

VERTICAL INTEGRATION AND PERFORMANCE

The Impact of Measurements and Industry

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ABSTRACT

Vertical integration (VI) is a frequently applied strategy in order to overcome market imperfections and thus enhance firms' performance. Empirical findings from past research, however, show mixed results. Positive, negative - as well as nonsignificant - covariation between VI and performance has been observed. Closer inspection of empirical findings also shows 1) that the covariation between VI and performance varies across industries and 2) that different measures have been applied in different studies.

This paper reviews findings reported related to the vertical integration - performance relationships (covariation). To examine the strengths and weaknesses of the various measures we control for the so-called "industry-effect" by applying various measures of vertical integration in one industry setting - the Norwegian fish processing industry. In doing so 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 VI-performance link across measures and firms. The applicability of the various measures is critically assessed – and managerial implications highlighted.

Key Words: Vertical integration, performance, measurements, fish processing industry

1. INTRODUCTION

Vertical integration is believed to create different economies and thereby influence performance positively, when applied under conditions characterised by market failures, e.g. substantial transaction costs, demand variability, high market uncertainty. However, when reviewing literature on vertical integration, findings with regard to performance effect are not unequivocal. Here we attempt to shed some light over this puzzle, by the means of a closer inspection of measurements controlling for the industry effect. Our primary objective is to examine the performance of an industry, consisting of multiple firms, and where vertical integration (VI) is applied to a varying degree. We therefore attempt to examine to what extent the implementation of varying degree of vertical integration influence financial performance, from not integrated at all to fully integrated. In addition, we will focus on some problems regarding choice of measurements, and also discuss how the industry effect tend to alter conclusions in studies like our.

The essence of the phenomenon vertical integration can be decomposed to one economic entity's possession of successive stages in the input-throughput-output paradigm, i.e. the value chain from raw material to consumers. A suitable question can be why adjacent stages of production, which could have been undertaken by separate firms, are governed within the boundaries of one firm? The answer is concealed in the weighted cost comparison between market exchanges and internal resources. Within the field of logistics the presence of vertical integration have been given explanatory force when assessing reduced transportation costs and lowered cost structures (Copacino, 1999), and can be viewed as an alternative to supply chain management (Ellram, 1991). VI is therefore an often addressed topic when buyer-seller relationships are investigated (see e.g. Bowersox and Droge, 1989, Caputo and Mininno, 1996, Heriot and Kulkarni, 2001, Hingley, 2001, Mixon Jr. and Upadhyaya, 1994, Smith, 1993, Spina and Zotteri, 2001)

Several problems arise when trying to assess the performance effects from firms integrating vertically into adjacent stages of the value chain. First, measurement problems exist regarding both VI and performance: How do we capture the true nature of VI on one hand, and on the other hand financial performance of firms (and industry). Second, when trying to isolate this effect: How do we know that what we measure assert itself at the firm level and is not a product of the industry structure in question? In this paper we offer some suggestions to how these problems can be dealt with, by employing different measurements for VI and performance, and thoroughly analysing the environment in which firms are situated. We also report findings from a study carried out in the Norwegian fish processing industry, where firms' upstream VI towards the fishing fleet was assessed, and compared with the financial outcome of their businesses.

The rest of the paper is organised as follows: the next section give a short review of theories helping to explain the persistence of VI as well as their predictions on performance effects. We also provide a review of earlier empirical studies on the VI-performance (VI-P) relationship. In section 3 we present our data and the setting studied, before we in section 4 give our analyses and results. Included, of course, is a critical assessment of our findings, where managerial and methodological implications are highlighted.

2. VERTICAL INTEGRATION – APPROACH

Vertical integration has attracted researchers' interest for decades, if not centuries, going back to Adam Smith and the division of labour, brought forward by Young (1928), and Stigler (1951). In *neoclassic theory* co-ordination between separate organisations – even in the presence of bounded rationality and opportunism – will be governed by a market system rather than managed internally within a firm. 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 was 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 motives for 'making' instead of 'buying' and 'using' instead of 'selling'. Transaction costs being merely "...the cost of organizing the economic system" (Arrow, 1969), and "...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 and Pagoulatos, 1999; p. 10).

