Vertical Integration and Performance: Measurement Issues – and an Empirical Illustration from the Norwegian Fisheries Industry

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Abstract Norwegian:
Vertikal integrasjon er ofte utnyttet for å takle markedsproblemer og fremme bedrifters lønnsomhet. Empiriske funn fra tidligere forskning omkring lønnsomhetseffektene fra dette strategiske grepet viser imidlertid at forskjellig resultat: Positiv og negativ – så vel som betydningsløs – samvariasjon mellom vertikal integrasjon og lønnsomhet er observert og rapportert. I tillegg viser nærmere ettersyn av empiriske funn at samvariasjon mellom lønnsomhet og vertikal integrasjon varierer mellom næringer, og at forskjellige mål – både for vertikal integrasjon og lønnsomhet – har vært benyttet i tidligere empirisk forskning.

Denne artikkelen gjennomgår tidligere funn med tanke på forholdet mellom vertikal integrasjon og lønnsomhet. For å sammenlikne deres fordeler og ulemper benyttes ulike mål for oppstrøms vertikal integrasjon i den samme konteksten; norsk fiskeindustri. Et unikt datasett over paneldata fra bedrifter, som inneholder detaljert informasjon vedrørende lønnsomhet og vertikal integrasjon, benyttes. Våre funn viser at det er stor variasjon i forbindelsen mellom vertikal integrasjon og lønnsomhet, både i forhold til mål og mellom bedrifter. Avslutningsvis vurderes anvendeligheten av ulike mål for vertikal integrasjon, samtidig som implikasjoner understrekes.

Abstract English:
Vertical integration (VI) is a strategy frequently applied to overcome market imperfections and, thus, enhance firms' performance. Empirical findings from past research, however, show mixed results regarding the covariation between VI and performance, and positive, negative, and non-significant covariation has been observed. Closer inspection of empirical findings also reveals that the covariation between VI and performance varies across industries, and different measures, for both VI and performance, have been applied in past empirical research.

This paper reviews findings related to the vertical integration – performance relationship (covariation). To examine the strengths and weaknesses of various measures we control for the so-called "industry-effect" by applying various measures of upstream vertical integration in a single industry setting – the Norwegian fish processing industry. In so doing, a unique data set from a panel of firms containing detailed information about performance indicators and vertical integration is applied. Our findings show variations in the vertical integration–performance link across measures and firms. The applicability of measures is critically assessed and implications highlighted.

Keywords: Vertical integration, performance, measurement, Norwegian fisheries industry

Introduction

Vertical integration is an often addressed topic within corporate and industry strategy research. When applied under conditions characterised by market failures, (e.g. substantial transaction costs, demand variability and high market uncertainty) vertical integration is believed to create different economies and to positively influence firm performance. However, reviews of the literature reveal that the research undertaken

to empirically examine performance effects from vertical integration is limited (Bhuyan, 2002; Shelansky & Klein, 1995; Spiller, 1985). Furthermore, findings regarding the vertical integration performance effect are inconclusive. This article attempts to shed some light on this issue, as the "make-or-buy" dilemma has great practical implications for any firm, and a decision either way should be guided by robust knowledge. In studying this relationship, we carefully examine measurements applied in past research. We also empirically examine the performance of firms in one industry, where vertical integration (VI) is applied to a varying degree. More precisely, we examine the extent to which the varying degree of VI implementation in firms influences their financial performance. In addition, we focus on the problems regarding choice of measurements when testing the VI-performance relationship.

The essence of the VI phenomenon can be broken down to one economic entity's possession of successive stages in the input-throughput-output system, i.e. the value chain from raw material to consumers.[1] The obvious question is why adjacent stages of production, which could have been handled by separate firms, are managed within the boundaries of one firm? The answer is believed to be concealed in the weighted cost comparison between market exchanges and internal resources.

Several problems arise when assessing performance effects from the integration of firms into adjacent stages of the value chain. Measurement problems exist, both regarding VI and performance: How do we capture the true nature of VI on one hand and the financial performance of firms (and industries) on the other? How do we know that our findings at firm level are not a product of the industry structure in question? In this paper, we offer some suggestions for how to address these problems. We do so by employing different measurements for VI and performance, and thoroughly analyse the environment in which firms are embedded. In so doing, we report findings from a study carried out in the Norwegian fish processing industry, where the upstream VI of firms towards their raw material source was assessed and compared with the financial outcome of their businesses.

The rest of the paper is organised as follows: The next section gives a brief review of theories explaining the persistence of VI. We also provide a review of earlier empirical studies on the vertical integration-performance (VI-P) relationship. Then we present our data and the setting studied, before our analyses and results are reported. We also include a critical assessment of our findings, and highlight managerial and methodological implications as well.

Vertical Integration – approach

Vertical integration has interested researchers for decades, going back to Adam Smith and the division of labour, as advocated by Young (1928: 48), and Stigler (1951). In *neoclassic economic theory,* coordination between separate organisations is governed by a market system rather than managed internally within a firm, even in the presence of bounded rationality and opportunism. In the early work of Coase (1937), which has been revitalised and 'illuminated' by Chandler (1962) and Williamson (1971), among others, the boundaries of the firm were ascertained in light of transaction costs. The transaction costs explanation was grounded by the shortcomings of exploiting the market for allocating resources between adjacent stages in the value chain. This, in turn, gave firms motivations for 'making' instead of 'buying' and 'using' instead of 'selling'. Transaction costs were merely *"…the cost of organizing the economic system"* (Arrow, 1969: 48), or as stated: *"…there would be no reason for business firms to exist if (…) we could foresee the future perfectly and there were no costs in negotiating and renegotiating long-term contracts"* (Azzam & Pagoulatos,

1999: 10). *Transaction cost economics* (TCE), *industrial organisation* (IO) and *strategic management* (SM) are the theoretical domains that dominate the analysis of VI, according to Chatterjee (1991).

