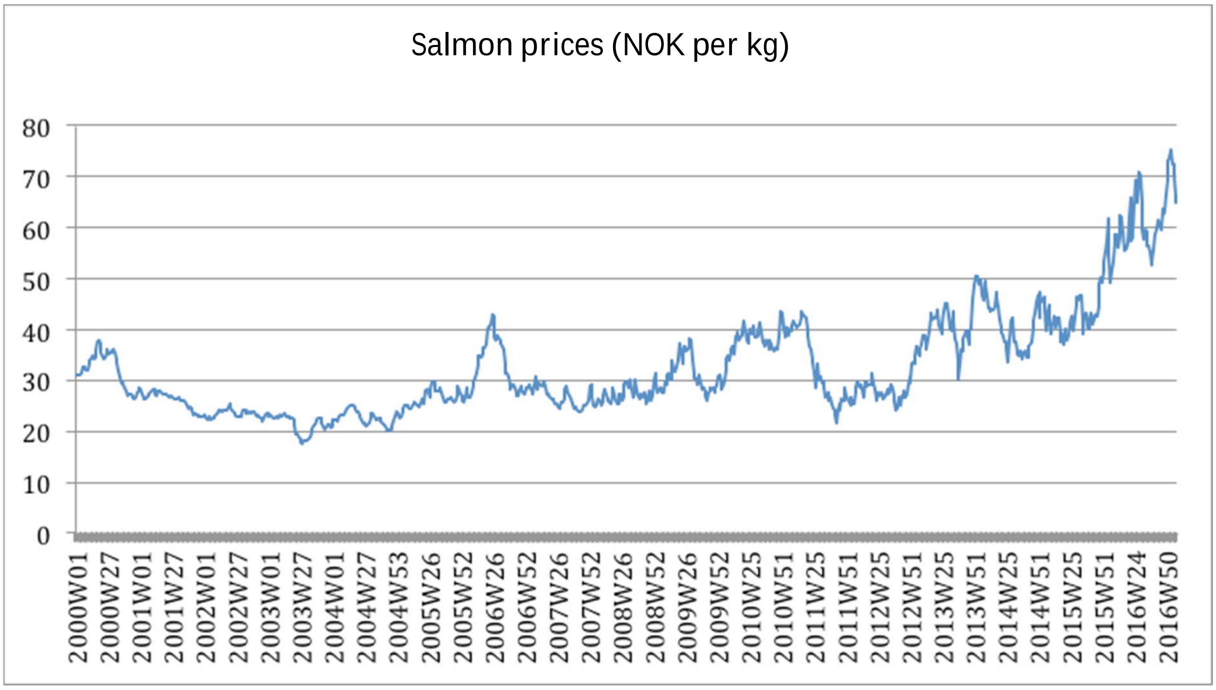

Figure 3: Source: Statistics Norway weekly export prices. Nominal export prices for fresh salmon

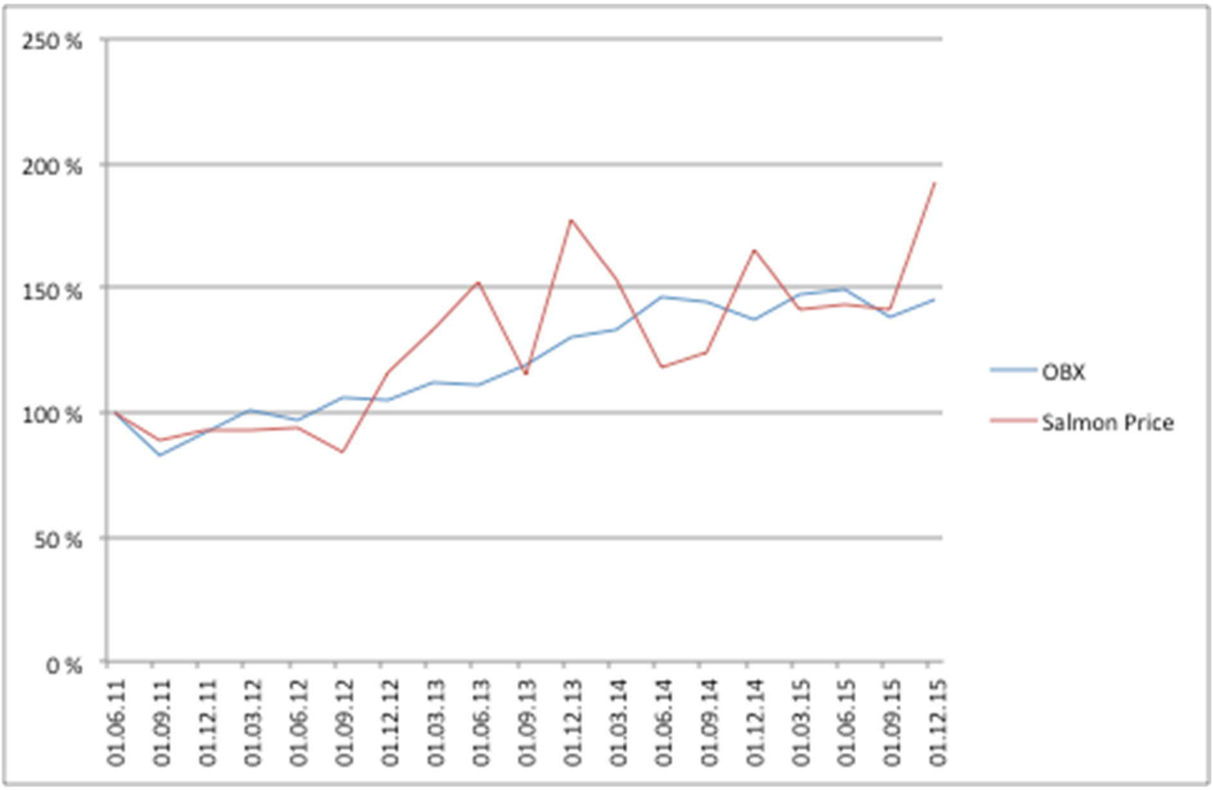

Figure 4 The OBX-index comprises the 25 mostly traded stocks at Oslo Børs. The index is a free float, adjusted return index (adjusted for dividends). The index itself is tradable. Salmon prices are weekly export prices for fresh Salmon from Statistics Norway. Both are set to 100% at the start of the observation period.

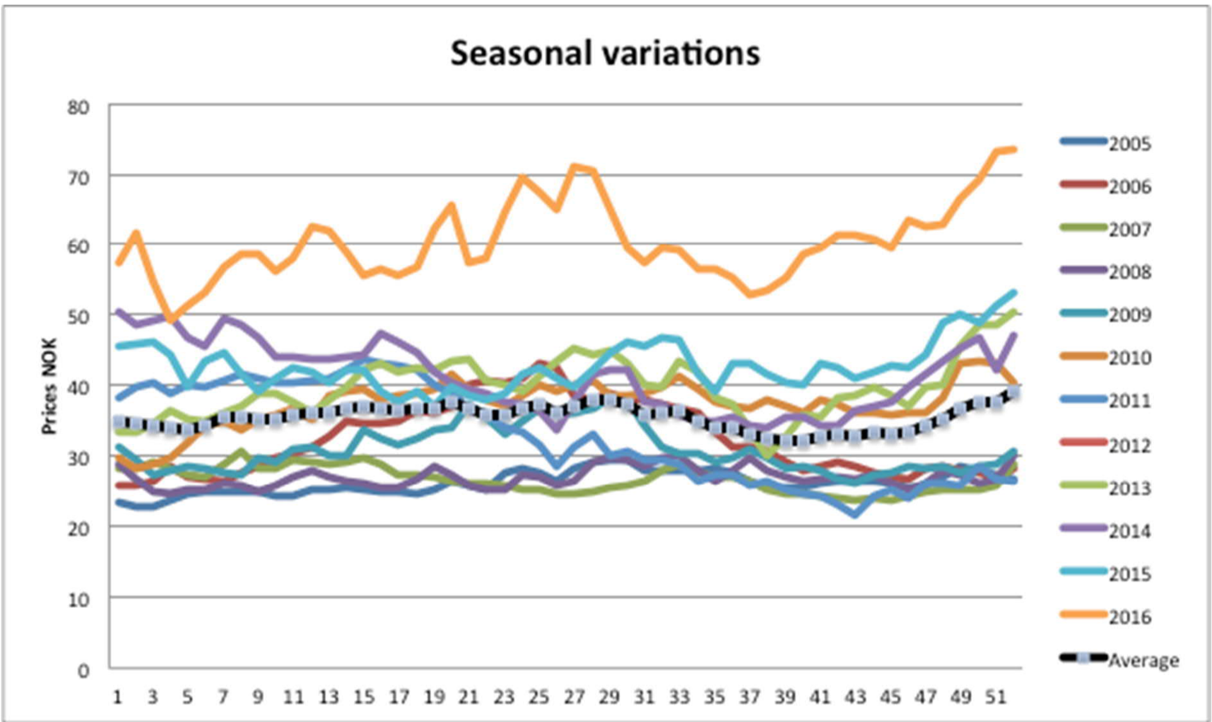

Figure 5 Weekly export prices for fresh salmon obtained from Statistics Norway. Nominal prices in NOK. Average without any corrections for inflation. The averages for q1, q2, q3 and q4 across all years observed are NOK 35.0, 36.7, 35,6 and 34,7 per kg respectively.

TABLE 2.1

Separate regressions based on fair value and historic cost

	Full Sample			Sub Sample		
Dep. Var.: *Share price*	Fair Value	Hist Cost	Hist Cost	Fair Value	Hist Cost	Hist Cost
B	2.708**	2.496**	2.400**	2.338**	2.180**	2.043**
Standard Error	(0.400)	(0.347)	(0.367)	(0.167)	(0.139)	(0.174)
Noplat	3.043**	9.163**	6.923**	2.794**	7.973**	4.975**
Standard Error	(0.400)	(1.418)	(1.671)	(0.349)	(1.143)	(1.573)
Salmon price			0.741**			1.027**
Standard Error			(0.297)			(0.292)
R2						
-Within	0.677	0.685	0.699	0.650	0.648	0.672
-Between	0.848	0.873	0.870	0.932	0.942	0.938
-Overall	0.730	0.751	0.765	0.765	0.788	0.808
Observations	243	243	243	175	175	175
Groups	8	8	8	6	6	6
Observations per group						
-Min	20	20	20	32	32	32
-Average	30.4	30.4	30.4	35.2	35.2	35.2
-Max	37	37	37	37	37	37

In the Fair Value columns accounting measures are based on FV while in the Hist Cost columns the accounting measures are based on HC. The superscript ** represents significance level of 0.05 in a two-tailed test.

TABLE 2.2 – SPECIFICATION 1

Incremental Value Relevance

	Full Sample			Sub sample
Dependent variable: *Share price*	(1a)	(1b)	(1c)	(2)
B(HC)	2.360**	2.438**	2.432**	2.092**
Standard Error	(0.352)	(0.348)	(0.347)	(0.183)
FV	-0.036	2.385	2.282	4.553**
Standard Error	(2.895)	(2.596)	(2.552)	(1.190)
Noplat(HC)_W	7.704	7.476	7.477	3.383**
Standard Error	(4.169)	(4.240)	(4.197)	(1.182)
ΔFV	-1.418	0.979	0.996	2.925**
Standard Error	(2.518)	(2.052)	(2.147)	(0.573)
Finance	-0.881**	-0.677		
Standard deviation	(0.298)	(0.398)		
Salmon Price	0.836**			
Standard Error	(0.324)			
R2				
-Within	0.703	0.690	0.689	0.664
-Between	0.874	0.870	0.870	0.938
-Overall	0.770	0.752	0.752	0.797
Observations	243	243	243	176
Groups	8	8	8	5
Observations per group				
-Min	20	20	20	32
-Average	30.4	30.4	30.4	35.2
-Max	37	37	37	37

Specification 1 tests for incremental value relevance in a price specification. The regressions are made on panel data with company and time specific effects. The superscript ** represents significance level of 0.05 in a two-tailed test. Noplat winsorized at 1% level for all columns. For the full sample the effects of removing controls for Finance and Salmon Price are shown separately.

TABLE 2.3 – SPECIFICATION 2

Incremental Value Relevance		
Dependent variable: *Return*	(1)	(2)
Noplat(HC)	2.434**	2.302**
Standard Error	(0.627)	(0.364)
ΔFV	1.815**	1.960**
Standard Error	(0.619)	(0.286)
Finance	-0.462	
Standard Error	(1.109)	
R2		
-Within	0.304	0.303
-Between	0.013	0.026
-Overall	0.299	0.298
Observations	235	235
Groups	8	8
Observation per Group		
-Min	19	19
-Average	29.4	29.4
-Max	36	36

Specification 2 tests for incremental value relevance in a price specification The regressions are made on panel data with company and time specific effects. The superscript ** represents significance level of 0.05 in a two-tailed test. (2) shows the effects of removing controls for Finance.