2.1. Three theoretical approaches

In an earlier paper we have argued that three perspectives dominate the analysis of VI (Dreyer *et al.*, 2001) – namely *transaction costs economics* (TCE), *industrial organisation* (IO) and *strategic management* (SM), as do Chatterjee (1991). Other scholars have emphasised different perspectives: TCE and property rights (Woodruff, 2002), TCE and imperfect competition/neoclassical approach (McFetridge, 1999), TCE and market power (MacDonald, 1985), TCE and demand variability (Carlton, 1979; Lieberman, 1991), while others again stress industrial development and historical change (Desai and Mukherji, 2001; French, 1989). Theories can be viewed upon as explanations, and different theories capture partly different aspects of the phenomenon under scrutiny. Here we are applying elements from theories that – for the best of our knowledge – capture the actual phenomenon. One single general theory might indeed not be able to provide a compact explanation of VI (Joskow, 1988). Langlois and Robertson (1989; p. 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) have received considerably attention in explaining the existence – and effects – of VI. It is frequently applied to document the outcome regarding the vertical structuring of production (Shelanski and Klein, 1995). In particular, the arguments of asset specificity, which refers to the existence of significant transaction-specific sunk costs (Whyte, 1994), and uncertainty (Balakrishnan and Wernerfelt, 1986) are given considerably power to explain the occurrence of VI. Another distinctive variable is small-number exchange conditions, i.e. few transactors on both sides of the market (Caves and Bradburd, 1988; Frank and Henderson, 1992). TCE also predicts that organising transactions internally, through VI or other forms of vertical coordination, creates

economies that make it profitable as long as “...costs of transacting over market outweighs internal costs of management” (Levy, 1985; p. 439). In its ‘purest’ form, i.e. vertical financial ownership, VI enhance profits since inter-firm profit claims are eliminated (Mahoney, 1992). This strategic decision is then a transaction-cost-minimising response to the limited information and the cost of contracting (Medema, 1992).

Within the field of *industrial organisation* (IO) economics, the primary determinant of VI is market structure – or rather *asymmetric* market structures (Chatterjee, 1991). This school of thought has traditionally been preoccupied with VI when focusing on barriers to entry (Aghion and Bolton, 1988), raising rivals costs (Salop and Scheffman, 1987) and foreclosure (Hart and Tirole, 1990; Salinger, 1988). According to this theoretical perspective VI can constitute a valuable instrument to create competitive advantages, either by utilising different economies (combined operations, internal control and co-ordination, information, avoiding the market, and stable relationship) or merely by reducing external uncertainty or securing supply of critical input (Porter, 1980). According to the IO perspective VI should lower firm’s risk in markets with demand and volume uncertainty, which consist of few actors, increasing the profits for those applying the VI strategy.

Within the field of *strategic management* (SM) multiple approaches have been applied to ease managerial processes in situations with high uncertainty. The SM-approach is heavily grounded in managerial and organisational practice (Rumelt *et al.*, 1991). According to Chatterjee (1991) and Chatterjee *et al.* (1992) SM has so far been the sparsest and most inconsistent one of the three streams of research into VI. However, the resource-based view of the firm (RBV), in emphasising creation of heterogeneous, valuable and rare combinations of resources giving rise to competitive advantages that are hard to imitate (Barney, 1991; Wernerfelt, 1984), have contributed to improvements in our understanding of VI (Mahoney, 1992). The RBV approach implies, however, that there are no simple rules of thumb on when, and how to apply VI. For every VI decision the actual situation must be taken into account (Balakrishnan and Wernerfelt, 1986), requiring thorough and detailed analysis of the actual situation and context.

These theoretical fields, together with contributions from scholars within these, form the basis of the following analysis. TCE provides insights on the benefits of VI. IO explains how the competitive setting makes VI a valuable strategy and how to elaborate adequate VI measures. SM and the RBV emphasises the importance of internal resources when implementing VI and how complexity and internal barriers can make VI a costly strategy. Though, first we will present a synopsis of the empirical work concerning the relationship between VI and performance.