Theories can be viewed as explanations. Here we apply elements from several theories that help illuminating and capturing the actual phenomenon. One theory alone will seldom or never be able to provide a complete explanation of VI (Joskow, 1988). As Langlois & Robertson (1989: 361) concluded in their study of VI in American automobile industry,: *"An examination of the whole history suggests that no single theory always fits the facts perfectly. A complete explanation must combine specific theories in a way that is attentive to such factors as industry life-cycle, demand, economies of scale, and appropriability."*

Transaction costs economics (TCE) has received considerable attention in efforts to explain the existence and effects of VI, and it is frequently applied to explain the outcome of the vertical structuring of production (Shelanski & Klein, 1995). TCE predicts that organising transactions internally creates economies that are profitable, as long as *"… costs of transacting over market outweigh internal costs of management"* (Levy, 1985: 439). In its 'purest' form, i.e. vertical financial ownership, VI enhances profitability, since inter-firm profit claims are eliminated (Mahoney, 1992). This "make" alternative is – in the view of TCE – the "*organization form of last resort"* (Williamson, 2008: 5).

According to *industrial organisation* (IO), the primary determinant of VI is market structure (Chatterjee, 1991) and VI can constitute a valuable instrument for creating competitive advantages, either by utilising different economies, by reducing external uncertainty, or by securing the supply of critical input (Porter, 1980). Following the IO perspective, VI should lower the risk to firms in markets with few actors and with demand and volume uncertainties, and thereby increasing profitability for those applying a VI strategy.

S*trategic management* (SM) is based on managerial and organisational practice (Rumelt *et al.*,1991) and VI is applied to ease managerial processes in situations with high uncertainty. According to Chatterjee, Lubatkin & Schoenecker (1992), however, SM has so far been the sparsest and most inconsistent one of the three streams of research explaining VI. Within SM, the resource-based view of the firm (RBV) , have improved the understanding of VI (Mahoney, 1992). RBV emphasises heterogeneous, valuable, and rare combinations of resources that give rise to "hard-to-imitate" competitive advantages (Barney, 1991; Wernerfelt, 1984). This perspective, however, gives no simple rules of thumb for *when* to integrate vertically, since for each case the actual situation must be taken into account (Balakrishnan & Wernerfelt, 1986; Barney 1991). Scholars in this field have also pointed to the possible cost disadvantages and potential fallacies when a VI strategy is wrongfully implemented (Collis & Montgomery, 1997; Stuckey & White, 1993).

The VI-performance relationship: Empirical findings

Researchers from various disciplines have addressed the issue of the VI-performance relationship empirically. The points of departure for these studies differ, but they tend to apply the same research strategy. Usually, the impact of one or more explanatory factors on performance is estimated by using some statistical procedure(s), keeping other factors constant. Findings must be treated critically, as performance measurement imposes potential shortcomings, such as instability of performance, causal complexity and use of retrospective data (March & Sutton, 1997).
Within neoclassical economics, perfect competition prevails; firms within an industry are identical, and price- and quantity decisions are the only strategic choices. In meeting the same demand, firms would in the long run achieve average profits.

Hence, an analysis of inter-firm differences would give no meaning, given that market failures do not exist (Yao, 1988). In real world, however, this is not the case.

A useful point of departure for assessing past empirical research related to the VI-performance relationship is the meta-analysis by Capon *et al.*, (1990). Their analysis was based on 320 empirical studies – stemming from journals, books, proceedings, dissertations and working papers during the period from 1921 to 1987 – wherein financial performance is the dependent variable. In their analysis, they identified 15 studies where VI (forward or backward) is utilised for explaining firm (or industry) performance. Several studies used multiple tests. 69 cases reported a positive relationship between VI and financial performance, while 35 reported a negative relationship. In sum, this is indicative of a positive covariation between VI and performance. However, when distinguishing between industries and firms/business units, the findings become highly mixed. The aggregated findings, thus, obviously need closer examination.

In Table 1, studies investigating the VI-performance relationship are summarised. The table reports the industry analysed, theory applied, covariation between VI and performance, and measures applied for each study.

Table 1 Studies investigating the VI-performance relationship empirically*

Source	*Focal industry (sample)*	*Theory*	*Co-variation*	*Measure*	
				Vertical integration	*Financial performance*
Vesey (1978)	600 BUs from 100 companies (PIMS)	IO	+/-	VA/S (profit adjusted)	ROI
Levin (1981)	53 oil industry companies	IO	0	Self sufficiency ratio (crude oil and refinery)	(Net income + interest payments) / sales
Buzzel (1983)	PIMS (1,649 BUs)	IO	+/-	- adjusted VA/S - Relative to competitors (self report)	ROI and others
Maddigan & Zaima (1985)	Random sample of 45 firms	IO	-/+	VIC index (Maddigan [42])	ROA
Harrigan (1986)	192 firms in 16 industries	IO	+/-	Degree, breadth, stages and form	Successful vs. unsuccessful (self report and objective measure; ROS)
Martin (1986)	288 US industries	IO (SCP)	+/-	Back- and forward integration from Input-/output tables	Price cost margin = VA adjusted for labour and capital costs/sales
Chatterjee (1991)	116 vertical mergers (1962-79)	SM	0/+	Actual mergers compared to firms in the same industry (SIC)	Cumulative abnormal return in market value
D'Aveni & Ravenscraft (1994)	3,185 BUs from 200 industries	SM IO	(+)	Internal flow of goods relative to external	Operating revenue over total sale
Edwards *et al.* (2000)	22 US oil companies	IO	+/++	Share of own production from subsidiaries	Standard & Poor's stock rating
Fan & Lang (2000)	About 500 industries	SM TCE	- -	Vertical relatedness (Rumelt [35]) – input transfer between industries	Excess value=firms actual value over imputed value, (market value)
Bhuyan (2002)	43 food manufacturing industries	IO TCE	- -	Forward integration from input-output tables (Davies & Morris [36])	Industry price cost margin: (total sales – total costs)/total sales
Peyrefitte & Golden (2004)	US Computer hardware industry (50 firms)	SM	-	Between and within stage vertical integration (Davis & Duhaime [37])	ROI and Net income/total sales

*) The 12 studies were published in 11 periodical journals. Analyses cover a great variety of industries – across as well as within – and time series as well as cross sectional data for the period from 1948 to 1997. None of the studies entered Capon *et al.*'s [34] meta-analysis.