TABLE 2.4 – SPECIFICATIONS 5A AND 5B

Stage 1 regressions alternative control for salmon prices						
Dependent variable			*ΔFV*		*FV*	
Company	Observations	R2 adj	Salmon Price	ΔSalmon Price	R2 adj	Salmon Price
Marine Harvest	37	0.71	0.016	3.693**	0.70	0.123**
Cermaq	32	0.44	0.047	3.226**	0.66	0.212**
Salmar	35	0.60	-0.021	4.823**	0.84	0.208**
Grieg	35	0.59	0.000	4.362**	0.34	0.076**
Bakkafrost	24	0.35	-0.020	2.878**	0.64	0.148**
Lerøy	37	0.81	0.013	19.761**	0.84	0.437**
NRS	20	0.25	-0.011	2.412*	0.71	0.101**
SCC	23	0.13	0.006	0.167	0.30	0.022**

The table shows the fair value adjustments regressed against salmon prices and changes in salmon prices for profit and loss and against salmon prices for the balance sheet. The superscript *, ** represents significance level of 0.10 and 0.05 respectively in a two-tailed test.

TABLE 2.5 – SPECIFICATIONS 6A AND 6B

Absolute Value Relevance		
Dependent variable: *Return*	(1)	(2)
Noplat(HC)	2.662**	
Standard Error	(0.803)	
Noplat(FV)		1.831**
Standard Error		(0.470)
R2 adj	0.204	0.298
P>│z│		0.076*
Observations	235	235

The superscript *, ** represents significance level of 0.10 and 0.05 respectively. P>│z│=0.076 is calculated using a bootstrapping procedure with 10,000 replications.

TABLE 3.1 – SPECIFICATION 3

Absolute Value Relevance		
Dependent variable: *Share Price*	(1)	(2)
Noplat	10.661**	14.578**
Standard Error	(2.083)	(2.129)
B	1.329**	1.144**
Standard Error	(0.137)	(0.132)
Indicator	-1.434	-1.527
Standard Error	(3.404)	(3.553)
Indicator x Noplat	-7.623**	-9.512**
Standard Error	(2.343)	(2.477)
Indicator x B	0.265	0.354**
Standard Error	(0.150)	(0.163)
Financial	-0.244	
Standard Error	(0.943)	
LN(Assets)	-1.607	
Standard Error	(1.282)	
Salmon Price	1.256**	
Standard Error	(0.191)	
R2 adj	0.787	0.766
Observations	486	486

The superscript ** represents significance level of 0.05 in a two-tailed test. (2) shows the effects of removing controls variables. The number of observations doubles because historic cost and fair value appear for each company and each period.

V Paper 3

Is Fair Value Measurement of Operational Assets in a Production Company Useful for Equity Analysts? Evidence from Norwegian Fish Farming

Is Fair Value Measurement of Operational Assets in a Production Company Useful for Equity Analysts? Evidence from Norwegian Fish Farming

Bjarne Møller

Department of Accounting Auditing and Law, Norwegian School of Economics, Bergen, Norway

bjarne.moller@nhh.no

Is Fair Value Measurement of Operational Assets in a Production Company Useful for Equity Analysts? Evidence from Norwegian Fish Farming

This paper examines the Sell Side Equity Analysts' (equity analysts) use of fair value reporting of inventory in a production company when historic cost reporting is also available for use. Norwegian salmon producers have sufficient levels of inventory reported at fair value, and such levels, together with volatile salmon prices, give sizable fair value adjustments. The availability of two reporting practices, transaction-based historic cost and fair value reporting, provides a unique opportunity to study the equity analysts' decision-making and their use of data.

The main outputs of the equity analysts' work are cash flow forecasts with a time horizon of a maximum of twenty-four months and a target price. The study shows that equity analysts generally disregard the fair value information available both for performance measurement and for predictive purposes. A review of analysts' reports and interviews with them demonstrates this conclusively. This practice seems rational because the fair value adjustments do not provide an economically meaningful contribution to the potential forecast accuracy of next period earnings based on a regression of observed earnings for t+1 against observed earnings for t. Formal and numerical examples suggest that earnings measured at fair value generate a noisier predictor of next period earnings than does historic cost. In addition, the fair value adjustment per se does not provide a relevant input to their valuation model.

The study is based on hand collected data from interim financial statements for eight listed salmon producers from the fourth quarter 2006 to fourth quarter 2015, equity analyses from 2016 obtained from 14 Investment Banks located in Norway that cover the fish farming industry, and from follow-up interviews.

Key words: Equity Analyst, Fair Value, Inventory, Production Company, Agriculture, IAS 41

1 Introduction

The only accounting standard that mandates fair value measurement for an operational asset in a production company is IAS 41[i], which requires fair value measurement of live biological assets. The implementation of IAS 41 has been controversial in Norway, and account preparers have objected on the grounds of lack of relevance, for example, that too much noise is added to the profit and loss statement. (Bernhoft and Fardal 2007). The critics claim that equity analysts actually rely on historic cost information for analysis of historical performance and that the fair value adjustments are not relevant to their valuation models.

The motivation of this article is to investigate the claim that the fair value information is not used and to document this claim. The study assumes that it is important to explore why the practice of not using the fair value information is employed and to ascertain whether useful information is lost due to such practice. The reasons for ignoring fair value information may not be the same for analysis of historical performance, cash flow forecasting and valuation modelling.

Knowledge about these matters is useful for several reasons. If analysts rationally ignore the fair value information, we should ask whether the disclosures to the financial statements might be amended in order to make the fair value information more useful. As an alternative, we may even revisit the question of whether the production of the information, assuming this is costly, passes a cost-benefit test.

The question of whether fair value information is used by analysts is addressed by reviewing valuation reports and by conducting interviews. The question of whether useful information is lost by not considering the fair value information is answered through an empirical study of whether earnings in period t is an informative predictor of earnings in period t+1 and by means of both a numerical and a formal example.

The salmon industry is important in Norway, and the eight listed companies receive broad coverage by analysts, both through sector analyses and company analyses. Information about valuation methodology and information sources from 14 investment banks headquartered in Norway was obtained through interviews and by review of valuation reports obtained in 2016 for the purpose of assessing the decision usefulness of fair value information that is provided by the financial statements. Most of the analysts apply relative valuation methods, but a significant number use so-called fundamental valuation methods such as Discounted Cash Flow (DCF) to allow the scholar to assess the information requirements for their valuation models. The abundant stock of valuation literature can also provide additional crucial information relevant to this study.

This examination of analyst practices makes use of a study to determine whether Net Operating Profit Less Adjusted Taxes (Noplat) based on fair value accounting is a better predictor than Noplat based on historic cost for cash flows for the next period. In this study, the observed Noplat for the next period serves as proxy for cash flow. Noplat is chosen not only because analysts try to predict earnings (but not cash flow), but also because Noplat is assumed to be a reasonable predictor for cash flow.

The study examines the interim (quarterly) financial data for eight companies hand collected for the period from the fourth quarter 2006 to fourth quarter 2015. The dual reporting of fair value and historic cost offers an opportunity for a within subject design.

Inventory measured at fair value reflects current prices of salmon, which is clearly of interest for forecasting purposes. This price information, however, will be easier to obtain and timelier from sources other than a company’s financial statements. In addition the transitory character of fair value adjustments in the profit and loss statement may distort analysis of historical performance. The fair value adjustment is not necessarily per se an input to a DCF model.

As equity analysts have examined the Norwegian salmon industry, they have chosen not to consider information about fair value. In a word: it appears that salmon industry analysts approach their task very much as they do whenever they make analyses in various other industries.   That is, they choose not to adapt their analytic approach or adjust their models to the fact that information about fair value about the salmon industry is available. They continue to use their standard models, and they do not apply the fair value information offered in the financial statements for specific analytical purposes. For example, the information about fair value of inventory is not used to estimate historic production cost, working capital requirements, future prices, or to predict earnings. When comparative valuations are performed, the comparisons between industry peers are based on historic cost figures.

Empirical research shows that analysts lose little if any information by ignoring fair value information. Historic cost is superior to fair value with respect to cash flow prediction, and while the fair value adjustment carries some information, it hardly makes an economically meaningful contribution to the prediction of future cash flow.

Numerical and formal examples show that price fluctuations either they are systematical, like seasonal variations, or random, in most cases make earnings in period t measured at fair value a noisier predictor of earnings in t+1 than earnings measured at historic cost. The level of noise is exacerbated by a high number of inventory days compared to the length of the reporting period. The noise from price fluctuations may overshadow the potential positive effect of recognising biological transformation.

Analysts' use of information in accruals has been studied by Bradshaw, Richardson and Sloan (2001) and by Balsam, Bartov and Marquardt (2002). Finger

(1994) studied earnings ability to predict earnings. The impact of fair value measurement on analysts' forecasts has been studied by Ayers, Huang and Myring (2017) and Badenhorst (2018), but the last two studies focused on fair value measurement in general, not specifically on measurement of operational assets. This study distinguishes itself from other research by isolating the impact of fair value measurement of operational assets. It combines a study of analysts' behaviour with a study of whether the behaviour is rational under the circumstances and shows both through models and empirical evidence that earnings based on fair value is likely to be a noisier predictor of future earnings than historic cost.

The remaining article is organised as follows: First, I refer to literature that summarizes the research in this field. Next, I describe the institutional background and reporting practice before I survey the analysts' use of accounting information, their methods and estimates. Then I link the fair value reporting and the analysts' methods to general valuation theory before I discuss the use of fair value information. I next develop my hypothesis about whether the fair value information better predicts future cash flows than does historic cost information. I describe the research design, the expected results, the data sources and the data treatment prior to explaining sample selection and descriptive statistics. I present the results of the tests, summarize and conclude. The appendices present the numerical and formal examples.

2 Literature

Bradshaw (2011) summarizes an understanding of analysts' role in the capital markets and an understanding of analysts' activities. Both input and output are extensively studied. The processes of analysis and various analytical approaches are studied by Demirakos, Strong and Walker (2004) and Brown, Call, Clement and Sharp (2015). The valuation models applied by analysts can be identified and described from the extant valuation literature and from previous research in several fields. Brown et al (2015) takes a broad perspective on the input used by analysts. Green, Hand and Zhang (2016) looks at how sell side analysts execute their valuations. The study points out theoretical errors and questionable judgements, and the researchers note that analysts are not incentivised to be textbook correct.

Barniv and Myring (2006) look at historical and forecasted earnings in the accounting based valuation models in different countries and within various accounting regimes. The primary findings suggest that the forecast model performs better than the historical in most regimes and countries.

Ayres et al. (2017) studies fair value accounting and analyst forecast accuracy on U.S. firms. Even though it finds significant positive associations between analysts' forecasts and level 1 and 2 fair value measurements in non-financial industry, the assets measured at fair value are not operational assets. Badenhorst (2018) shows that the increased use of fair value has a negative impact of analysts' ability to predict earnings and book values, but the study focuses on use of fair value in general, but not specifically on operational assets.

Except for financial instruments, fair value measurement is only applied for biological assets and investment property[ii]. Liang and Riedl (2014) found that historic cost measurement was preferable to fair value measurement for predictive purposes in the real estate industry. Salmon prices, however, are much more volatile than real estate price fluctuations, and the real estate industry is primarily a leasing activity while this study concentrates on production activity.

Argilés, Garcia-Blandon and Monllau (2011) looked at the differences in short term cash predictive capacity between fair value and historical cost accounting in Spanish agriculture and found no significant differences. Their sample consisted of miscellaneous Spanish agricultural businesses, but the average number of inventory days among their sample businesses was 58, which is very different from that of the salmon industry whose producers rarely have below 300 inventory days.

Hitz (2007) adopts a theoretical perspective on the decision usefulness of fair value reporting. Daly and Skaife (2016) finds a positive association between cost of debt and fair value accounting for biological assets, but the direction of causality is unclear. Botosan and Huffman (2015) concludes that fair value measurement is more decision useful for assets that are expected to be realised in exchange while historic cost measurement is more decision useful for in use assets and cash flow prediction. The distinction «in exchange» and «in use» may not be very useful in a production company that may have inventory in different stages of a long-lasting production process. This scholarly work addresses aspects of accounting theory and valuation theory and some aspects of practice.

Huffman (2014) considers matching measurement to asset use in an IAS 41 setting, and the study finds that companies that are matching asset use to measurement, i.e. applying fair value for in exchange assets and historic cost for assets in use provide more value relevant information. Apparently the distinction between «in use assets» and «in exchange assets» is the based on bearer plants or not, IAS 41.2(B) It may take 20 years or more to grow a bearer plant and during this period there will normally be no observable market price; that is, any fair value estimate may be highly uncertain. By contrast, the production cycle for most agricultural produce is less than two years. Because of these factors, bearer plants have been scoped out of IAS 41 because historic cost provides more relevant information, and the distinction of fixed assets versus inventory seems more relevant: In this context, bearer plants should be accounted for according to IAS 16.

Argilés-Borch, Miarons, Garcia-Blandon, Benavente and Ravenda (2018 studies the usefulness of fair value measurement for cash flow prediction by comparing companies that use either historic cost or fair value measurement. The study shows), based on different models for cash flow prediction, that it becomes increasingly difficult to predict cash flows when the portion of biological assets increases, which probably means that the occurrence of biological assets itself disturbs cash flow prediction. Biological assets are less informative of future cash flows relative to total assets less biological assets (all other assets aggregated). This effect is reduced when fair value measurement is applied; that is, the interaction between an indicator variable for fair value measurement and biological assets as portion of total assets is significantly negative. We may infer from the study that fair value measurement reduces the overall negative impact of an increasing portion of biological assets, but we cannot infer that biological assets actually are relevant for cash flow prediction even if measured at fair value. The study differs from the present study in both data and design.