2.2. Empirical findings on the VI-performance relationship

The way various explanatory factors affect financial performance is an often-addressed topic within several disciplines. Within traditional economics where perfect competition prevails, firms within an industry are supposed to be identical, where price- and quantity decisions are the only strategic choices. Meeting the same demand, such firms would in the long run exhibit average profits, and hence, an analysis of inter-firm differences would give no meaning, as long as market failures do not consist (Yao, 1988).

Researchers from various disciplines have addressed the VI-P relationship puzzle empirically. The point of departure of the conducted studies differs, but to some degree

they tend to coincide methodologically. Usually the impact of one or more explanatory factors on performance is estimated by using some statistical procedure(s) keeping other factors constant. The findings must be treated critically as measurement of performance inhibit potential shortcomings (e.g. performance is unstable, it is surrounded by causal complexity and data used are retrospective (March and Sutton, 1997)).

A useful point of departure for assessing past empirical research related to the VI-P relationship is the meta-analysis by Capon *et al.* (1990). This analysis include 320 empirical studies from disciplines mentioned above, stemming from journals, books, proceedings, dissertations and working papers during the period from 1921 to 1987, where financial performance is the dependent variable. The authors identify 15 studies in which VI (forward or backward) is utilised to examine its effect on financial performance. Several studies use multiple tests, and in 69 cases a positive relationship between VI and financial performance are reported, while 35 reported a negative relationship. Summing up, these studies show a positive relationship (covariation) between VI and performance. However, when distinguishing between industries and businesses (business units), the findings become highly mixed. Thus, the aggregated findings obviously need closer examination.

So far the great majority of the studies on VI and performance has been conceptual, while empirical studies have been relative few. From the limited number of empirical studies one can also conclude that the issues in question have concentrated on transaction costs, foreclosure, and causes for VI, rather than on the effects of VI on performance (Bhuyan, 2002). In the following sections, the specific empirical studies, dealing directly with the VI-P relationship, will be scrutinised. Table 1 sums up the characteristics and findings in some studies investigating the VI-P relationship. None of them entered Capon *et al.*'s (1990) meta-analysis.

Table 1 Studies investigating the VI-performance relationship empirically

| Source | Focal industry | Co-variation | Measure | |
|--------------------------------|--|--------------|--|--|
| | | | Vertical integration | Financial performance |
| Vesey (1978) | PIMS (1971-74) | +/- | VA/S (profit adjusted) | ROI |
| Levin (1981) | U.S. oil industry | 0/+ | Self sufficiency (crude oil and refinery) | (Net income + financial costs) / sales |
| Buzzel (1983) | PIMS (1,649 business units) | +/- | -VA/S (adjusted for investment and profit) -Relative VI (interview) | Mainly ROI |
| Maddigan and Zaima (1985) | Random sample of 45 firms | -/+ | Maddigans (1981) VIC measure | ROA |
| Harrigan (1986) | 192 firms in 16 industries, 1960-81 (SBUs) | +/- | Several (degree, breadth, stages and form) | Successful vs. unsuccessful |
| Martin (1986) | 288 U.S. industries | +/- | Back- and forward integration. Input Output tables | Price cost margin = VA adjusted for labour and capital costs / sales |
| Chatterjee (1991) | 116 vertical mergers (1962-79) | +/- | Actual merger (FTC) compared with firms in the same industry (SIC) | Cumulative abnormal return in market value (shares) |
| D'Aveni and Ravenscraft (1994) | 3,185 manufact. lines of business | (+) | Internal flow of goods relative to external | Operating revenue over total sale |
| Edwards <i>et al.</i> (2000) | U.S. Oil Companies | +;++ | Share of own production | Standard and Poor's stock rating |
| Fan and Lang (2000) | About 500 industries | -- | Vertical relatedness (Rumelt) – input transfer between industries | Excess value = firms actual value over imputed value, (market value) |
| Bhuyan (2002) | U.S. food manufacturing industry | - | Input-Output matrix (Davies and Morris, 1995) | Price cost margin: (total sales – tot. costs)/tot. sales |

Table 1 reveals that findings regarding the VI-P relationship are rather ambiguous. The table also shows that a number of various measures have been applied, for both VI and performance. In addition, the numerous settings and periods studied have to a large extent varied. Regarding the studies included in Table 1 we also want to emphasise the following.