Inspection of Table 1 reveals that findings regarding the VI-performance relationship are inconclusive. The table shows that a large number of measures have been applied, both for VI and for performance. In addition, the settings and periods studied also vary.

When going into more detail, we find that Vesey (1978: 11) defines VI as: *"…the ratio of value added to sales, with both numerator and denominator adjusted for profits"*. VA/S is a proxy measure for VI first suggested by Adelman (1955). Vesey uses the PIMS database including about 600 business units. Performance is measured by return on investments (ROI) and he finds that a high degree of VI is not always profitable. Backward VI, he claims, is more profitable than forward VI, and VI is the third most influential factor on performance, after market share and investment intensity.

Buzzell (1983) also employs the VA/S measure, adjusted for net profit and 20 percent of investments, and the PIMS database. His data covers 1,649 business units in manufacturing industries. Profitability is measured by means of ROI. He found that both very low and very high levels of VI yield above-average rates of return. Further, ROI decreased consistently across the whole range of VA/S for producers of raw and semi-finished material. When using a subjective measure for VI (obtained by asking managers whether their line of business is less or more VI than that of competitors), ROI was slightly enhanced by backward VI.

The justification for using VA/S as a measure for VI is based on the assumption that it will increase as firms integrate vertically, forwards and backwards, when transactions are carried out within instead of across firms (Davies & Morris, 1995). Several authors have pointed to several shortcomings in this measure. For instance, Maddigan & Zaima (1985) assert that more profitable firms, or firms with relatively high labour and capital productivity, will score better than other firms by using the VA/S measure. By comparing Maddigan's (1981) *vertical industry connections* (VIC) to the VA/S in a random sample of 45 firms' ROA, they found that the two measures yielded opposite conclusions. Also, the VA/S measure has been criticised for being higher the closer the firm is to the raw material source, and therefore for being more sensitive to backward than to forward integration (Martin, 1986). In addition, VA/S does not reflect the choices firms make about coordinating potential separate activities (Caves & Bradburd, 1988), and also – when measured at individual enterprises – it becomes sensitive to multi-plant backward integration (Levy, 1985). A final objection against this measure is its failure to capture a firm's partial consolidation of control due to contracts and other agreements (Frank & Henderson, 1992).

The VIC index introduced by Maddigan (1981) relies on national input-output tables (Leontief, 1951), information on the industries in which firms operate and the average share of these industries' production. This measure is also criticised, arguing that it fails to account for intra-industry partial integration (Levy, 1985) and that it is a firm-level index inadequate at industry level (Davies & Morris, 1995). Henderson (1994) also criticises this measure for only including industries in which the firm has a 100 percent ownership.

Levin (1981) introduces "self-sufficiency" as a measure of VI when examining VI in the US oil industry. According to Levin, self-sufficiency is the quotient of crude oil production divided by the sum of crude oil production plus refinery runs. For a refiner without its own crude oil supply, this quotient will take the value 0, whereas a crude oil producer without refinery capacity will have a quotient of 1. Balanced integration, then, is assigned the value 0.5, where over- and under-sufficiency deviates symmetrically from 0.5. Performance is measured by net income plus interest payments divided by total revenue. Levin found, however, that performance was not affected by the degree of VI towards crude oil or refin-

ery production, but he also observed that VI helps to reduce performance variations, and that the self-sufficiency ratios of firms vary over time, but without a specific evolutionary trend.

Harrigan (1986) underlines the many facets of VI and argues that it is a multidimensional construct. She distinguishes between *degree*, *stages*, *breadth,* and *form* of VI and identifies successful and unsuccessful firms from in-depth interviews with 192 firms in 16 industries for the period 1960–81. *Degree* of VI is measured by the percentage of internal purchases (backward VI) and sales (forward VI). *Form* of VI is measured by the ownership percentage in the venture. She asserts that involvement in many integrated stages can not be sustained with the same success throughout the industry's entire life-span and that VI is indeed a costly strategy. According to Harrigan, VI should therefore be adjusted as conditions change.

Martin (1986) constructs his measure by input-output tables of the average (backward and forward) VI in the industry, ranging from 0 (no VI) to 1 (full VI). It was tested within the limits of a structure-conduct-performance model, where performance was measured by an industry price-cost-margin. Martin found that the effect of VI on performance in manufacturing industries is complex, depending on whether integration goes *into* the industry or *out of* the industry. His findings revealed both positive and negative relationships, supporting a 'case by case' approach.

Chatterjee (1991) compared actual vertical mergers to firms in the same industry. Performance was measured by cumulative abnormal return (stock market measure). Profit gains were found to be about 20 percent in target firms, while acquiring firms recovered almost nothing. His findings corroborated those of the IO literature in the way that advantages through VI are the greatest when acquiring firms operate in concentrated markets and target firms are in competitive markets, as mergers then yield increased market power.

D'Aveni & Ravenscraft (1994) used internal flow of goods relative to external flows to measure VI in their study of 3,185 manufacturing business lines. Performance was measured by the rate of operating revenues to sales. They found that VI units performed marginally better than unintegrated business lines in the same industry after controlling for economies of scale and scope. However, VI units showed higher production costs (especially when integrated upstream), but were found to economise through other cost components (like R&D, advertising, administrative and general expenditures).

In the study by Edwards *et al*. (2000), the VI-performance relationship in the US oil industry was assessed. They measured VI as the share of production coming from own crude oil extraction (i.e. backward VI) and share of refinery runs shipped through own pipelines (i.e. forward VI). Performance was measured by the company stock rating of Standard and Poor's *Stock Guide*. Based on observations from two separate time periods – 1972 and 1992-1994 – they found that performance was strongly enhanced by crude oil production, whereas only a weak positive effect was observed from pipeline integration.

Fan & Lang's (2000) study departed from Rumelt's (1974) diversification strategies. They applied commodity flow input-output tables to capture inter-industry and inter-segment vertical relatedness and found vertical relatedness to be associated with poor performance.