3 Institutional Background

3.1 Context

The fish farming industry (salmon) is characterised by a production cycle of 2.5-3 years. Hence, the industry builds up a substantial amount of inventory. The number of inventory days (Inventory x 365 / Cost of goods sold) based on inventory measured at fair value changes due to seasonal variations in quantity and volatile prices, but during 2015 it averaged approximately 400 days, rarely dropping below 300 or rising above 500 days during the observation period from 2006 to 2015.[iii]

Biological assets reported at fair value constituted 30-50% of the fish farmers' total assets measured at booked value. The fair value adjustment of inventory on the balance sheet is in the range of 5 % of Enterprise Value based on the market value of the equity,[iv] but it could be larger, smaller and even negative as companies have been taking losses. The change in fair value reported in the profit and loss statement could be substantial and will be relatively larger whenever the reporting period is shorter as inventory days relative to reporting period days increases.

Seasonal variations are a result of the biological cycle where juveniles are released into sea in the spring and then harvested 15-20 months later. There are also seasonal variations in pace of growth due to light and temperature conditions. Seasonal variations in consumption (demand) patterns, to some extent correlated with the production cycle, are partly offsetting to the supply variations. Due to the long production cycle and volatile prices, we might have expected cattle cycles (Rosen, Murphy and Scheinkman 1994), but due to a healthy growth over the last decade, farmers have produced at capacity.

A licence regime regulates the industry partly to control environmental effects and partly to control externalities between producers, in particular, the spread of diseases. A side effect of the licence regime is substantial barriers to entry, effectively restricting the supply. The industry has been very profitable evidenced by high market capitalisation compared to net asset values and high prices on licences to operate.

Given these circumstances the Norwegian salmon industry has grown by 6.7% per year since 2006 in terms of volume and by 14.0% (nominal) in terms of turnover. The volume growth has been positive every year except for 2016, and the turnover growth has been positive every year except 2011. For the moment, the Norwegian fish farming industry recognizes a substantial super profit (economic rent) and acknowledges low growth expectations in terms of volume. A challenging biological situation has curbed short-term growth expectations, but the positive price effect of reduced supply has more than offset the negative effect of increased production cost.

In the table below, Price / Book is based on Market Capitalisation plus Net Interest Bearing Debt (P) / Net Operating Tangible Assets (B). Both share prices and book values are as of December 31, 2015. Because the companies have acquired concessions at very different prices, they cannot be compared on multiples that include intangible assets.

	Marine Harvest	Salmar	Grieg	Bakkafrost	Lerøy	NRS	SSC
P/B	3.9	4.8	2.1	4.1	3.8	4.9	1.2

Table 1: Price / Book as of December 31, 2015. Sources; Share prices are closing prices on the Oslo Stock Exchange. Accounts with reporting currency other than NOK are translated by foreign exchange rates obtained from Norges Bank (the Central Bank of Norway); both rates are as of the date nearest to 31.12.15.

During the period from December 31, 2015 to December 31, 2016, Oslo Stock Exchange Seafood Index (not dividend adjusted) increased from 618 to 974, by 58%. Hence, the P/B increased further throughout 2016.

Figure 1 to be placed here

Over the same period (2016), the salmon prices increased from NOK 46 per kg to NOK 74 per kg. Figure 1 shows that although quite volatile, the prices have been at a historically high level since late 2015. The low prices in 2011 caused several producers to experience losses and sent the P/B ratio towards one. Relatively low salmon prices combined with generally low asset prices during the financial crisis also resulted in low P/B ratios late in 2008 and in early 2009.

Salmon is close to a commodity; differences in quality exist and affect prices, but it is difficult for a producer to establish a strong brand for marketing purposes. In these circumstances, the producers are to a large extent price takers in a commodity market and players in a cost cutting game.

From an equity analyst perspective, it seems reasonable to assume that the producers differ in company size, production efficiency and growth opportunities. Within the industry, economies of scale may exist. Statistics are available from the Norwegian Directorate of Fisheries, but the picture is obscure, and variations within the industry defy simple generalization. Medium sized companies may have advantages over smaller while the advantage may be lost in large control span and inflexibility as company size increases beyond certain points. Biological risk through the salmon's life cycle constitutes an important dimension of every business, regardless of size and geographical scope, and such risk is difficult to insure. Hence, large, geographically diversified producers are likely to have less volatile cash flows and potentially lower cost of debt than smaller, more localized producers.

3.2 IFRS reporting of farmed fish in Norway

IAS 41 requires live biological assets to be measured at fair value. The 'highest and best use' IFRS 13.27 and 'most favourable market' IFRS 13.16 premises are interpreted as a requirement to include the value of the option to grow the fish to the optimal size. The practical implication is that a 2 kg fish expected to grow to 5 kg is valued at the expected proceeds from the sale of a 5 kg fish less cost to completion even if there is a market for 2 kg fish. The expected proceeds from sales are based on expected prices at the time of harvesting. Therefore, the fair value estimate is a marked to model or level 3 valuation and not a marked to market or level 1 valuation, according to IFRS 13.72.

Norwegian salmon producers voluntarily report transaction based sales and cost of goods sold on a historic cost and matching basis. They report separately the fair value adjustment in the profit and loss statement. The reported figure in the balance sheet is fair value, but reconciliation to historic cost is presented in the disclosures. According to Norwegian tax legislation, the fair value adjustment is not taxable income; taxation is based on transaction-based earnings. In this context, the fair value adjustments give rise to temporary differences and deferred tax. The empirical part of this study is based on tax-adjusted figures. When references are made to the fair value adjustment in the balance sheet, this marks the difference between tax adjusted fair value and historic cost of the inventory. In order to find this adjustment, the reader must revert to the disclosures.

Fair value measurement of inventory has two features. Most important is that weight gain is recognised as income; that is, income recognition is moved from when the fish is handed over to the buyer, transaction based, to when the fish gains weight. This method was categorised as ‘accretion accounting’ by Philips in (1963). The other implication, a second feature of the fair value measurement of inventory, is that inventory at the beginning of the period; that is, inventory still on the balance sheet, is remeasured.

The fair value adjustment in the profit and loss statement includes three elements:

(1) The value of the weight gain during the period measured at closing balance prices. This is always positive as long as the margin is positive (unless mortality causes a reduction in aggregate biomass).

(2) The impact of price changes on the part of the opening balance of inventory that is still on the closing balance sheet.

(3) A release of the fair value adjustment on harvested fish (a correction to cost of goods sold reported at historic cost)

Many producers report 1-3 as a single figure with no further specifications (or have at least done so during a part of the observation period).

The fair value estimates could potentially convey information in excess of salmon prices--for example, about size distribution, health status and cost to completion, and other factors--but lack of transparency makes the information difficult to extract. This information may also be available through guidance and other auxiliary information. Historically the industry has not disclosed sufficient information to allow analysts to make corroborative calculations of fair value. In particular, information about size distribution has been too coarse.

Variable	**Definition**
ΔFV_t	The tax adjusted fair value adjustment obtained from the profit and loss statement for the period ending at time t
FV_t	Fair Value of inventory less historic cost of inventory and less deferred tax obtained from the balance sheet at date t.
$Noplat(HC)_t$	Net operating profit less adjusted taxes for the period ending at time t
Noplat(FV)t	$Noplat(FV)_t = Noplat(HC)_t + \Delta FV_t$

A complete list of definitions and abbreviations is presented in Appendix 1.

3.3 Compliance with disclosure requirements

Whether the industry actually complies with IAS 41 is interesting to consider, because non-compliance may explain why equity analysts do not find the fair value information useful. Of particular interest are the following paragraphs of the standard:

- IAS 41.43 ‘An entity is encouraged to provide quantified description of each group of biological assets, distinguishing between consumable and bearer biological assets or between mature and immature biological assets, as appropriate.’

- IAS 41.43 ‘Biological assets may be classified either as mature biological assets or immature biological assets.’
- 41.46 ‘….an entity shall describe non-financial measures or estimates of the physical quantities of each group.’
- 41.51 ‘The fair value less cost to sell of a biological asset can change due to both physical changes and price changes in the market. Separate disclosures of physical and price changes is useful in appraising current period performance and future prospects, particularly when there is a production cycle of more than one year.’

Apparently, it is sufficient to distinguish between groups of mature and immature fish; for example, information per size category of immature fish is not required. «Encouraged» cannot by interpreted as an absolute requirement to provide information about quantities and size distributions. Information about effects of price and physical changes can hardly be interpreted as a requirement to disclose the price actually applied for each size category, but rather the aggregate price effect. It seems that the disclosures offered comply with a narrow interpretation of the standard, but at the same time, they are not sufficient to allow analysts to extract useful information from the fair value adjustments.

3.4 Management’s discretion

Generally fair value measurement has been considered to be more susceptible to manipulation, in particular, whenever valuations are model based (level 3, IFRS 13.72). The fair value measurement has an ambiguous impact on management’s ability to manage results. Fair value measurement introduces an estimate that may be manipulated. The two most important assumptions that need to be addressed are expected price at the time of sales and cost to completion. By contrast, timing of harvesting will have little or no impact on reported result under fair value measurement (accretion accounting) as contrasted to transaction based historic cost. This is because the income is already recognised. Accordingly, earnings cannot be manipulated either through timing or through the selection of population to be harvested (they may have different production cost). Fair value measurement also eliminates the effect of different principles for cost allocation and different treatment of mortality.[v] Improved knowledge about and control over biomass may improve the guidance about future harvesting; thus, equity investors may benefit from fair value measurement even if they do not use the information provided.

3.5 Estimation errors and volatility

Ideally, the fair value adjustment in the profit and loss statement should only consist of the three elements described above, but it will invariably represent any effect of management bias. Of course, management bias could be deliberate manipulation, but it may also express the effect of estimation uncertainty and imperfect valuation models. In this context, ΔFV_t comprises any estimation error made in period t, but it may also express estimation errors made in previous periods and later released in period t. Even in the absence of estimation errors, ΔFV_t is highly volatile and because of the large number of inventory days relative to the reporting period, the fair value adjustment may not move Noplat towards its recurring level (Appendices 3 and 4).

A possible explanation for why analysts do not use the fair value information and why the fair value information is not informative of future cash flows is lack of reliability. A study of value relevance done by the author [citation] shows that fair value measurement is value relevant. Because the fair value adjustments are informative of share prices, there must be information content that will also be relevant for equity analysts.

3.6 Price Expectations

When salmon farmers assess expected future harvesting prices for accounting purposes, their expectations will be influenced (but not totally determined) by current spot prices, recent bilateral contracts for future delivery into which they have entered, futures prices in the derivative market, and reports from independent analysts who have collected supply side information. Other factors may also be taken into account. Fresh (harvested) salmon has very limited storage capacity, and frozen salmon is not a perfect substitute for fresh salmon. The possibility of departing from long term harvesting plans by delaying or advancing harvesting is limited. Like for any commodity, future production does not affect the current supply/demand balance.[vi] Finally, there is no reason to believe that the financial market is sufficiently liquid to eliminate any possible arbitrage between the physical and financial market.

IFRS 13 requires producers of financial statements to rely mostly on external evidence, i.e. the observable futures prices. This reduces the risk that heterogeneous expectations will reduce the comparability of financial statements across different producers. By contrast, the risk that not all available information about future salmon prices, within the time horizon of the production cycle, is reflected in the balance sheet, may be increased because the opportunity to disperse private information is lost; that is, there may be a trade-off between relevance and reliability.

Sell side equity analysts may have expectations that deviate from management's expectations, and they may be rightly convinced that future movements of product price are predictable and that prices are not a «random walk». Accordingly, they may want to replace management's expectations with their own cash flow projections.

In this respect, fair value measurement of inventory of fish is very different from fair value measurement of financial instruments. Like in their assessments of financial instruments, equity analysts may disagree with management's assessment (in particular, for level 3 valuations), but with financial instruments there is no need to consider future price movements (in contrast to the inventory of fish.)

4 Observations from valuation reports and interviews

The purpose of this review of the reports and interviews of equity analysts is to survey their approach to making cash flow estimates and target prices, to consider whether or not the fair value information is applied, and if it is not considered, to ascertain why.

During November 2016, the author sent requests to 14 investment banks with offices in Norway. The list of analysts was obtained from http://marineharvest.com/investor/share-and-bond-info/analyst-coverage/. The list was crosschecked against ThomsonReuters. The analyses downloaded from ThomsonReuters were either rebranding of some of the analyses already obtained or analysis of historical information with no cash flow forecasts. No subject was added because of this cross check. The researcher asked each analyst to submit a typical recently issued report. These analysts knew the purpose of the review, and they chose which reports to submit to the author. There is no reason to believe that any analyst applies different methods for different companies. Each of the 14 banks provided minimum one sell side / investment analysis report. Some analysts issue industry surveys where all the listed fish farmers are covered.

The reviews of the analysts' reports were based on reading, tracing of figures to official financial statements and recalculation of ratios. To the extent the received reports were not sufficiently transparent to reveal the methods used by analysts in their production, the reviews of the reports were followed up by telephone interviews. All analysts also participated in telephone interviews where follow up and confirmatory questions were asked based on the initial review of their reports. The follow up questions covered the issues of whether 1) fair value or historic cost figures are applied for the analysis of historic performance, 2) fair value or historic cost figures are applied for comparison between companies and multiple analysis, 3) the fair value adjustments are used for any other purposes[vii].

Inferences are made based on the uniformity of the answers with no statistical analysis due to the sample size and because the data set covers all companies and all analysts; that is, it constitutes a complete universe.