Based on the proxy measure first suggested by Adelman (1955) Vesey, (1978; p. 11) defines VI as: “*the ratio of value added to sales, with both numerator and denominator adjusted for profits.*” (E.g. value added divided by sales, VA/S). He measures profitability by the return on investments (ROI), and uses the PIMS database with about 600 businesses from 100 companies. He finds that high degree of VI is not always the most profitable, that backward VI is more profitable than forward, and that VI, in the business climate at that time, was the third most profit influencing factor, after market share and business climate.

Buzzel (1983) also employ the VA/S measure (adjusted for net profit and 20% of investments) and the PIMS database, where he utilised data covering 1,649 business units in the manufacturing industries. He also used a relative measure for VI, obtained by asking managers whether their line of business or company were more or less VI than competitors. Profitability was (mainly) measured by means of ROI, and he found that either very low or very high levels of VI yields above-average rate of return. Further, that ROI declined consistently over the whole range of VA/S for producers of raw and semifinished material and that for the relative VI measure, ROI was slightly enhanced from backward VI.

The justification for using VA/S as a measure for VI was the assumption that it would increase as firms integrated vertically, forwards and backwards, when transactions were carried out within instead of across firms (Davies and Morris, 1995). Several authors have pointed at many shortcomings of this measure. For instance Maddigan and Zaima (1985), as a direct answer to Buzzel’s study, asserts that that VA/S will be higher at earlier stages of production, and that more profitable firms, or firms with relatively higher labour and capital productivity, will tend to score higher on this measure. Maddigan and Zaima, by comparing Maddigan’s (1981) vertical industry connections (VIC) to the VA/S indices on a random sample of 45 firms’ return on assets (ROA), found that the two drew the opposite conclusions. While VA/S again showed that the extreme levels of VI were the most profitable Maddigans VIC index suggested that moderate levels of VI would induce the greatest profitability.

The arguments against VA/S for being higher the closer the firm is to the raw material source have been conspicuous. Others have criticised the measure for being more sensitive for backward than forward integration (Martin, 1986), that it does not reflect the choices firms make about coordinating potentially separable economic activities (Caves and Bradburd, 1988), and also when measured at individual enterprises it becomes sensitive for multiplant backward integration (Levy, 1985). An additional objection is that it does not capture the firm’s partial consolidation of control through contracts and other agreements (Frank and Henderson, 1992).

The VIC index introduced by Maddigan (1981) – which relies on national input-output tables (Leontief, 1951) and information on the industries in which a firm operates with the average share of these industries’ production – has also been met with criticism, arguing that it fails to account for partial integration within an industry (Levy, 1985), and that it is a firm level index and therefore not feasible on the industry level (Davies and Morris, 1995). Henderson (1994) also criticises this measure of VI for only including industries in which the firm has a 100 per cent ownership, and thereby omitting what Blois (1972) calls ‘quasi-vertical integration (i.e. control through partial ownership).

Levin (1981), in relating VI and profitability in the U.S. oil industry (43 companies in the period 1948-72), introduces “self-sufficiency” as a measure of VI. Self-sufficiency is the quotient of crude oil production divided by the sum of crude oil production plus refinery runs, which will be 0 for unintegrated refiners and 1 for unintegrated crude oil producers. Balanced integration, he states, will be given the value 0.5. Profitability is measured by net income plus interest payments divided by total revenue. Levin finds that this is not affected by the degree of VI towards crude oil or refinery production but VI helps reducing the variation in profits over time. He identifies considerable variation in the self-sufficiency ratio for most firms over time, and that this evolutionary approach does not reveal any trends in neither more nor less VI.

Harrigan (1986), in underlining the many faces of VI, states 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 in the period 1960-81. *Degree* of VI was measured by the percentage of internal purchases (backward VI) and sales (forward VI), and *form* of VI was measured by the ownership percentage in the venture. Her main findings were that involvement in many integrated stages couldn't be sustained with the same success throughout the industry's entire span of life and that VI was indeed a costly strategy. VI should therefore be adjusted to changing conditions.

Martin (1986) constructs an input-output table measure of the average industry (backward and forward) vertical integration, varying between 0 (no VI) and 1 (full VI) and tests it within the limits of a structure-conduct-performance model. Profitability is measured by a price cost margin, and he finds that the effect of VI on profitability is complex: depending on whether one integrates *into* the industry or *out of* the industry. Some time it's positive and sometimes its negative, which supports a 'case by case' approach when VI is contemplated.