Bhuyan (2002) examined how vertical mergers in US food manufacturing industries affect performance, when simultaneously controlling for industry characteristics (like productivity and competitive conditions). His VI measure was based on input-output tables and earlier work (Caves & Bradburd, 1988; Davies & Morris, 1995; MacDonald, 1985) while net industry profit – computed as a price-cost margin – served as a performance proxy. Bhuyan found that VI negatively affects profitability, as – he asserted – vertical mergers fail to

create differential advantages for the integrated firm.

Peyrefitte & Golden (2004) examined how the performance scores (average 7 years ROI and profit margin) of 50 US computer hardware industry firms were affected by VI. Their study covered the years 1987–1993, and VI variables were constructed as dichotomous dummies (0 or 1) to cover within or between stages VI. By regressing VI variables (together with firm size, financial leverage, debt/equity, and diversification level) against performance they found that VI within a single value chain stage had a significant negative effect on performance – opposite of expected. Between stage VI had an incremental negative, yet insignificant, effect in their study.

Based on the review and discussion above we can conclude that: First, the findings from the different studies above on the VI-performance relationship are ambiguous, which makes it difficult to compare the results. Second, VI is a multidimensional construct, which cover many aspects of organisational life. This property makes VI difficult to measure.

In our view, measures applied to capture VI must be suitable to the specific research problem. Harrigan (1986; 538) expresses it this way: *"…to be useful to managers, measures of VI should not be made at the industry level […]. Some measures should be at the 'firm' level, some measures should look at relationships between business units, and others should incorporate comparisons with how competitors use vertical integration."* Also, how to measure performance presents a measurement problem when attempting to establish the VI-performance relationship. Like Keats & Hitt (1988: 576), we conclude that: *"Performance is a difficult concept, both in terms of definitions and measurement"*. Past empirical studies show that multiple measures have been used.

Below, we present a specific industry setting, in which VI is utilised by firms. We utilise several measures in our examination of the VI-performance relationship in this setting.

Testing the VI-performance relationship

This section reports a test of the VI-performance relationship when taking the concerns regarding measurement difficulties into account. We restrict our study to the Norwegian fish processing industry, and our reasons for doing so are: First, we need a competitive setting in which the units studied are motivated to integrate vertically, and do so to a varying degree. Second, industry firms must vary in terms of the degree of VI, and, finally, detailed data at firm level must be available in order to measure performance and degree of VI. By limiting the study to one industry we avoid problems of the so-called "industry effect", i.e. that performance effects are linked to the industry in which firms operate, not results of the actions firms take. In addition, the difficulties caused by variations across industries and misperceptions about the explained phenomenon (Casson, 1984) are avoided. Thorough knowledge to the industry studied, is a necessity to comprehend which factors influence specific dependent variables (Joskow, 1988).

The Norwegian fish processing industry is an intervening link in the seafood value chain, whose *centre of gravity* lies in manufacturing semi-finished or end products of fish, in which several structural variables motivate for VI. Managers of fish processing firms are exposed to an almost stochastic supply of the most important input factor; namely fish (Dreyer, 1998; Prochaska, 1984). Uncertainty is present downstream the value chain as well, where prices fluctuate heavily and seasonally. Uncertainty is an emphasised motive for VI (Carlton, 1979; Miller & Shamsie, 1999; Walker & Weber, 1987; Williamson, 1991a). Here, uncertainty variations among firms also emerge, as some rely on wild-

caught fish, whereas others process farmed fish – a much more stable supply source. Upstream VI towards fishing or aquaculture, in order to gain control over the most important input factor, is thus a meaningful strategy to reduce uncertainty and/or to secure sufficient supply. Fish farming has emerged as a prominent actor in the industry over the latter five decades. However, traditional fish processing firms have only to a limited extent seized the opportunity to take advantage of this source of supply by integrating upstream towards the fish farming industry.

Industry age has also been argued to be a catalyst for VI. According to the industry life-cycle hypothesis, firms in young and fast growing industries are expected to integrate backwards in order to secure important input factors. As the industry matures, the need for VI diminishes, until it increases once again in the industry's last stages (Langlois & Robertson, 1989; Tucker & Wilder, 1977). The Norwegian fish processing industry can be divided into a "young" and an "old" part. In the young part of the industry, the most important input factor come from aquaculture, whereas the older part relies on wild-caught fish.

The Norwegian fish processing industry constitutes a highly competitive setting, where the input market for fish has been referred to as 'next to perfect', where almost identical commodities are traded between numerous sellers and buyers (Ottesen & Grønhaug, 2005). The fish processing industry consists of approximatly 550 firms of varying sizes. The concentration in the industry is modest, where revenues from the 20 largest actors constitute less than 50 percent of industry revenues. These firms employ about 40 percent of the workforce. The Hirschman/Herfindahl index is about 0.025, indicating very low concentration (Bendiksen, 2001). Few barriers to entry are present, although primary producers (fishing vessels and fish farms) need a license in order to gain entry to the business. Upstream integration towards fishing vessels is, however, strictly regulated.[2]

Detailed data at firm level, both for VI and performance, is needed. Here we had access to a unique database, which has surveyed the profitability and structure of the Norwegian fish processing industry on an annual basis since 1977 (Bendiksen, 2007). From this database, firm level data from financial statements were accessible, and quantities of fish (inputs) purchased. We also interviewed general managers of the 100 largest processing firms, regarding their VI strategies, which enabled us to construct a measure of VI.

Measures

As shown in Table 1 above, multiple measures have been applied in empirical studies to capture both VI and performance. Below we report our effort to measure these variables. The measure for upstream VI constructed for this study is the share of supply from upstream units in which the firm holds proprietary ownership interests (SO). It requires direct ownership and is truncated at zero and one,[3] but is still in agreement with methodological literature recommendations (Blair & Kaserman, 1983; de Koning, 1994; Frank & Henderson, 1992; Peterson *et al.*, 2001), i.e. to ensure continuity in the VI variable. Our VI-variable is based on transfers that can be judged as *internal* (i.e. flows of goods between stages tied together by common ownership) – and displays properties like MacDonald's more macro-oriented MVI-variable.[4] This variable incorporates the main content of the self-sufficiency ratios employed by Levin (1981) and Edwards *et al.* (2000), which assesses the share of total inputs to the focal firm supplied by owned subsidiaries, and is similar to the variable Ohanian (1994) utilised in her study of the US pulp and paper industry. Our operationalisation of VI fully covers at least two of the four dimensions emphasised by Harrigan (1984): *degree* and *form* of VI.