4.1 Methods and estimates

The review of the reports submitted revealed a number of features. All the analysts present cash flow estimates for two years, often split by quarters, and each states a target price. It was not usual for the analyst to set a time frame for when a given target price was to be reached, but given the short-term focus for all of the analyses, 6-12 months is a reasonable interpretation (Bradshaw 2002). None of the reports present a full DCF analysis, but some refer to DCF analyses and a very few present the outcome of such and their assumptions for key value drivers. All present multiple based valuations and key multiple / ratios include EV/EBIT(DA), EV/Normalised production, EBIT/kg and P/E. In most cases, the multiples are calculated based on forecasted earnings t+1 directly.[viii] The multiples are also presented based on t+2. The observations are summarised below.

Table 2 to be placed here

The analysts base their short term (0-24 months) estimates about future salmon prices on the current price levels and the estimated effect of expected changes in the supply / demand balance for the next 0-24 months. As the farming conditions and supply fluctuations are impossible to predict beyond a normal production cycle, it is reasonable that nobody makes specific price estimates beyond 24 months. Surprisingly, nine of the fourteen refer neither to a DCF analysis nor to a long-term equilibrium price or long-term equilibrium EBIT/kg, but Bradshaw (2004) suggests that analysts' stock recommendations are more closely related with heuristic valuation models than with present value models.

In making their forecasts, analysts do not try to extract management's expectations about prices from accounting information. Overall volume (supply) growth is forecast based on information about the quantity of juveniles released, farming conditions, public regulation, productivity improvements, company guiding, and other factors. Short-term supply fluctuations are assumed to cause price fluctuations (this is supported by regression analyses), while analysts believe long-term growth to be absorbed by a growing demand for seafood combined with depleted fishing resources. Comparisons with substituting protein sources are commonly made both with respect to product and share prices. Estimates about future production cost, in particular, differences in efficiency, are derived from historic information, but adjustments are made based on information about farming conditions, expected changes in feed prices, currency effects, and several other factors.

The nine analysts who refer neither to long-term prices nor to growth do not attempt to justify the absolute level of the multiples applied, but occasionally they discuss development and make comparisons to other protein producers.

4.2 Equity analysts' use of fair value estimates

The fair value adjustments reported in the balance sheet and the changes to the fair value adjustment reported in the profit and loss statement are not subject to any explicit discussion or examination by any of the analysts, and there is no explicit attempt to extract information from the fair value adjustments. When key ratios are presented (EPS, EV/EBIT, EV/EBITDA), the focus is always on the historic cost figures although some analysts also present the figures as reported by the company, for example EPS (adjusted) and EPS (as reported). The analysis of production cost per kg and EBIT per kg is exclusively based on the historic cost figures. This is confirmed by interviews with all the analysts included in the study.

Due to the large differences in the historic cost of acquired licences, the Price / Book ratio varies between the companies for reasons other than cost efficiency and growth opportunities; therefore this particular multiple does not receive much focus by analysts, but this information is commonly presented within the reports, and occasionally the development over time is discussed. Some analysts eliminate the fair value adjustment from «book» while others do not. The variance in practice appears to be due to the scant attention that analysts pay to this ratio. None of the analysts presented any rationale for their choice.

To the extent that the analysts include an analysis of changes in net working capital, their examination is based on historic cost figures. None of the analysts presents an integrated analysis showing profit and loss, cash flow and balance sheet development beyond two years.

One analyst mentioned during the interview that the fair value adjustment could carry information about current mortality and production issues that are relevant for the prediction of cost per kg the next 6-12 months. The reason why this information is not analysed could be lack of transparency or cost benefit considerations.[ix]

5 How the observations link to valuation models

Analysts rarely use explicitly described DCF models (Green et al 2016). None of the analysts in the sample present a full-fledged DCF model, but several refer to this type of model and indicated valuation results.

More commonly, analysts apply single period multiple models where a multiple is applied to a Noplat or EBIT(DA) forecast for the next 12 months, sometimes with various adjustments. Hybrid models where a multiple is applied in combination with a very short explicit cash flow forecast (maximum three years) are commonly observed. This is the most common model observed within the salmon industry. The term «hybrid model», however, is not very precise; virtually all valuation models apply some sort of multiple method to the end of the explicit period.

A hybrid model may be synthesised as follows:

(1) $$\text{Equity Value} = \frac{CF_1}{(1+K_A)^1} + \frac{CF_2}{(1+K_A)^2} + \frac{CF_2(1+g)M}{(1+K_A)^2} - \text{NIBD}$$

Equity Value is the discounted value of the Cash Flows (CF_i) for the next two years plus a Continuing Value where $M=1/(K_A\text{-}g)$ is based on Gordon's Growth, and NIBD is Net Interest Bearing Debt. In this model, fair value information may be incorporated in NIBD for non-operational assets or in the cash flow estimates for operational assets.[x]

To be sure, M is a crucial input factor to the target price; in particular, whenever the explicit forecast period is short. M may be based on an undisclosed more sophisticated valuation model, but only five of fourteen analysts disclosed assumptions about long- term growth and prices / margins per kg. The reports do not disclose the discount rate, K_A; therefore, the implicit growth, g, cannot easily be derived.

Valuation models may be chosen because of the information available. Parsimonious models or simple heuristics may be used when little information is available, and models that are more complex may be used to take advantage of richer sources of information. The models applied by analysts for salmon companies do not differ from models commonly applied in other industries. We may conclude that in these particular reports, the analysts apply the models they typically use and that such models ignore fair value. The analysts do not attempt to amend the models to allow for the use of the available fair value information.

Even if income is forecast based on expected volumes and prices, analysts need to estimate production cost. When analysts try to establish the expected production cost per kg, the fair value adjustment in the profit and loss statement, which may be considered as an adjustment to income, is disregarded. Cost of goods sold relates to the actual amount harvested and a transaction based historic production cost per kg harvested is easily derived. This is usually disclosed separately by the companies. There is no reason to include noisy information about income whenever information about cost is readily available.

The fair value adjustment in the profit and loss statement represents management's, potentially useful, private information about fish health, size distribution, farming conditions and cost development. This information, however, is noisy. The information will incorporate management's expectations about future product prices that are not disclosed separately, and management will release the fair value adjustment for prior periods. As the disclosures are too coarse to allow corroborative calculations, the forward-looking information about production cost cannot easily be extracted. Without precluding the possibility that the fair value estimate may contain forward-looking information that might potentially improve cash flow forecasts, historical production cost is much more accessible and less noisy.

We may extend our conclusions; analysts do not need the fair value information as direct input to their valuation model, and analysis of historical performance might be done based on historic cost information. Although analysts disregard information that might have improved their predictions, that information is not easily accessible.

6 Cash flow prediction – Hypothesis development

The purpose of this section is to explore whether analysts overlook information that potentially could improve their predictions and whether it is rational to disregard the fair value information.

6.1 Logical model

Accruals carry information relevant to prediction of future earnings and cash flows (Barth, Beaver, Hand and Landsman 1999; Barth, Cram and Nelson 2001; Finger 1994), but whether analysts utilise such information is questionable. Some research suggests that they do not (Bradshaw et al 2001), while other research suggests that the accrual management is quickly impounded into stock prices (Balsam et al 2002). If growth is low, fixed assets are replaced regularly and the level of discretionary accruals is low, it may be reasonable to apply earnings as proxy for cash flow. In the reports under review, analysts use EBIT or Noplat as a proxy for cash flow and do not attempt to predict fluctuations in net working capital.[xi]

If we disregard working capital elements other than inventory, we have that[xii]

(2) $$\mathrm{Noplat(HC)}_t - \Delta\mathrm{Inventory(HC)}_t = \mathrm{Cash\ Flow}_t$$

(3) $$\mathrm{Noplat(FV)}_t - \Delta FV_t - \Delta\mathrm{Inventory(HC)}_t = \mathrm{Cash\ Flow}_t$$

Where Noplat(HC) and Noplat(FV) are Noplat based on historic cost and fair value respectively, and ΔFV_t is the tax adjusted Fair Value adjustment. We note that ΔFV_t is the profit and loss effect of changes in the fair value adjustment alone, not the total change in inventory measured at fair value.

Under historic cost measurement, ΔInventory$(HC)_t$ will not only be a difference between earnings and cash flow but also have predictive power on Noplat$(HC)_{t+1}$. The normal situation is that inventory is built up in one period and sold with a profit in the next.

It may be interesting to look at a steady state situation where inventory volume is constant; for example, when harvesting is equal to production or increase in biomass. In this case, we could isolate the impact of price fluctuations. Appendix 3 shows a numerical example where inventory is five times the production and where prices first fluctuate due to seasonal variations. The example is used to explore the effect of a price shift. Appendix 4 shows a formal example of cash flow prediction in period t+1 based on earnings in period t.

We observe that both Noplat$(HC)_t$ and Noplat$(FV)_t$ are noisy predictors of cash flow in period t+1 and that the level of noise depends on the level of inventory and the pattern and timing (early or late in the reporting period) of price fluctuations. In particular:

- High levels of inventory increase the amount of noise.
- FV information provides more information about future cash flows if the price change has taken place late in period t.

Analysts try to estimate transaction based Noplat(HC)$_{t+1}$ based on expected harvested volume, expected price and expected production cost. [xiii] They do not try to predict ΔFV_{t+1} and Noplat(FV)$_{t+1}$. The reasons why analysts focus on Noplat(HC)$_{t+1}$ rather than Noplat(FV)$_{t+1}$ are:

- If Noplat(HC)$_{t+n}$ is estimated based on expected harvested volume, expected price and expected production cost for each future period, the cash flows generated from the current inventory is already reflected in the cash flow model.
- If we still assume constant volume of inventory, ΔFV_{t+1} is purely a revaluation of the inventory and has no cash-flow impact in period t+1. (The same reasoning could be applied for t+2 and so on. The ΔFV is a forward-looking adjustment to an accrual and has no cash flow implication in the current period.)

Although the fair value estimates are not required for the analysts' models, the fair value estimates may convey information about amount and timing of future cash flows. Future prices, production cost including mortality, and pace of growth will be the key value drivers. Obviously, an increase in the fair value adjustment in the balance sheet represents increased expectations about future cash flows, holding the discount rate constant. In this section, I will explore whether analysts overlook useful information.

The hypothesis is that although it may not be very useful for analysts, ΔFV has information content. ΔFV reflects information about (although the information is not exhaustive), changes in biological conditions, price changes, weight gain, and future production cost, all of which are relevant for prediction purposes, although potentially rather noisy.

We test whether Noplat(FV)_t better predicts Noplat(HC)_{t+1} than does Noplat(HC)_t where Noplat(HC)_{t+1} is a proxy for cash flow. We also test whether the fair value adjustment, ΔFV_t, (Noplat(FV)_t minus Noplat(HC)_t) carries any incremental information.

6.2 Hypotheses

We test the hypotheses:

- $H0_a$: Noplat(HC)_t is a better predictor of Noplat(HC)_{t+1} than Noplat(FV)_t.
- $H0_b$: The fair value adjustment, ΔFV_t, does not contribute incrementally to the prediction of Noplat(HC)_{t+1}.

7 Empirical Analysis

7.1 Research Design

The hypothesis will be tested by regressing Noplat(HC)_{t+1} against Noplat(HC)_t and Noplat(FV)_t. Whether Noplat(FV)_t is a better predictor than Noplat(HC)_t is tested by considering the two reporting regimes as independent samples (Biddle, Seow, Siegel 1995). Obviously, more sophisticated cash flow prediction models could be applied (Barth et al. 2001), but because analysts apply Noplat as a proxy for cash flow, it seems reasonable to test whether Noplat_t is an informative predictor of Noplat_{t+1}.

Let $\text{Noplat}_j = \text{Noplat(HC)} - \text{Noplat(HC)}I_j + \text{Noplat(FV)}I_j$. I_j=0 for J=1 and I_j=1 for J=2. These expressions allows Noplat_j=Noplat(HC) when j=1 and Noplat_j=Noplat(FV) when j=2.

(4) $\text{Noplat}_{i,t+1,j} = \alpha + \beta_1 \text{Noplat}_{i,t,j} + \beta_2 I_{i,t,j} + \beta_3 \text{Noplat}_{i,t,j} \times I_{i,t,j} + \beta_4 C_{i,t,j} + \varepsilon_{i,t,j}$
i=1,….8, t=1,…36, j=1,2.

Here Noplat will appear both based on Historic Cost and Fair Value. I expect positive coefficients for β_1, β_2, and β_3. The intuition is that the coefficient before the Interaction Term, $Noplat_t$ x $Indicator(FV)_t$ describes the difference between two slopes and that FV is the better predictor if the coefficient is positive and significant. The formal test criterion is:

$$H0_a: \beta_3 > 0$$

Incremental information content is tested by separate regressions on the formats

(5a) $$Noplat(HC)_{i,t+1} = \alpha + \beta_1 Noplat(HC)_{i,t} + \beta_2 C_{i,t} + \varepsilon_{i,t}$$

(5b) $$Noplat(HC)_{i,t+1} = \alpha + \beta_1 Noplat(HC)_{i,t} + \beta_2 \Delta FV_{i,t} + \beta_3 C_{i,t} + \varepsilon_{i,t}$$

(5c) $$Noplat(HC)_{i,t+1} = \alpha + \beta_1 Noplat(FV)_{i,t} + \beta_2 C_{i,t} + \varepsilon_{i,t}$$

Hypothesis $H0_b$ is tested by comparing R squared and by testing the coefficient for the fair value adjustment in 5b.

$$H0_b: \beta_2 > 0$$

Control for seasonality

In specification 4, $Noplat_t$, which appears as independent variable both based on HC and based on FV, is controlled for seasonality by introducing an Indicator, Sq, taking the value, 1, 2, 3 and 4 for each quarter.

$$S_q = \begin{cases} 1, \text{if } q = 1 \text{ quarter} \\ 2, \text{if } q = 2 \text{ quarter} \\ 3, \text{if } q = 3 \text{ quarter} \\ 4, \text{if } q = 4 \text{ quarter} \end{cases}$$

Three separate interaction terms for $Noplat_t$ x S_q are introduced for the quarters 1-3.