Chatterjee (1991) studies 116 U.S. vertical mergers from 1962 to 1979 and compares them with firms in the same industry. He measures profitability by cumulative abnormal return (stock market measure) and finds that target firms gain about 20 per cent while the acquiring firm have next to no effect on profit. His findings support those of the IO literature in the way that advantages through VI are greatest when the acquiring firm operates in concentrated markets, while target firms where in competitive markets, so that mergers leads to increased market power.

D'Aveni and Ravenscraft (1994), in their study of 3,185 manufacturing business lines, use internal flow of goods relative to external as a measure of VI. Operating revenues over sales was their performance measure, and they report that VI units displayed marginally better profitability than nonintegrated business lines in the same industry, after controlling for economies of scale and scope. However, VI units had higher production costs (especially backward vertically integrated units), but economised through other cost components (R&D, advertising, administrative and general expenditures).

Another study examining the VI-P relationship in the U.S. oil industry is presented by Edwards *et al.*, (2000). They regard 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). Profitability is measured by the company's stock rating of Standard and Poor's *Stock Guide*. Observing two distinct separate time periods – 1972 and 1992-94 – they find that crude oil production strongly enhances performance, while pipeline integration shows a weak positive effect despite an efficient market with many independent

pipeline companies. Further, the average level of integration fell between the early 1970's and 1990's and larger oil companies remain the most integrated.

The only study using Rumelts diversification strategies (Rumelt, 1974) is Fan and Lang (2000). The authors apply commodity flow input-output tables to capture interindustry and intersegment vertical relatedness and complementarity. They find that vertical relatedness is, on average, associated with poor performance. Complementarity, on the other hand, is positively correlated with firm value, as measured by excess value.

Bhuyan (2002) examines how the impact from vertical mergers in U.S. food manufacturing industries affect profitability, simultaneously controlling for industry characteristics like productivity and competitive conditions. His VI measure is based on input-output tables and the earlier work by Caves and Bradburd (1988), MacDonald (1985) and Davies and Morris (1995), while net industry profit - computed as a price cost margin - serves as proxy to performance. Bhuyan finds that VI negatively affects profitability, which he explains by the failure of vertical mergers to creating differential advantages for the integrated firm.

Another study, which do not enter Table 1, is Shin (2001) who examines the impact of information technology (IT) spending on performance. He finds that this has a significant effect in vertical *disintegrated* (as measured by the inverse of VA/S) firms when performance is measured by net profits (not ROE or ROA).

Noting the recommendations from other researchers we emphasise the suitability of the measures to be applied. In accordance with Harrigan (1986; p. 538): “...*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.*”

When summing up the empirical work on the VI-performance relationship, we find that:

- ✓ VI is a multidimensional construct
- ✓ VI is difficult to measure
- ✓ Results from different studies are difficult to compare
- ✓ Findings on the VI-P relationship is ambiguous

Another measurement problem arising in attempts trying to establish the VI-P relationship, is how to measure performance. In past empirical studies multiple measures have been applied, including accounting measures providing the operating performance – giving an indication of past and present organisational adoption – and market based performance measures (Tobin's *q*, abnormal return, etc.) – giving a future-oriented consideration of organisations ability to change (Keats and Hitt, 1988). They concluded (p. 526): “*Performance is a difficult concept, both in terms of definitions and measurement.*”

Here we address the measurement problem and the way application of different measures impact on the VI-P relationship. To focus on this problem we have chosen to avoid the potential industry effect by focusing on a single industry. Based on the review on how VI have been measured in previous studies, we intend to include several measurements, adopting them to this specific setting, and inspecting to what degree the VI-P relationship alter when different measures are applied.