The emphasis on the actual flow of goods between value chain stages, where ownership counters the flow of goods, makes it natural to label our variable as *use* of vertical integration (the extent to which ownership interests in adjacent upstream stages in the value chain appears in the form of actual input streams). From this point of view, it becomes a well-suited measure for the setting studied, and is believed to incorporate the core of the concept *upstream vertical integration.*

When comparing it to other measures applied in the literature, the most obvious and reasonable counterpart would be the 'Value Added over Sales' (VA/S) measure, utilised to a large extent in prior research according to Table 1. Both measures are at firm level, but whilst our measure rests on ownership and "internal" transfers, the VA/S-measure is a proxy to VI, collected from firm accounts. To avoid the potential connection to performance, we also utilise a version of this measure, where profits are subtracted from both numerator and denominator, as previously applied by Vesey (1978) and Buzzell (1983). By comparing these three explanatory variables (SO, VA/S and profit adjusted VA/S), one deficiency emerges: While our measure only reveals upstream VI, value added to sales also embodies effects from downstream integration, i.e. towards the customers. However, following Adelman's (1955) critical remark when introducing VA/S as a measure for VI, it is sensitive for proximity to the raw material source. Hence, upstream VI of firms will be offset – at least partly – by downstream VI, when measured by VA/S.

When measuring performance, stock market based measures – mirroring the expected profitability – are disqualified since, hitherto, shares in fish processing firms are generally not found on the stock exchange. Therefore we utilise the key figures *gross profit margin* (GPM) and *return on total assets* (RTA), meaning the ratio of pre-tax net profits to sales, and the yield of the total capital employed, respectively. Measures like these are the most employed in earlier research (cf. Table 1).

Data

Vertical integration is dynamic (Langlois & Robertson, 1989), a feature retained by our operationalisation (eg. SO). We therefore need to narrow the scope of our analysis. Performance measures are based on annual account reports, and we have chosen the year 2000 as our basis. In 2001, we addressed 100 managers of fish processing firms, and asked them – in hindsight – to state their firm's specific levels of upstream VI, as captured by our VI-measure (SO).

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Table 2 Statistical means for groups of fish processing firms on our variables

Industry segment	*Share from upstream units (SO)*	*Value added over sales (VA/S)*	*Profit adjusted value added over sales (π-adj. VA/S)*	*Gross profit margin (GPM)*	*Return on total assets (RTA)*
White fish (n=55)	17%	16%	15%	- 1.8%	4.4%
Farmed fish (n=18)	76%	26%	23%	2.6%	9.9%
Both inputs (n=18)	29%	20%	17%	2.9%	10.1%
Total (N=91)	31%	18%	17%	0.0%	6.6%

Since different processing firms utilise different input sources, we distinguish between groups of processors in an input-dependent manner: firms who process *i)* only white fish, *ii)* only farmed fish (e.g. salmon and trout), and *iii)* both farmed and white fish. As emphasised earlier, the motives for, and outcomes from, VI can vary depending on the nature of the input. This grouping coincides with the focus on 'stra-

tegic groups' (Thomas & Venkatraman, 1988), where industry member firms are classified according to their competitive strategies. Descriptive statistics for the groups are entered in Table 2.Table 2 shows that firms utilising farmed fish on average are more vertically integrated and more profitable than those processing only white fish. Even though the tendency is weak, it seems as though firms producing both white and farmed fish are the most profitable, even though their level of VI (on average) is lower than for farmed fish firms. For comparison, the average RTA for all Norwegian mainland industries (oil- and gas extraction excluded) was 6.7 percent that year (Statistics Norway, 2003). In the Appendix, the data set is more thoroughly examined with respects to statistical analyses.

Pearson's correlation tests (see A2 in Appendix) reveal that the groups of white fish and farmed fish processors differ significantly in terms of all three VI-measures. The farmed fish and the combined white/farmed fish groups differ only in terms of share from own units (SO), while no significant difference can be found between the white fish group and the combined white/farmed fish group. Also, all the VI measures are significantly correlated to each other (see A2 in Appendix). With measures showing correlation to this degree, we can conclude that they more or less capture the same phenomenon.

In the next section, we test the correlation between our independent and dependent variables, reveal our findings, and comment on the implications thereof.

Results and discussion

Table 3 shows the results from our regression analyses, where each of our explanatory variables (the three VI measures SO, VA/S, and π-adjusted VA/S) is regressed against our two dependent performance variables (GPM and RTA). Six different OLS regressions are applied to test for covariation between VI and performance.

Table 3 Test statistics (constants, unstandardised coefficients (β), R^2 and p-value). Separate (OLS) regressions of vertical integration against performance (in 2000)

Dependent	*Independent*	*Constant (β_0)*	*β_1*	*R^2*	*p-value*
Gross Profit Margin	Share from own (SO)	- 0.016	0.052*	0.049	0.035*
	VA/S	- 0.043*	0.236**	0.089	0.004**
	VA/S (π-adjusted)	- 0.004	0.024	0.001	0.793
Return on Total Assets	Share from own (SO)	0.048**	0.058	0.027	0.121
	VA/S	0.017	0.268*	0.051	0.031*
	VA/S (π-adjusted)	0.062*	0.024	0.000	0.856

*) Significant correlation at a 0.05 level (2-tailed).