In specification 5, both $Noplat(HC)_t$ and ΔFV_t appear as independent variables and both may include seasonal components, partly due to price fluctuations, but this is also because of seasonal variations in weight gain, size distribution harvesting and level of inventory. By applying the same S_q and the interaction terms S_q x Noplat$(HC)_t$ and S_q x ΔFV_t, we have six interaction terms.

7.2 Expectations

If we assume a constant level of inventory volume and then observe a parallel shift in the price curve in period t, the impact on Noplat$(HC)_t$, will depend on whether the shift took place early or late during the period.[xiv] The fair value effect on the inventory will depend on the magnitude of the price change.

Prices are volatile, they change all the time, and although a 3 months future may correlate with a 6 months future, shifts in the price curve are not parallel. Hence, we may expect Noplat$(HC)_t$ to be a noisy predictor for Noplat$(HC)_{t+1}$, and Noplat$(FV)_t$ to be an even more noisy predictor of Noplat$(HC)_{t+1}$ (Appendices 3 and 4).

If we leave the assumption about constant level of inventory, the change in fair value in the profit and loss statement comprises the 3 elements described under 3.2. While an increase in stock of inventory in period t may predict Noplat$(HC)_{t+1}$, the effect of changing prices may not bring Noplat$(FV)_t$ closer to recurring Noplat nor to expected Noplat for the next period. If inventory of harvestable fish is high and salmon prices are spiking, the adjustment could be large, see Table 3.1.

We may expect seasonality to have an impact. Seasonality is created by both price and volume fluctuations, and the impact is different in timing and magnitude on transaction based historic cost figures and fair value measures. If prices during the fourth quarter systematically are 10% above the rest of the year (seasonal variations), Noplat(HC) has no capacity to predict this fourth quarter effect. Under fair value measurement, the weight gain in the third quarter that is expected to be realised in fourth quarter is measured at fair value. When seasonal variations encompass volume and price variations, fair value measurement may smooth seasonal variations, but we cannot infer that the fair value adjustment is enhancing predictions of next period earnings (cash flow).

Given this, we may expect that the association between $Noplat(HC)_{t+1}$ and $Noplat(FV)_t$ is weaker than for $Noplat(HC)_{t+1}$ and $Noplat(HC)_t$. Liang and Riedl (2014) found that historic cost accounting was associated with better forecast accuracy of earnings per share in investment property firms reporting based either on fair value or historic cost. Argiles et al. (2011) looked at the differences in short term cash predictive capacity between fair value and historical cost accounting in Spanish agriculture and found no difference. Their sample encompassed miscellaneous Spanish agricultural businesses, but the average number of inventory days was 58, markedly lower than that of the salmon industry where the number of inventory days rarely is below 300.

The fair value adjustment in the balance sheet is based on information about volume and size distribution, expected prices, expected cost to completion and expected harvesting cost. Even if Noplat(FV) is unlikely to outperform Noplat(HC) as predictor for future cash flow or earnings, this does not preclude that ΔFV may have information content; that is, incrementally contribute to the prediction of Noplat for future periods.

The fair value adjustments may convey management's view on price development for the next 12-18 months. The adjustment may also convey information about cost development as cost to completion is the other important input to the fair value adjustment. Even considering this, the data may be too noisy to get significant results.

7.3 Data sources and data manipulation

The analysis will be based on hand-collected data from interim financial statements for each quarter for the period, fourth quarter 2006 to fourth quarter 2015.[xv] The tests for specification 4 is based on ordinary multiple regression analyses on the full data set with no identification of company or period and where fair value and historic cost are considered to be independent samples, 470 data points. The tests for incremental information content are performed on unbalanced panel data and as ordinary regression with no identification of company and period. This gives 235 data points. The tests will be based mainly on the significance of regression coefficients and on comparing differences between R squared values. No manual adjustments are made except for those described below and under the definitions of variables.

For the accounting data, the following adjustments are made:

Standardization

All figures are per number of outstanding share at the end of the period.

Fair Value Adjustment

The fair value adjustments do not always reconcile; that is $FV_{t-1} + \Delta FV_t$ may differ from FV_t in the financial statements. The data set does not allow a detailed analysis, but occasionally fair value adjustments on derivatives are grouped with ΔFV. In addition, mergers and acquisitions cause changes in the fair value adjustment in the balance sheet that are not reflected in the profit and loss statement. Low reporting quality can also be a possible explanation. Primarily because FV adjustments on inventory acquired together with concessions are not charged to the profit and loss statement, ΔFV is likely to be better for predictive purposes than the differences between two balance sheets.

Noplat(FV) does always reflect ΔFV; that is, the adjustment is obtained from the profit and loss statement. No attempt is made to control for reconciliation differences.

Tax

The companies are located in different countries with different tax rates, but 25% is assumed to be a sufficiently accurate estimate for the average tax rate. Taxes are allocated to Noplat(HC) and ΔFV based on a 25% template rate. Noplat(HC) is EBIT(HC) x (1-s) where s=0.25. The fair value adjustment in the profit and loss statement, ΔFV(pre tax), should also be tax adjusted by the same tax rate in order to arrive at Noplat(FV). Noplat(HC) + ΔFV(pre tax) x (1-s) = Noplat (FV).

Net Income and Financial Items

Although the regression focuses on Noplat as an independent variable, controls are performed for the difference between Net Income and Noplat, mainly because some companies may classify the effect of foreign exchange hedging as financial items (Financial).

$$\text{Financial} = \text{NI} - \text{Noplat(FV)}$$

The residual tax expense is allocated to Financial which includes the actual tax expenses on financial items plus the difference between actual tax and template tax on Noplat(FV). If there are systematic differences between template and actual taxes rates on EBIT(HC) and on ΔFV, we should expect these differences to cause correlations between Noplat(HC) and Financial and between ΔFV and Financial. The correlation between Noplat(HC) and Financial is 0.06 (not significant) and the correlation between ΔFV and Financial is -0.17 (significant). I expect successful hedging of FX-risk to cause negative correlation between ΔFV and Financial.

Adjustments (Non GAAP)

Management focuses on unusual and non-recurring events in auxiliary information, and some account producers present such information in the financial statements. In particular, the treatment of above normal mortality and the definition of normal is controversial because this will have an impact on the historic cost figures.

Although managements' adjustments or 'Non GAAP' may be important in order to distinguish between management performance and luck, the information is difficult to verify. Accordingly, there is limited merit to the claim that value relevance is increased (Landsman, Miller and Yeh 2007). For the purpose of this article, such information is disregarded; i.e., no corrections are made even for items that are verifiable. Because the focus is on Noplat and not on Net Income, financial items and OCI will not affect the analyses. Dhaliwal, Subramanyam and Trezevant (1999) showed that there is little association between OCI and firm performance.

7.4 Sample selection

The data material for the analysis of the predictive ability of fair value information, accounting information was obtained for a set of eight listed companies from the fourth quarter 2006 to the fourth quarter 2015 (37 periods.) Not all companies were listed during the whole period.

Company	Total Assets* NOK Billions	CAGR** Total Assets	From	To	Periods of Price data
Marine Harvest	40.2	4.4%	4q2006	4q2015	37
Cermaq	9.0	4.9%	4q2006	3q2014	32
Salmar	10.9	19.4%	2q2007	4q2015	35
Grieg	6.0	9.0%	2q2007	4q2015	35
Bakkafrost	5.1	26.9%	3q2010	4q2015	24
Lerøy	16.0	12.7%	4q2006	4q2015	37
NRS	2.9	15.5%	3q2011	4q2015	20
SSC	2.1	7.4%	2q2010	4q2015	23

Table 3: NRS=Norwegian Royal Salmon; SSC=the Scottish Salmon Company. *Total Assets as of the fourth quarter of 2015 except for Cermaq, which is as of the third quarter 2014. **Compound Annual Growth Rate is calculated for the periods included.

The data set consists of all salmon producers listed on the Oslo Stock Exchange during the observation period except for one company, Lighthouse Caledonia, which was listed for a shorter period. The reason why the fourth quarter 2006 is selected as starting point is that at that time the industry collectively adopted a new interpretation of IAS 41 issued by the Financial Statements Oversights Board.

7.5 Descriptive statistics

The total number of data points for the accounting data is 243, which is reduced to 235 when period t+1 is regressed against period t. Due to differences in geographic location and vertical integration, there are company specific effects. Because all companies are affected by general price fluctuations and farming conditions, there will be time effects. This supports that an analysis on panel data should be analysed for fixed effects; this approach is also supported by a Hausman test (the hypothesis; «random effect is appropriate» is falsified at prob>chi2 = 0.0000).

Data characteristics are summarised in Table 3.1. Correlations are presented in Table 3.2.

In a separate Table 3.3, correlations between $Noplat(FV)_t$, $Noplat(FV)_{t+1}$, $Noplat(HC)_t$ and $Noplat(HC)_{t+1}$ are shown. It is interesting to observe that the right column, which shows the correlations between Noplat(FV)$_{t+1}$ and prior period profit and loss measures, shows weaker correlations than the left column which indicates the correlations between Noplat(HC)$_{t+1}$ and prior period profit and loss measures. Noplat(FV)$_{t+1}$, which includes the noisy ΔFV_{t+1}, is more weakly correlated to the preceding period regardless of measurement attribute.

When ΔFV_{t+1} is regressed against ΔFV_t, there is a significant negative coefficient. However, R squared is only 0.04. A negative coefficient may be explained by mean reverting salmon prices/seasonality (Table 3.4), and with fluctuations in inventory quantities. ΔFV is linked to the level of inventory due to the accretion effect. If inventory is built up in one period and built down the subsequent period, we should expect ΔFV to follow the same pattern.

7.6 Analyses

Stata14 is applied for all statistical analyses. All regressions, except when panel data are applied, have been tested for size effects both by including a control variable for size and by inspecting the interaction between the control variable for size. The problem of heteroskedasticity is reduced by applying robust standard errors.

7.7 Results; Forecast accuracy Historic Cost vs Fair Value

Table 4.1 is based on specification 4. The regression coefficient for Noplat$_t$ relates to historic cost while the regression coefficient for the Interaction Term, I_j x Noplat$_t$ relates to the difference in slope between the coefficients for Noplat(HC)$_t$ and Noplat(FV)$_t$. A negative coefficient means that the fair value adjustment ΔFV_t moves Noplat$_t$ away from its recurring level. Hence, the test criterion

$$H0_a: \beta_3 > 0$$

We observe a negative and significant coefficient for the Interaction Term for Noplat(FV).

In a growing industry, we should expect a coefficient close to 1 or slightly above 1 for $Noplat_t$. In a cyclical industry that has seasonal variations, the start and stop of the time series could have a large impact, and the coefficient 0.824 for $Noplat_t$ is not unreasonable (column 1).

Effect of seasonality

In column two, the regression is controlled for seasonality where each of the quarters is assigned an indicator variable. The coefficients for the three interaction terms show that there is a significant seasonality. The correction for seasonality does not change very much the coefficient for I_j x $Noplat_t$. This coefficient is still negative (-0.343) and significant. Failing the test criterion means that historic cost is a better predictor relative to fair value.

7.8 Results; Information content of fair value adjustment

Table 4.2 shows separate regressions of $Noplat_{t+1}$ on (5a) $Noplat(HC)_t$, on (5b) $Noplat(HC)_t$ and ΔFV_t, and on (5c) $Noplat(FV)_t$, according to specifications 5a-c. 5b shows the effect of adding the fair value adjustment ΔFV_t to the historic cost regression 5a. The coefficient for ΔFV_t is not significantly different from nil, and the effect on R squared is negligible, 0.638 (5a) vs 0.640 (5b). We further observe that $Noplat(HC)_t$ explains more of the volatility in $Noplat_{t+1}$ than does $Noplat(FV)_t$, R squared of 0.638 (5a) compared to 0.354 (5c), and that $Noplat(FV)_t$ (5c) has lower a coefficient compared to $Noplat(HC)_t$ (5a), 0.417 vs 0.824. Controlling for Salmon $Prices_t$ and change in Salmon $Price_t$, not tabulated, does not improve the historic cost regression.

Based on Table 4.1 and Table 4.2, neither the null hypothesis about historic cost being a better predictor than fair value nor the null hypothesis about no information content in the fair value adjustment may be rejected.

Table 4.3 repeats Table 4.2, but the data is structured as panel data and analysed for fixed company and time effects. The results are basically the same. It also shows that controlling for Financial and Salmon Price$_t$ 5b(i) makes no difference even though their regression coefficients are significant.

5b(ii) shows that by adding (controlling for) FVBal$_t$, i.e. the fair value adjustment in the balance sheet at t, both the coefficients for ΔFV_t and FVBal$_t$ become significant. While ΔFV_t primarily includes information about changes in prices and stock of inventory, FVBal$_t$ includes information about the levels of inventory and prices. The correlation between ΔFV_t and FVBal$_t$ is 0.38. However, R squared is not different from 5a and 5b(iii). We suspect that ΔFV_t may have information content, but the regression model 5b(ii) is not better than 5a.