**) Significant correlation at a 0.01 level (2-tailed).

The main findings from Table 3 is that VI only to a very limited extent can explain the inter-firm differences in profitability in the Norwegian fish processing industry in 2000, as the models have modest explanatory power (R^2) and regression coefficients are rather low (except for VA/S). None of our six models are able to explain more than nine percent of the variation in profitability in our sample – and the worst model is unable to explain any of the variation. This is in line with Wensley's (1997) claim that, since measurement problems are highly present when financial performance measures are used, no single variable can account for more than 10 percent of the variation in business performance. In addition, the determinants of business success are multiple. He (Wensley) concludes, accordingly, that: *"…in strategy situations the*

variance nearly always matters more than the mean!" (p. 75). Hence, it comes as no surprise that our regressions demonstrate modest explanatory power, since – obviously – many explanatory variables are left out. Bhuyan's study (2002) can serve an example in that respect. When testing nine industrial organisation variables on industry profitability (measured by a price cost margin) in the US food manufacturing industries, only 36 percent of the total variance was explained (R^2). In his case, the contribution from including VI to explain industry profitability was small, and its impact was negative.

Our results show that when measuring VI by VA/S, it significantly improves firm performance (though, with modest explanatory power). As noted by several authors,[5] a major weakness of this measure is its positive correlation to profits, i.e. it is influenced by factors other than VI, leading to spurious results when regressed against profit. When regressing VA/S against gross profit margin (i.e. the model with the highest explanatory power), we merely state that pre-tax profit should equal a constant multiplied by the value added, which in fact should hold since profit should be strongly correlated to the value added. When utilising π-adjusted VA/S, the effect of VI becomes insignificant, R-squared shrinks to nothing, and the coefficients (β_1's) are decimated.

Our own measure (SO) seems to have a significant, yet negligible, positive effect on performance measured by GPM. When measured by RTA, the effect is similar, but insignificant. Applying this measure to white fish firms only, using 1997 data, Dreyer *et al*. (2001) found that VI had contradictory, but non-significant, effects on the two performance measures; positive for GPM but negative for RTA. One explanation could be that VI brought about positive profitability effects, but insufficiently to give a reasonable return to the additional funding required when obtaining proprietary interests in upstream supply units. Here, the effects from VI are uniform for both performance measures, and the difference compared to Dreyer *et al*.'s (2001) findings, can be interpreted as stemming from altered input market conditions in the period. In 1997, the fish supply exceeded demand. From 1997 until 2000, cod catches fell by 45 percent, and demand exceeded supplies, which led to a 90 percent input price increase. In addition, the performance of white fish firms was influenced by low market prices for salted and frozen fish in 2000. The markets for farmed fish were good, with peak prices, which increased the performance of fish farmers. Farmed fish processors, however, struggled with high input prices, which resulted in weak performances for this segment. Obviously, the forces influencing the profitability of VI were altered in the period, since the value of the "controlling" supply increased from an input-security point of view. However, by including farmed fish processors in the sample scrutinised here, comparisons between the studies cannot easily be made, since sourcing conditions are qualitatively different in the white fish and farmed fish segments. Finally, the possibility that our data deviates from the normality criteria justifies a cautious treatment of our findings. Hence, the effect of upstream VI on performance is vague and difficult to evaluate coherently.

The curse of endogeneity

In every attempt to reveal the performance effect from strategic change – the main objective of strategic management – researchers are facing the problem of endogeneity[6]. Since the strategic choices made by managers are guided by their expectation of future performance, i.e. management's self-selection of strategy, econometric procedures to account for possible omitted variables should be employed – an argument put forward by Wensley (1997) above and further elaborated by Masten (1993), Hamilton & Nickerson (2003), Jacobides (2005) and Desyllas (2009) among others.

In our research problem several problems arise when trying to address endogeneity. Firm heterogeneity regarding the origin of vertical integrated fish processing firms is highly present in our setting. Some firms are vertically integrated due to political legitimacy, regulations and legal exemptions. This is the case for large white fish filleting plants, who were granted cod trawling licences and by exception clauses allowed the right to own (majority interests in) fishing vessels, from regional and industrial policy reasoning. The main objective was to ensure a stable supply to large plants, in order to secure employment in communities relying heavily on fish processing firms, and to improve profitability, since supply from smaller coastal vessel could be limited due to weather and availability conditions. These fish processing firms can be argued to be "locked into" a VI strategy, dating back at least 20–30 years. Hence, the firm's existing managerial team, have had next to no influence in this decision, even though they prevail over the flow of fish from these vessels. In as much as we want to measure the outcome of strategic decisions, in some of our cases we measure long term lagged variables of policy outcomes. The variables we utilise are continuous, so that it is not a question of make or buy, but to what degree firms make. Also, our variable (SO) depends – among other things – on the size of the quotas allocated to vessels balanced against the capacity of firms.

What further complicates, and render good endogeneity tests impossible, is that some processing firms have minority interests in fishing vessels, and cannot dictate landings or input prices. In such cases, the agreement is more of a social contract, where the processing firm receive landings from the vessel in question if fishing grounds are in proximity to the landing site. Other processing firms are the result of a downstream vertical integration, where fish vessel owners or aquaculture firms have set up or acquired a processing plant. Others again are the result of a long term structuring process, including both horizontal and vertical integration. Hence, the strategic choice of make or buy is enveloped in a heterogeneous industry context, not easily transferable into econometric models. As underlined in Isaksen (2007), a survey among processing firms in 1998 revealed that most firms in this industry (58 per cent) considered upstream vertical integration to be more important in the future. 85 per cent of the managers considered increasing their upstream VI in near future. Five years later, it was hardly any that had pursued this strategy, and the will to VI was vaporised. The reasons for this are many, but by large that the cod quotas in the period fell by nearly 50 per cent, so that upstream VI as a mean to secure inputs lost some of its attraction. Also, reduced industry profitability in the period might have contributed. Hence, the flaw of not correcting for endogeneity in this research is left open, as we subscribe to the motion of Jacobides (2005: 490) that: *"To understand vertical scope, scholars have to understand, at the industry level, the forces that affect it."*

Concluding remarks

Our results reveal that vertical integration has modest effects on firm performance. But can it be that the causality goes the opposite way? Should the research question rather be directed the other way around? Researchers have shown that strategic change is triggered by shifts in competition, and especially declining profits (see Webb & Dawson, 1991). Antithetically; do firms who obtain superior results and succeed in outperforming their competitors, create the financial power and autonomy necessary to bring about the ability to invest in adjacent value chain stages? Instead of scrutinising firms' strategy formulation and alignment, we have measured the actual use of VI. In so doing, we avoid the fact that strategy, or strategy change, outcomes occur in subsequent periods to the actual incorporation of change. We may,

however, simply have revealed the financial effects from capital outlays stemming from strategic alignments like VI. Analogously, firms may integrate vertically for tax reasons (since internal transactions can be carried out at favourable transfer prices to avoid direct taxes like VAT) or in order to create barriers to entry for competitors. To grasp the complexity of the vertical integration-performance puzzle, further research should incorporate other measures for success than merely financial performance. Also, insights into the way strategic changes like VI is formulated, and – of course – implemented in different firms and industries, is likely to generate more knowledge related to this research problem.