Effect of Seasonality

Controlling for seasonality does not change the overall results although seasonal effects are observed. When I introduce a correction for seasonality in Table 4.4, the coefficient for ΔFV_t in 5b(i) becomes positive, but it still is not significant. The coefficients for some of the interaction terms with Noplat(HC)$_t$ are significant, and there is a small increase in R squared compared to Table 4.3, indicating that there is a significant seasonal component.[xvi] None of the coefficients for interaction terms with ΔFV_t are significant.

If we disregard the seasonal component in Noplat(HC); that is, omit the interaction terms even though significant, the coefficient for ΔFV_t becomes negative and significant, 5b(ii), and some of the coefficients for the interaction terms with ΔFV_t also become significant. In this specification, a negative coefficient for ΔFV_t per se is not problematic. The explanation may be because of mean reverting salmon prices or inventory building up one period and down the next. It is, however, more difficult to accept such explanations when adjusting for seasonality because such effects should be expected to be driven mainly by seasonality. ΔFV_t may serve as a correction to $Noplat(HC)_t$ when we omit the interaction terms for seasonality in $Noplat(HC)_t$.

We are not able to reject the hypothesis $H0_a$ that «historic cost is a better predictor of $Noplat_{t+1}$ relative to fair value». Neither can we reject the weaker assertion, «the fair value adjustment does not have incremental information value», Table 4.4 5b(i). Seasonal components seem to be disturbing. Table 4.4 5b(ii) indicates that ΔFV_t may carry some information, but the economic significance is negligible. This means that when seasonality is take into consideration, the fair value adjustment ΔFV_t hardly improves a naïve prediction model of $Noplat_{t+1}$. When we compare Table 4.4 5(iii) with Table 4.4 5b(ii) and Table 4.3 5a and 5b, $Noplat(HC)_t$ adjusted for seasonality seems to be the best predictor of $Noplat_{t+1}$. The seasonality is well-known among analysts.

8 Discussion

Apparently, analysts rationally ignore the fair value information offered.

In steady state with stable prices, FV measurement moves income recognition from the point of transaction to the time of value creation or biological transformation. In an environment with shifting farming conditions, the amount of value creation might be volatile, and FV measurement may carry information about value creation that is informative about cash flows in future periods. However, due to volatile prices, the effect of biological transformation is difficult to observe. Biological transformation within fish farming cannot take place unless the fish are fed, and feed expenses are observable under historic cost measurement. Thus, FV measurement may not necessarily carry any additional information.

Regression analyses indicate that profit and loss measures based on historic cost better predict future cash flows than measures based on fair value (Table 4.1). The information content in the fair value adjustment in the profit and loss statement, ΔFV, is not significant (Tables 4.2 and 4.3).

There are seasonal variations (Table 4.4), and the fair value adjustments in the profit and loss statement and the balance sheet, may to some extent serve as seasonal adjustment to the historic cost figures, Table 4.3 5b(ii); but historic cost measurement with adjustment for seasonality, Table 4.4 5b(iii), has somewhat higher R squared, though hardly significant.

Fair value measurement may have a smoothing effect on seasonality. Each period, the measurement of the accretion effect is based on undisclosed expected prices at the expected time of harvesting. Management may have private information about the quality of the fish and future production cost that could improve cash flow forecasting, but ΔFV is apparently too noisy and the disclosures too scarce. As management's assumptions about future salmon prices may differ from the analyst's and the information about size distribution is rather coarse,[xvii] the analyst will not have sufficient information to make a corroborative calculation of the fair value estimates and thereby to extract information about management's estimates about cost to completion. It is not likely that an estimate of cost to completion based on historic production cost could be improved by such analysis.

The equity analysts' choice to disregard the fair value adjustments, as evidenced both by their valuation reports and by interviews, seems rational. The most obvious explanations are that the fair value adjustment is not an input parameter to their valuation model, the information is too difficult to extract, and the information content is too low to justify the effort. In particular, this is because analysts have other information sources including management presentations. To be sure, this does not rule out lack of reliability as a possible explanation. The author's own research [paper 2] shows that fair value measurement is value relevant, which means that there must be information content; this finding weakens lack of reliability as a possible explanation.

Even so, the information may be perceived as unreliable by analysts (Gassen, J. and Schwedler K. 2010). Another possible explanation is that analysts probably want to present their clients with recognisable analyses, i.e. they do not want to present a different, unfamiliar model.

From a performance measurement perspective, it seems reasonable to ignore the fair value adjustments as analysts generally work with time series that are too short to compensate for the transitory characteristics of the adjustment. A longer time series, however, may introduce out-dated information to the analysis. Information about historic production cost and EBIT margins are best derived from transaction based historic cost. Assuming that all producers face the same price conditions, transaction-based production cost may be the most important differentiator, i.e. a sound measure of operational efficiency.

It is likely that analysts obtain all relevant information about prices in more timely fashion, at lower cost and with lower risk of bias from sources other than the financial statements. Information about volumes and size distribution are partly available through disclosures and guidance about harvesting. It is likely that improved disclosures, in particular, about size distribution, might enhance the analysts' ability to extract information from the fair value adjustment—especially, if this information is combined with information about the price estimate applied for each size category.

Surprisingly, long-term EBIT margins and long-term growth potential get little attention from analysts, but if these parameters are assumed to be stable, this may explain the analysts' focus on short-term cash flow estimates and the direction of share price movements. This might especially be the case if no assertions are made about intrinsic value. The fair value adjustments are unlikely to carry any information about long-term price development.

Industry knowledge and a person's standing in the analyst rankings are important incentives for sell side analysts. Profitability of stock recommendations and accuracy of earnings forecasts are somewhat less important, but these things have some significance (Brown et al. 2015). The profitability of stock recommendations may be a question of time horizon. The most common time horizon for target prices is 12 months (Bradshaw 2002). The observations from analysts who cover salmon producers fit into this picture.

The controversies about IAS 41 have addressed issues of unwanted volatility, lack of reliability, i.e. high estimation uncertainty, and lack of usefulness. None of the listed companies, however, has called upon a reliability exception. Volatile earnings figures are not a problem per se and could convey information about the underlying business risk. Although fair value measurement is relevant in the balance sheet (Hodder, Hopkins and Schipper 2013), neither valuation theory nor empirical evidence supports the position that changes in fair value improve the relevance of earnings for cash flow predictive purposes, regardless of reliability.

[i] By «operational assets» I mean assets that are acquired for the use in the conduct of the operations and are necessary to generate revenue. Normally Operational assets do not generate separate independent cash flows, but they contribute to generate operating result or EBIT. Operational assets cannot be disposed of except as a part of executing the business plan, without negative consequences for the operation. An investment property company is for this purpose considered as an investment company, not a production company. Revaluations under the revaluation option in IAS 16 are not included in net income.

[ii] Revaluations under the revaluation option in IAS 16 are not included in net income.

[iii] The number of inventory days and tons of inventory do not fully correlate as the size distribution, which influences fair value per kg, is not constant during the year.

[iv] Salmar ASA, Interim financial reporting September 30, 2015.

[v] Under historic cost measurement, the cost of mortality may be considered as a normal production cost.

[vi] You cannot borrow from the future.

[vii] No information about the analysts was collected or stored except for their names and answers to the follow up questions.

[viii] Textbook approach suggests that future cash flow estimates are discounted.

[ix] Another observation is that the methods applied are not adapted to the characteristics of the industry; in particular, the availability of fair value information, the high economic rent evident by high concession prices, and high price to book ratios.

[x] In this context, a non-operational asset does not interact with other assets and may be disposed of without any effect on the future cash flow from other assets.

[xi] It should be noted that by predicting harvesting that could differ from regeneration analysts will indirectly allow for changes in inventory.

[xii] None of the analysts made an attempt to distinguish between tax expenses and tax payable.

[xiii] As frozen salmon is not a perfect substitute for fresh salmon, harvesting can only be delayed for shorter periods, and shortage in current supply cannot be covered by future production, it is not reasonable to assume that future salmon prices will follow a random walk. Analysts assume that short-term supply fluctuations will cause price fluctuations.
The futures price, which is the basis for the valuation of current inventory, may theoretically come closer to a random walk in an efficient market.

[xiv] The sensitivity to price changes depends on size distribution.

[xv] Logical tests and manual reconciliations are applied to verify correct entries.

[xvi] A significance test on the difference in R squared is not carried out due to the high number of independent variables.

[xvii] In particular, towards the end of the observation period, some of the subjects have fairly good disclosures about size distribution, but generally the data set does not lend itself to cross sectional tests of differences in valuation practice.

References

Argilés-Bosch, J. M., Miarons, M., J. Garcia-Blandon, C. Benavente, and D. Ravenda. (2018) Usefulness of Fair Valuation of Biological Assets for Cash Flow Prediction. Spanish Journal of Finance and Accounting / Revista Española de Financiación y Contabilidad 47 (2): 157-180

Argilés, J. M. Garcia-Blandon, J. and Monllau, T. (2011) Fair value versus historical cost-based valuation for biological assets: predictability of financial information. Revista de Contabilidad-Spanish Accounting Review Vol. 14 - No 2 2011 87-113

Ayres, D., X. Huang, and M. Myring. (2017). Fair Value Accounting and Analyst Forecast Accuracy. Advances in Accounting 37:58-70.

Badenhorst, W. M. (2018). Fair Value Intensity and Analyst Forecasts. Journal of Economic and Financial Sciences 11(1)

Balsam, S., Bartov, E. and Marquardt, C. (2002) Accruals Management, Investor Sophistication, and Equity Valuation: Evidence from 10-Q Filings. Journal of Accounting Research, Volume 40, Issue 4, September 2002, 987-1012

Barniv, R. and Myring, M. (2006). An International Analysis of Historical and Forecast Earnings in Accounting-Based Valuation Models. Journal of Business Finance & Accounting, 33(7) & (8), 1087-1109 September/October 2006

Barth, M. E., Beaver, W. H., Hand, J. M. and Landsman, W. R. (1999) Accruals Cash Flows and Equity Values. Review of Accounting Studies 3: 205-229

Barth, M. E., Cram, D. P. and Nelson, K. K. (2001) Accruals and the Prediction of Future Cash Flows. The Accounting Review Vol. 76, No. 1 January 2001 pp 27-58

Bernhoft, A. C. and Fardal, A. (2007). IFRS and Fish Farming, Magma 6, 49-58.

Biddle, G. C., Seow G. S. and Siegel, A. F. (1995). Relative versus Incremental Information Content. Contemporary Accounting Research. Fall, Vol. 12 Issue 1, 1-23.

Botosan, C. A. and Huffman A. A. (2015). Decision-Useful Asset Measurement from a Business Valuation Perspective. Accounting Horizons Vol. 29, No. 4 2015 pp. 757-776

Bradshaw, M. T. (2002). The use of target prices to justify sell-side analysts' stock recommendations. Accounting Horizons, 16, 27-41.

Bradshaw, M. T. (2004). How Do Analysts Use Their Earnings Forecasts in Generating Stock Recommendations? The Accounting Review Vol. 79. No. 1 2004 pp. 25-50.

Bradshaw, M. T. (2011). Analysts' Forecast: What Do We Know After Decades of Work? http://ssrn.com/abstract=1880339

Bradshaw, M. T., Richardson, S. A. and Sloan, R. G. (2001). Do Analysts and Auditors Use Information in Accruals? Journal of Accounting Research Vol. 39 No. 1 June 2001

Brown, L. D., Call, A. C. and Clement, M. B., Sharp, N. Y. (2015). Inside the «Black Box» of Sell-Side Financial Analysts. Journal of Accounting Research. Vol. 53 No. 1 March 2015.

Daly, A. and Skaife H. A. (2016). Accounting for Biological Assets and the Cost of Debt. Journal of International Accounting Research, Vol. 15, No. 2, Summer 2016, pp. 31-47

Demirakos, E. G., Strong, N. C. and Walker, M. (2004). What Valuation Models Do Analysts Use? Accounting Horizons Vol. 18, No. 4 December 2004 pp. 221-240

Dhaliwal, D., Subramanyam, K. R. and Trezevant, R. (1999). Is Comprehensive Income Superior to Net Income as a Measure of Firm Performance? Journal of Accounting & Economics, 26 (1-3), 43-67.

Finger, C. A. (1994) The Ability of Earnings to Predict Future Earnings and Cash Flow. Journal of Accounting Research Vol. 32 No. 2 Autumn 1994

Gassen, J. and Schwedler K. (2010) The Decision Usefulness of Financial Accounting Measurement Concepts: Evidence from an Online Survey of Professional Investors and their Advisors. European Accounting Review Vol. 19, No. 3, 495-509

Green, J., Hand, J. R. M. and Zhang, X. F. (2016). Errors and questionable judgements in analyst's DCF models. Review of Accounting Studies. June 2016, Vol. 21 Issue 2, p596-632. 37p.