The use of vertical integration in this industry is not easy to comprehend, due to the firm heterogeneity and variation in organising the buyer-seller relationships. Whereas many businesses have invested in fishing vessels, others manage the buyer-seller relationship by other means, for instance by offering local vessel owners loans to contract vessels, with an underlying tacit agreement that tie landings to the lender when feasible. As emphasised by Williamsson (1991b: 84): *"Debt, equity, leasing, etc., are more than financial instruments. They are also instruments for governance"*. Others maintain their relationship to fishermen by placing plant premises at fishermen's disposal (for carrying out onshore-related activities, such as baiting, lodging and fishing gear mending), while others again, merely by ways of a common understanding of what is best for the local community, tacitly agree to serve each other. And, as noted by Fine & Hax (1985: 32): *"The crucial element of success of integrating operations is not ownership, but management and co-ordination of the series of processes"*.

Measurement problems are crucial in all empirical studies of VI and have, in fact, been accused for being the primary reason for the limited number of studies carried out (Hay & Morris, 1991; Spiller, 1985). Our results indicate that the VI-performance relationship is sensitive to the measure chosen to test the relation. Measures that easily can be applied in different settings are often based on financial accounts' data. As performance measures often originate from the same data source, potential multicollinearity problems may weaken the statistical validity. Here, we apply a VI measure based on input volume to evade this problem. Our conclusions regarding the VI-performance relationship were not altered by using account-based measures of VI, which indicate a high level of internal validity when applying different measures of VI at firm level.

External validity, however, is at stake, since the sample examined here was collected in the same industry in a single year. Our choice of industry was made to control for the potential industry effect, since all firms entering the analysis face similar external conditions. However, as our findings are based on the situation at only one point of time, some variation can be lost. As emphasised earlier, VI is a highly dynamic concept, which makes inter-year comparisons both time- and resource-consuming. However, earlier time series approaches, utilising the whole population for the period 1977–1992 indicate no direct effect between VI and performance in this industry (Dreyer *et al*., 2001). From a policy point of view, knowledge of this relationship can guide authorities considering regulations regarding the boundaries between segments in the seafood value chain.

Since one third of the firms state their share of inputs from subsidiaries to be zero, our operationalisation of VI violates the requirements for a normal distribution – on which the OLS procedure relies – due to skewness. One way of avoiding this could be to omit the 'zeros', which would have reduced our sample dramatically. But it would also imply a reluctance see the choice of *no* vertical integration as part of the business strategy of a huge number of fish processing firms. A test, wherein we divided only between those who were inte-

grated and those who were not, yielded no additional explanatory force. Neither did it do so when we omitted the 'zeros'. Therefore we present the material 'as is'. As the zero-group can be argued to consist of two strategically different groups of firms – one group choosing to use the market for transactions and the other wanting to integrate vertically but lacking the financial ability – a way of separating these two groups would be recommended for refining our research.

Our findings, however, support Harrigan's (1986) conclusion that degree of VI should be measured at firm instead of industry level when assessing the impact of VI on performance. As demonstrated here, conclusions concerning this relationship are sensitive to studies based on measures at different levels, i.e. at firm level and industry level. Thus, we recommend applying measures of VI developed at firm level that do not originate from financial statements when analysing the VI-performance relationship, in order to avoid possible spuriousness in regression results. We also suggest developing measures that are adapted to the production and setting studied. This recommendation may, however, limit the external validity and application of the same measurements to different industries.

A relevant question for future research is whether the VI-performance relationship is sensitive also for the way performance is measured. Our literature review revealed that several measures of performance had been applied in previous studies of this relation. According to conceptual models, internal pricing strategies between adjacent stages in the value chain are crucial for situations where profit is directed in the financial statements of firms. This indicates that in order to better understand the ambiguous findings in studies of the VI-performance relationship, we need to apply different measures of performance when assessing this relationship. That remains for further research.

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Appendix

Table A1 Pearson's correlation matrix – between measures in groups of processors

Groups	*Farmed fish (n=18)*					*White and farmed fish (n=18)*				
	SO	*VA/S*	*π-adj. VA/S*	*GPM*	*RTA*	*SO*	*VA/S*	*π-adj. VA/S*	*GPM*	*RTA*
White fish (n=55)	0.00*	0.01*	0.02*	0.19	*0.10*	0.11	*0.02**	*0.22*	*0.00**	*0.05*
Farmed fish						*0.00**	0.16	0.15	0.92	0.96

*) Significant correlation on a 0.01 level (2-tailed). Figures in *italics* imply tests assuming equal variance, as determined by Levene's test for equality of variances. Means, by groups of processors, are given in Table 2.

Table A2 Pearson's correlation matrix for measures utilised on total sample (N=91).

	SO	*VA/S*	*π-adj. VA/S*	*GPM*	*RTA*
SO	1	0.46**	0.38**	0.22*	0.16
VA/S		1	0.94**	0.23**	0.23*
π-adj. VA/S			1	0.28	0.19
GPM				1	0.82**
RTA					1

*) Significant correlation on a 0.05 level (2-tailed).
**) Significant correlation on a 0.01 level (2-tailed).