Hitz, J-M. (2007) The Decision Usefulness of Fair Value Accounting – A Theoretical Perspective. European Accounting Review, Vol. 16, No. 2, 323-362

Hodder, L., Hopkins, P. and Schipper, K. (2013) Fair Value Measurement in Financial Reporting. Foundations and Trends in Accounting, Vol. 8, Nos. 3-4, 143-270

Huffman, A. A. (2014). Matching Measurement to Asset Use: Evidence from IAS 41. Working Paper 2014

Landsman, W. R., Miller, B. L. and Yeh, S. Implications of Components of Income Excluded from Pro Forma Earnings for Future Profitability and Equity Valuation. Journal of Business Finance and Accounting. Vol 34 Issue 3-4, April/May 2007, 650-675

Liang L. and Edward J. Riedl, E. J. (2014) The Effect of Fair Value versus Historical Cost Reporting Model on Analyst Forecast Accuracy. The Accounting Review: May 2014, Vol. 89, No. 3, pp. 1151-1177.

Philips G. E:, The Accretion Concept of Income. The Accounting Review, January 1963

Rosen, S., Murphy, K. and Scheinkman, J. (1994), Cattle Cycles, Journal of Political Economy, 102 (3), 468-492

Appendix 1: Variable definitions and abbreviations

Variable	Definition
B_t	Net Operating Tangible Assets in period t
CF_t	Cash Flow from operations in period t
DCF	Discounted Cash Flow
$EBIT_t$	Earnings Before Interest and Tax in period t
EBITDA	Earnings Before Interest, Tax, Depreciations and Amortisations
EPS	Earnings Per Share
EV	Enterprise Value = Equity Value + NIBD
$Financial_t$	NI_t=$Noplat(HC)_t$+ ΔFV_t +$Financial_t$. Financial comprises net financial items less tax on such in period t. The difference between the template tax on EBIT(HC)t and $\Delta FV(\text{pre tax})_t$ and the recognised tax expense on these items will be included in $Financial_t$.
FV_t	The fair value adjustment in the balance sheet in period t adjusted for deferred tax by 25%. Inventory is reported at fair value in the balance sheet and FV is only available in the disclosures and without tax adjustment. FV is also the difference between Net Assets based on historic cost and fair value; B(HC) and B(FV).
ΔFV_t	The fair value adjustment in the Profit and Loss statement in period t adjusted for deferred tax by 25%. The difference between Noplat based on historic cost and based on fair value. $Noplat(HC)_t$+ΔFV_t=$Noplat(FV)_t$
g	Growth as defined in Gordon's Growth, i.e. nominal annual growth in Cash Flow
I_j	In regressions were historic cost observations and fair value observations occur as independent variables for the same company and for the same period I=0 signals historic cost and Indicator=1 signals fair value.
Inventory Days	Inventory x 365 / Cost of goods sold
K_A	Nominal discount rate to cash flow from operations
M	M=1/(K_A-g), Gordon's growth applied to estimate Continuing Value
NI_t	Net Income in period t.
NIBD	Net Interest Bearing Debt
$Noplat_t$	NI_t=$Noplat_t$+$Financial_t$. Net Operating Profit Less Adjusted Tax or Earnings Before Interest and Tax adjusted for 25% tax. Noplat could be based on historic cost or fair value; Noplat(HC) and Noplat(FV). This is highlighted when relevant. The reason why Noplat is used instead of EBIT is to avoid that tax on EBIT is included in Financial and hereby creating a dependency between the two variables. $Noplat(FV)_t$ = $Noplat(HC)_t$+ ΔFV_t
P/B	Price / Net Operating Tangible Assets
P/E	Price/Earnings; Share Price / NI per share
Sq	When an Indicator is used to adjust for seasonality 1 signals that the observations stem from 1 quarter, 2 signals 2 quarter and so on.
s	Template tax rate; 25%
Salmon Price_t	The average export price for the week ending at the reporting date for fresh salmon reported by Statistics Norway in NOK.

Appendix 2: Tables and Figures

TABLE 2

Analyst	CF	TP	Multiple based Methods	Projections	Explicit reference to DCF	Explicit reference to long term growth, price and EBIT/KG
[redacted]	X	X	EBIT/KG EV/EBIT P/E	Volumes, price, cost 5 years	Yes	Yes
[redacted]	X	X	EBIT/KG EV/EBIT P/E	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EV/EBIT(DA) P/E	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 2 years	No	Yes
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 2 years	No	Yes
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 3 years	No	No
[redacted]	X	X	EV/EBIT	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 4 years	Yes	Yes
[redacted]	X	X	EBIT/KG EV/EBIT	Volumes, price, cost 2 years	No	No
[redacted]	X	X	EBIT/KG EV/EBIT(DA) P/E	Volumes, price, cost 4 years	Yes	Yes
[redacted]	X	X	EBIT/KG EV/EBIT P/E	Volumes, price, cost 2 years	No	No

CF=Cash flow analysis, TP=Target price. Multiple based methods means that the analysts refer to the ratios tabulated, make comparisons based on these or apply multiple-based valuations directly to arrive at the target price.

TABLE 3.1

Sample distribution and descriptive statistics

Normalised by number of shares

	N	Mean	S.D.	5%	Min	95%	Max	Skew	Kurt
Share Price	243	65.28	59.79	4.08	2.13	177.00	330.00	1.723	6.576
FV	243	2.497	2.275	0.08	-0.40	6.24	15.36	2.023	9.422
Noplat(FV)	243	1.622	2.718	-1.243	-3.31	5.785	19.41	2.834	16.426
ΔFV	243	0.095	1.701	-2.15	-7.51	2.08	10.83	1.401	16.417
Noplat(HC)	243	1.527	1.774	-0.33	-3.15	5.19	8.58	1.368	5.407
Financial	243	0.030	1.882	-1.41	-3.41	1.24	26.91	12.018	172.931

For variable definitions see Appendix 1. For all variables Skew/Kurtosis Prob>Chi2=0.000

TABLE 3.2

Correlations

The variables are normalised by share price

	(1)	(2)	(3)	(4)	(5)	(6)
(1) $Noplat(HC)_{t+1}$	**1.00**					
(2) $Noplat(HC)_t$	**0.80**	**1.00**				
(3) ΔFV_t	0.08	**0.16**	**1.00**			
(4) $Financial_t$	0.01	0.06	**-0.17**	**1.00**		
(5) Salmon $Price_t$	**0.34**	**0.39**	**0.26**	0.10	**1.00**	
(6) $Noplat(FV)_t$	**0.60**	**0.78**	**0.74**	-0.07	**0.43**	**1.00**

The table shows correlations between the analysed variables. Bold figures signal significance at 5% level in a two-tailed test. The significance level is adjusted for number of correlations.

TABLE 3.3

Correlations

The variables are normalised by share price

	$Noplat(HC)_{t+1}$	$Noplat(FV)_{t+1}$
$Noplat(HC)_t$	**0.80**	**0.41**
$Noplat(FV)_t$	**0.60**	**0.23**

The table shows correlations between the analysed variables. Bold figures signal significance at 5% level in a two-tailed test. The significance level is adjusted for number of correlations.

TABLE 3.4

Quarterly Salmon prices

	Q4	Q1	Q2	Q3
2006/07	28.26	28.78	24.77	24.49
2007/08	28.79	27.21	25.98	26.98
2008/09	29.95	30.10	35.73	28.31
2009/10	30.88	38.46	39.09	37.20
2010/11	40.37	40.94	28.54	25.23
2011/12	26.40	26.64	26.90	23.99
2012/13	33.11	37.93	43.40	32.82
2013/14	50.58	43.83	33.60	35.43
2014/15	47.20	40.32	40.94	40.39
Average	35.06	34.91	33.22	30.54
Std. Dev.	8.83	6.66	6.98	6.08
Diff from total average	4.9 %	4.4 %	-0.6 %	-8.7 %

For variable definitions see Appendix 1.

TABLE 4.1

Specification 4

Dep. Var.: $Noplat(HC)_{t+1}$	(1)	(2)
$Noplat_t$	0.824^{**}	0.678^{**}
Standard Error (Robust)	(0.060)	(0.059)
I_1	0.593^{**}	0.549^{**}
Standard Error (Robust)	(0.149)	(0.142)
I_1 x $Noplat_t$	-0.407^{**}	-0.343^{**}
Standard Error (Robust)	(0.083)	(0.064)
S_1		0.118
Standard Error (Robust)		(0.165)
S_2		0.029
Standard Error (Robust)		(0.083)
S_3		0.096
Standard Error (Robust)		(0.073)
S_1 x $Noplat_t$		0.194^{**}
Standard Error (Robust)		(0.073)
S_2 x $Noplat_t$		0.079^{*}
Standard Error (Robust)		(0.042)
S_3 x $Noplat_t$		0.122^{**}
Standard Error (Robust)		(0.038)
R2 adj	0.496	0.549
Observations	470	470

The superscript ** represents significance level of 0.05 in a two-tailed test. T-statistics in parentheses are calculated using robust standard errors clustered by firm. The Independent variable $Noplat_t$ occur both based on Historic Cost and Fair Value Indicated 0 or 1. The number of observations doubles because historic cost and fair value appear for each company and each period.

TABLE 4.2

Specification 5			
Dependent variable: *Noplat(HC)$_{t+1}$*	5a	5b	5c
Noplat(HC)$_t$	0.824**	0.833**	
Standard Error (Robust)	(0.060)	(0.060)	
ΔFV_t		-0.055	
Standard Error (Robust)		(0.073)	
Noplat(FV)$_t$			0.417**
Standard Error (Robust)			(0.058)
R2 adj	0.638	0.640	0.354
Observations	235	235	235

The superscript ** represents significance level of 0.05 in a two-tailed test. T-statistics in parentheses are calculated using robust standard errors clustered by firm.

TABLE 4.3

Specification 5					
	5a	5b			5c
Dep. Var.: *Noplat(HC)$_{t+1}$*		(i)	(ii)	(iii)	
Noplat(HC)$_t$	0.653**	0.537**	0.372**	0.660**	
Standard Error (Robust)	(0.041)	(0.059)	0.096)	(0.052)	
ΔFV_t		-0.064	-0.113**	-0.025	
Standard Error (Robust)		(0.058)	(0.037)	(0.071)	
Noplat(FV)$_t$					0.254**
Standard Error (Robust)					(0.072)
Financial$_t$		-0.049**			
Standard Error (Robust)		(0.008)			
Salmon Price$_t$		0.043**			
Standard Error (Robust)		(0.013)			
FVBal$_t$			0.269**		
Standard Error (Robust)			(0.075)		
R2					
-Within	0.399	0.436	0.435	0.400	0.189
-Between	0.996	0.997	0.962	0.996	0.995
-Overall	0.640	0.619	0.641	0.640	0.354
Observations	235	235	235	235	235
Groups	8	8	8	8	8
-Min	19	19	19	19	19
-Average	29.4	29.4	29.4	29.4	29.4
-Max	36	36	36	36	36

The superscript ** represents significance level of 0.05 in a two-tailed test. T-statistics in parentheses are calculated using robust standard errors clustered by firm. Separate regressions for historic cost 5a, historic cost with fair value adjustment 5b and fair value 5c. The regressions are made on panel data with company and time fixed effects.

TABLE 4.4

Specification 5				
		5b		5c
Dep. Var.: *Noplat(HC)*$_{t+1}$	(i)	(ii)	(iii)	
Noplat(HC)$_t$	0.479**	0.690**	0.513**	
Standard Error (Robust)	(0.083)	0.053)	(0.057)	
ΔFV_t	0.064	-0.097**		
Standard Error (Robust)	(0.048)	(0.036)		
Noplat(FV)$_t$				0.196**
Standard Error (Robust)				(0.038)
S_1	-0.180	0.136	-0.179	0.160
Standard Error (Robust)	(0.170)	(0.194)	(0.167)	(0.170)
S_2	-0.039	0.036	-0.060	0.030
Standard Error (Robust)	(0.141)	(0.163)	(0.152)	(0.085)
S_3	-0.007	0.141	0.005	0.124
Standard Error (Robust)	(0.068)	(0.070)	(0.057)	(0.084)
S_1 x Noplat(HC)$_t$	0.293**		0.249**	
Standard Error (Robust)	(0.057)		(0.055)	
S_2 x Noplat(HC)$_t$	0.087		0.052	
Standard Error (Robust)	(0.067)		(0.650)	
S_3 x Noplat(HC)$_t$	0.132**		0.129*	
Standard Error (Robust)	(0.051)		(0.066)	
S_1 x ΔFV_t	-0.018	0.134**		
Standard Error (Robust)	(0.026)	(0.034)		
S_2 x ΔFV_t	0.081	0.166*		
Standard Error (Robust)	(0.060)	(0.052)		
S_3 x ΔFV_t	-0.112	-0.083		
Standard Error (Robust)	(0.069)	(0.093)		
S_1 x Noplat(FV)$_t$				0.129**
Standard Error (Robust)				(0.032)
S_2 x Noplat(FV)$_t$				0.087*
Standard Error (Robust)				(0.038)
S_3 x Noplat(FV)$_t$				0.099**
Standard Error (Robust)				(0.013)
R2				
-Within	0.500	0.470	0.469	0.276
-Between	0.998	0.987	0.995	0.964
-Overall	0.696	0.676	0.680	0.417
Observations	235	235	235	235
Groups	8	8	8	8
-Min	19	19	19	19
-Average	29.4	29.4	29.4	29.4
-Max	36	36	36	36

The superscript ** represents significance level of 0.05 in a two-tailed test. T-statistics in parentheses are calculated using robust standard errors clustered by firm. Separate regressions for historic cost with fair value adjustment 5b and fair value 5c. The regressions are made on panel data with company and time fixed effects.

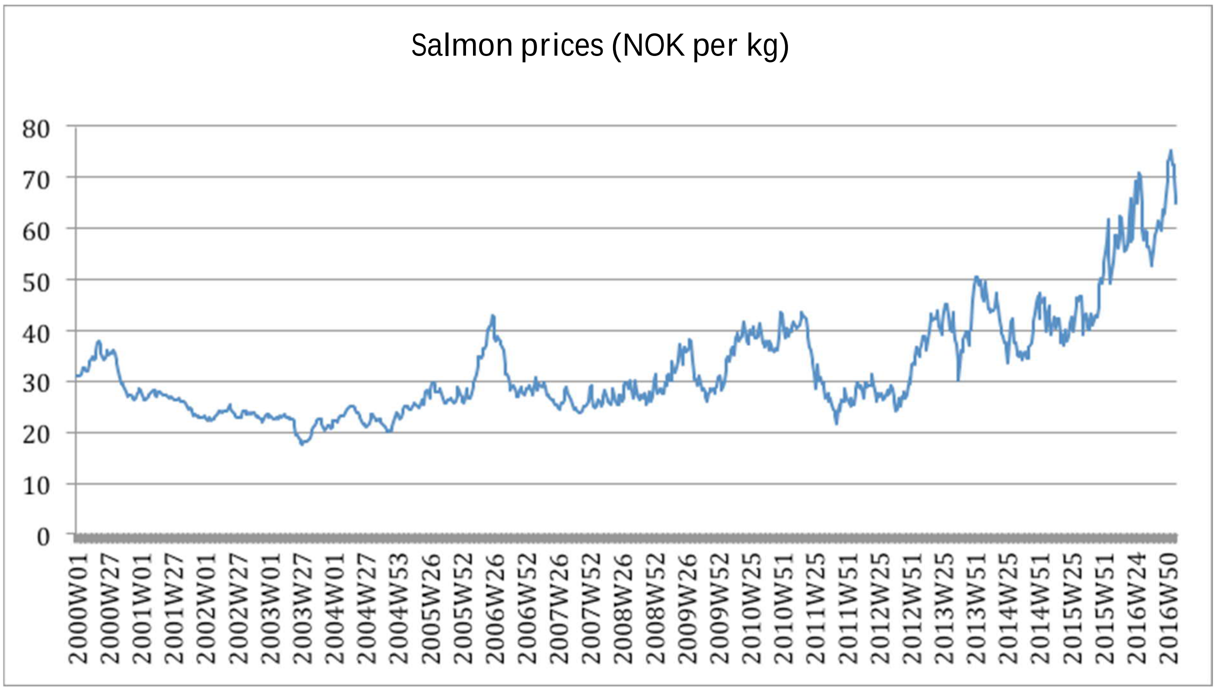

Figure 1: Source: Statistics Norway weekly export prices. Nominal export prices for fresh salmon

Appendix 3: Numerical example

Seasonal variation

The following example shows the difference between historic cost and fair value measurement under seasonal variations.

Every quarter we produce a quantity of 10 and harvest the same amount. By the end of each quarter, we have 50 in stock. The 50 in stock is realized with 1/5 in each of the following 5 quarters at the price predicted. In this simplified example we do not consider different size categories or different stages of completeness. It does not matter which unit we sell, but the market can only absorb 10 units at the price predicted. The price is 100% predictable.

	q0	q1	q2	q3	q4	q5	q6	q7	q8
Production cost	1	1	1	1	1	1	1	1	1
Sales price	2.5	2.5	1.5	1.5	2.5	2.5	1.5	1.5	2.5
Revenue (transaction based)		25	15	15	25	25	15	15	25
Cost of goods sold		10	10	10	10	10	10	10	10
Change in inventory (FV)		-10	0	10	0	-10	0	10	0
Result		5	5	15	15	5	5	15	15
Result transaction based HC		15	5	5	15	15	5	5	15
Release of FV adjustment harvested		-15	-5	-5	-15	-15	-5	-5	-15
Result from realisation of inventory		0	0	0	0	0	0	0	0
FV uplift on production		9	9	11	11	9	9	11	11
Release of FV adjustment on harvest		-15	-5	-5	-15	-15	-5	-5	-15
Remeasurement/Movment along price curve		-4	-4	4	4	-4	-4	4	4
FV adjustment		-10	0	10	0	-10	0	10	0
	OB								
Inventory(FV)	105	95	95	105	105	95	95	105	105
Inventory(HC)	50	50	50	50	50	50	50	50	50
Quantity in stock	50	50	50	50	50	50	50	50	50
Production quantity	10	10	10	10	10	10	10	10	10
Harvest quantity	10	10	10	10	10	10	10	10	10

The opening balance of inventory measured at fair value is $Q_0/5$ x ($P_1+P_2+P_3+P_4+P_5$), where Q_0 is quantity in period 0 and P_1 is price in period 1.

$$50/5 \text{ x } (2.5+1.5+1.5+2.5.2.5) = 105$$

We observe that under historic cost measurement we make a profit of (sales price – production cost) x harvested quantity. When prices are high, the historic cost result is high. We observe that the FV result depends on the prices when the current production is expected to be sold. In q_1, where the price is high, the current production is expected to be sold at lower prices. The result based on fair value measurement is higher than the result based on historic cost in q_3, even if the price is low, because the production is expected to be realized at higher prices.

The caption 'movement along the price curve' needs some explanation. Remeasurement is not relevant in a deterministic model, but by the end of q_2 the inventory as of q_1 remaining in stock has a new average price per unit because of movement along the price curve; $(Q_1-H_2)/4 \times (P_3+P_4+P_5+P_6) - (Q_1-H_2)/5 \times (P_2+P_3+P_4+P_5+P_6)$. H_2 is the sold or harvested amount in period 2. In this simplified model the inventory in stock at the end of q1 will be sold in equal parts over the 5 next quarters. By the end of q2, 1/5 is sold and the remaining inventory will be sold over the next 4 quarter and hence the average price has changed (but not the observable prices).

We observe that the results based on historic cost and fair value are equally volatile. Under historic cost measurement results are created when goods are sold at high prices while under fair value measurement results are created when goods that are expected to be sold at high prices, are produced. In the deterministic example, the fair value adjustment neither improves nor distorts a naïve prediction of next period result, or recurring result, based on this period.

We may extend the example to allow production, harvesting and inventory in stock to fluctuate either because of biological factors or because of production planning. In such case fair value measurement may smooth or amplify seasonal variations compared to historic cost measurement, i.e. it is not obvious that fair value measurement increases the volatility.

Random price change

We may use the model above to explore the impact of an unexpected price change. The price increases from 2.5 in q1 to 3.0 in q2 and for all future periods, taking place at the beginning of q2. The transaction based HC result for q2 will be (3.0-1.0) x 10 = 20. The fair value adjustment of the stock of inventory of 50 by the end of q1 was 50/5 x (1.5+2.5+2.5+1.5+1.5) - 50 = 45, of which 9 is realised. The fair value adjustment of the remaining 40 increases by 40x3.0 - (95-19) = 44. Finally we have an uplift on the production of (3.0-1.0) x 10 = 20. The total FV adjustment is -9+44+20=55. Hence, we report a total FV based result of 20+55 = 75 which is considerably above the recurring result of 20, which in this case happens to equal the HC result. (An alternative explanation is that we have a transaction based historic cost result of 20 plus and increase in inventory from 95 to 150).

If the price change takes place at the end of the period, we report a result of 60. We have lost the effect of a price increase of 1.5 on the realised volume of 10. Hence the HC result is 5.

Due to the high level of inventory, the fair value adjustment, ΔFV is highly volatile and Noplat(FV) is much more volatile than Noplat(HC). Although ΔFV may have information content, it is too noisy to improve a naïve prediction model.

Although fair value measurement does not necessarily increase volatility if price fluctuations stem from seasonality, random price fluctuations increase volatility. This is also what we observe. Table 3.1 shows that Noplat(FV) is far more volatile than Noplat(HC).

Appendix 4: Prediction of cash flow in period t+1 based on earnings in period t

We assume 0-growth steady state in production volume q and a constant inventory Q. Cost of production is a constant d. The product price p is random. Historic cost (HC) inventory at the end of period t is valued at d whereas fair value inventory is valued at p_t.

Two stochastic price models are considered:

Random walk: $$p_{t+1} = p_t + \epsilon_{t+1}$$

and, IID: $$p_{t+1} = p + \epsilon_{t+1}$$

ε_t is assumed to be independently and identically distributed over time. These models should be considered as extremes. A more realistic model would probably exhibit some mean reversion.

For each stochastic model two scenarios are considered. In scenario A (after) the price in period t is realized after the products are sold, but before the books are closed. Thus, the sales price in period t is p_{t-1}. In scenario B (before), the price is realized before sales. The sales price in period t this scenario will be p_t. In both scenarios fair value of inventory at the end of period t will be Qp_t. With random walk this is easy to justify, as the current price is the best predictor of future prices. With iid prices this assumption is less obvious. It could be argued that at least part of inventory should be valued at the long-term expected price p. In that case, inventory will vary less with prices.

Expected cash flow in period t+1 is denoted C_{t+1}. Note that in this 0-growth situation historic cost earnings equals cash flow in any given period. There are four cases to consider (combinations of price model and scenario).

1. Random walk and scenario A

Historic cost earning in period t:

$$\pi_t^{HC} = p_{t-1}q - dq$$

Fair value earnings in period t:

$$\pi_t^{FV} = p_{t-1}q - dq + \epsilon_t Q$$

Expected cash flow in period t+1:

$$C_{t+1} = p_t q - dq = \pi_t^{HC} + \epsilon_t q = \pi_t^{FV} + \epsilon_t (q - Q)$$

Thus, cash flow in period t+1 equals earnings in the previous period plus a random component which depends on the change in price at the end of period t. As long as Q < 2q fair value earnings will be a better (lower variance) predictor of cash flow. It will be a perfect predictor if Q = q. In that case sales in period t+1 equals inventory in period t. Not surprisingly, fair value is useful information in this particular situation. On the other hand if Q > 2q, FV earnings will be a more noisy predictor. Note that the ratio Q/q will be larger on quarterly data than on annual data.

2. Random walk and scenario B

Historic cost earning in period t:

$$\pi_t^{HC} = p_t q - dq$$

Fair value earnings in period t:

$$\pi_t^{FV} = p_t q - dq + \epsilon_t Q$$

Expected cash flow in period t+1:

$$C_{t+1} = (p_t + \epsilon_{t+1})q - dq = \pi_t^{HC} + \epsilon_{t+1} q = \pi_t^{FV} + \epsilon_{t+1} q - \epsilon_t Q$$

Once again, cash flow in period t+1 equals earnings in period t plus a random term. However, in this particular case fair value earnings is a noisier predictor of future cash flow than historical cost earnings. The reason is that all information contained in the period t price is already captured by period t cash flow (and historical cost earnings). Fair value of inventory does not provide relevant information – only noise! This is true regardless of Q.

3. I I D and scenario A

Historic cost earning in period t:

$$\pi_t^{HC} = (p + \epsilon_{t-1})q - dq$$

Fair value earnings in period t:

$$\pi_t^{FV} = (p + \epsilon_{t-1})q - dq + (\epsilon_t - \epsilon_{t-1})Q$$

Expected cash flow in period t+1:

$$C_{t+1} = (p + \epsilon_t)q - dq = \pi_t^{HC} + (\epsilon_t - \epsilon_{t-1})q = \pi_t^{FV} + (\epsilon_t - \epsilon_{t-1})(q - Q)$$

This case is fairly similar to the corresponding random walk case. The difference between next period's cash flow and this period's earnings is first of all the change in revenue driven by the change in output price. However, again the FV earnings may be a better predictor as inventory at the end of t is already valued at the period t+1 sales price (= p_t).

4. I I D and scenario B

Historic cost earning in period t:

$$\pi_t^{HC} = (p + \epsilon_t)q - dq$$

Fair value earnings in period t:

$$\pi_t^{FV} = (p + \epsilon_t)q - dq + (\epsilon_t - \epsilon_{t-1})Q$$

Expected cash flow in period t+1:

$$C_{t+1} = (p + \epsilon_{t+1})q - dq = \pi_t^{HC} + (\epsilon_{t+1} - \epsilon_t)q$$

$$= \pi_t^{FV} + (\epsilon_{t+1} - \epsilon_t)q - (\epsilon_t - \epsilon_{t-1})Q$$

Again, this case is fairly similar to the analogous case with random walk. Fair value earnings provides extra noise as the change in inventory value is independent of future changes in revenue. Future revenue is determined by the new price in period t+1.

Summary

Comparing the predictive abilities of historic cost and fair value earnings, the stochastic process of the random price does not seem to be crucial.

What is important for the informativeness of earnings, is the timing of price changes. The change in (fair value) inventory provides information about future cash flow if prices tend to change at the end of the period. In that case, the average market price in period t will differ from the price at the end of period t whereas the average market price in period t+1 will be close to the price at the end of the previous period. Thus, the price at the end of period t (and the fair value of inventory) will provide information about period t+1 revenue that is not contained in period t revenue.

Perhaps a more realistic case would be to assume that price changes gradually, and that the sales price in t is the average of p_t and p_{t-1}. Presumably, the result will be a mix of A and B.

On the other hand, when prices change early in the period the change in the value of inventory due to output price changes is just noise. Period t revenue already reflects the price at the end of period t, and, moreover, the average price in period t+1 is likely to differ from the price at the end of t.