Normality tests

Our data exhibit some features demanding awareness when regressing the level of VI to performance. Two conditions put forward this demand. Of the 100 firm manager in-

terviews, only 92 answers were satisfactory. One firm, however, was identified as an outlier due to extreme values on the performance variables. First, of these 91 observations, EBIT was negative for 43 firms (white fish firms were overrepresented among these). Hence, for these firms the VA/S and profit-adjusted VA/S measures were identical and almost perfectly correlated (0.94 and significant at a one-percent level). Second, the extent to which firms are not vertically integrated, as captured by our variable (SO), also brings about more careful treatment. Since about one third of our firms has no ownership in the upstream industry and attains a null value for this variable, the median of SO is only 0.2, even though firms can be found all along the range from null to one. Table 6 presents the key statistics of our variables for the whole population (N=91).

Table A3 Descriptive statistics for the variables – N=91

Variable	*Mean*	*Std. Error*	*Median*	*Minimum*	*Maximum*	*Skewness*	*Kurtosis*
SO	0.3076	0.0349	0.20	0	1	0.836	-0.508
VA/S	0.1844	0.0104	0.17	0	0.48	0.945	0.833
VA/S (π-adj.)	0.1674	0.0097	0.15	0	0.43	0.945	0.948
GPM	0.0003	0.0082	0.00	-0.17	0.30	0.982	3.326
RTA	0.0659	0.0123	0.06	-0.17	0.44	0.664	0.805
					Std. Error	0.253	0.500

Table 6 displays the mean and its standard error, the median, maximum and minimum values that our variables take. Additionally we have included the skewness and kurtosis of the variables, since these features are decisive for the normality properties of our variables. Perfect normal distributions would display skewness and kurtosis values of zero. This is, however, rather uncommon in social sciences data (de Vaus, 2002).

With our variables, concerns regarding skewness and kurtosis exist. However, we have deliberately not attached asterisks to these values, indicating them to be diverging from the normal distribution assumptions, since methodological advice is conflicting. For instance, according to SPSS, both skewness and kurtosis is within the range of a normal distribution range if the ratio of the values to their standard error is less than +/- 2. In our case, all variable are skew (to the right) while only the GPM variable is more than normally peaking unacceptable. When utilising *Pearsons index of skewness*, which Byrkit (1987) ascribes as a correct operator for deciding whether or not distributions are significantly skewed, none of the variables are deemed too skew. The *Jarque-Bera* test (Gujarati, 1995), which simultaneously tests for skewness and kurtosis, and the *z*-test (Hair Jr. *et al.*, 1995) return values for all variables that are inconsistent with normality. And, finally, the *Kolmogorov-Smirnov* and the *Shapiro-Wilks* tests return test statistic values for all variables (RTA excepted) that suggest violations to the normality assumption.

While the negative kurtosis for our vertical integration measure (SO) indicates a distribution with heavy tails, the other variables are distributed with peaks greater than in standard normal distributions, especially for the gross profit margin, where the histogram shows that about half the firms have a gross profit margin within the range of +/– 3 percent.

As mentioned, the kurtosis and skewness of the data are decisive for the normality of the distribution. The tendency displayed here, especially the skewness of the variable distributions, questions the fundamental assumption of normality. However, inspecting our plots (box plots, normal probability plots and plots of the

actual deviation of the scores from a straight 'normal probability' line) and outliers gave no further reasons for concerns, therefore, we continued as if our data were normally distributed.

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As mentioned, the kurtosis and skewness of the data are decisive for the normality of the distribution. The tendency displayed here, especially the skewness of the variable distributions, questions the fundamental assumption of normality. However, inspecting our plots (box plots, normal probability plots and plots of the actual deviation of the scores from a straight 'normal probability' line) and outliers gave no further reasons for concerns, therefore, we continued as if our data were normally distributed.

Notes

1 When introducing the value chain concept, Porter (1985: 36) defined it as "…a collection of activities that are performed by the firm to design, market, deliver and support its product". He further remarked that "A firm's value chain is embedded in a larger stream of activities (…) the value system" (p. 34). Others use the term value-added chain to denote the various steps goods or services go through from raw material to final consumption (Johnston & Lawrence, 1988). The use of the term value chain in this article covers the adjacent vertical activities both within and outside the firm, and thus contradicts Porter's terminology, as does Cacciatori & Jacobides (2005).

2 Legislation calls for majority owners of fishing vessels to be registered fishermen. In some cases, white fish filleting firms were granted sole ownership to a fleet of wet fish trawlers, which served the firms with most of their input needs. However, in terms of long time industry performance, during the period 1993–2001, these firms have been the industry losers (Bendiksen, 2001), and the number of filleting plants has been dramatically reduced.

3 Unintegrated firms – or more accurately, units without ownership interests in upstream units – will be assigned the value 0, while 1 is assigned to firms receiving all inputs from subsidiaries. We do not assign values > 1, even though situations can occur where firms sell excess upstream production. In our industry this might arise in seasons with high geographical fishing pressure. Over the year, however, this will balance.

4 MVI = vertical integration restricted to the manufacturing channel; the share of industry shipments to manufacturing establishments that are directed internally, to the sellers establishments (MacDonald, 1985).

5 See for instance Burgess' comment (1983) to Buzzel (1983), where he demonstrates that the 'VA/S'-measure for vertical integration has a positive correlation with return on investments (ROI), and therefore is subject to tautological entities, which in regression analyses give rise to the discovery that profit equals profit.

6 According to Hamilton & Nickerson (2003: 53) the concept of endogeneity in this research problem can be illustrated: "…an analysis that regresses profitability on make versus buy will likely lead to biased coefficient estimates of the impact of this strategic choice on performance unless we control for self-selection. The fundamental question for assessing the impact of choosing to buy is this: What profit would the manager's organization earn if he had chosen to make instead? We are not likely to provide an accurate answer to this question by comparing the profits of firms choosing to make with the profits of those choosing to buy, since the observed outcomes may not correspond to the counterfactual performance levels of interest. For example, firms choosing to make may have particular production capabilities that make this a highly profitable choice. On the other hand, firms choosing to buy may not have these production capabilities. Consequently, had the 'buy' firm chosen to make, they would have been much less profitable than those firms who actually chose to make. As a result, a regression of performance on the make versus buy choice, that does not allow for endogeneity of the choice may not answer the strategy effect question of interest."