3. TESTING THE VI-PERFORMANCE RELATIONSHIP

In order to test the relationship between VI and performance some prerequisites must be met by the data applied. We have in earlier studies focused on various concepts regarding VI in the Norwegian fish processing industry: In Dreyer *et al.* (2001) we explored ways to overcome difficulties in carrying out empirical studies on the impact of VI on performance. Especially how to operationalise VI in such a setting by designing a measure that captures the actual ‘level’ of VI in this particular industry. In Isaksen *et al.* (2002) we further investigated the state of VI in this industry by means of finding the determinants for integrating vertically – primary uncertainty in the industry and/or the industry age. Trading on these two studies this research stream will here be further developed by trying to establish the proper way to measure VI and performance. In this section we elaborate the setting more thoroughly, present our research design before elucidating which measures to use for testing the impact from VI on performance.

3.1. The Norwegian fish processing industry

Some basic requirements must be met in order to explore the effect from VI upon performance. By limiting our study to the Norwegian fish processing industry we will argue that the following needs are met: First, we need a competitive setting in which the units studied are motivated to integrate vertically. Second, the industry must be composed of firms that vary in degree of VI, and third, detailed data at firm level must be available in order to measure performance and degree of VI.

By limiting our study to the Norwegian fish processing industry we apprehend a link in the seafood value chain, situated between the resource and the consumers, in which several structural variables motivate for VI. As underlined by Dreyer (1998) and Prochaska (1984) among others, managers of fish processing firms are subject to an almost stochastic supply of the most important input factor; namely fish. Uncertainty is also persistent in the other end of the value chain, where prices and output fluctuate heavily. In the literature this has been emphasised as a situation bringing about needs for VI by several authors (Carlton, 1979; Fan, 2000; MacMillan *et al.*, 1986; Miller and Shamsie, 1999; Perry, 1982; Walker and Weber, 1987; Williamson, 1991a). In our setting uncertainty differences among firms also emerge as some rely on wild caught fish – with the risky environment surrounding this biological resource (seasonality, quality, abundancy, meteorology) – while others processing farmed fish have more stable supply. Therefore upstream VI towards the fishing fleet or aquaculture industry, in order to achieve control over the most important input factor is a meaningful strategy to reduce uncertainty or to secure a sufficient supply. Even though farmed fish, as a more stable source of supply, has emerged the last decades, firms in the traditional part of the industry have only to a limited extent ceased the opportunity to take advantage of this. The reason why is hard to grasp, as this raw material source easily could be implemented as a substitute in complementary production processes. However, firms defining their core competencies (see e.g. Kannan and Tan, 2002, Reve, 1991) might have contributed to this exclusion of farmed fish, together with persistent high uncertainty levels in the emerging stages of this industry’s life-cycle (c.f. Isaksen *et al.*, 2002).

Another feature descriptive of this industry, which also makes VI an attractive strategy, is the age of the industry (cf. Stigler's (1951) life cycle hypothesis). One can divide the industry in a young and an old component, the young being those which most important input factor come from aquaculture and the older being those relying on caught wild fish. According to this 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 in the last stages of the industry life cycle again increase (Langlois and Robertson, 1989; Tucker and Wilder, 1977). The difficulty remains, however, to determine whether those relying on while caught fish as the most important input factor are to be considered a mature or an old industry. This, however, do not reduce the feasibility of integrating vertically towards the raw material source.

That the Norwegian fish processing industry in fact is a very competitive setting remains to be elaborated a bit further. In 2000, 550 firms were found in this industry (limited to those processing fish for consumption, i.e. NACE code 15.2), with total revenues in the range of mNOK 1 to 1,500, averaging mNOK 25, and with about 25 per cent utilising farmed fish. Some companies in the industry are present, forming large entities of the industry, which reduces the number of 'actors' to about 470. However, the concentration in the industry must be said to be modest, where the revenues of the 20 largest actors constitute less than half of the industry's revenues, and employ about 40 per cent of the employees in it. At firm level the same ratios would be 25 and 20 per cent respectively. The Hirschman/Herfindahl index is about 0.025 (Bendiksen, 2001) indicating very low concentration. In addition, few barriers to entry exist in this industry although on first hand (fishing vessels and fish farms) a license from the Government is required in order to start in business. Some effective barriers also exist when integrating backwards towards fishing vessels, as the legislation call for majority owners to be registered fishermen. Some historical industrial factors have, however, given fish processing firms sole ownership to a fleet of wet fish trawlers, that to some degree have been sole suppliers of fish to these firms. These firms have been the losers in terms of long time profits in the period 1993-2001 (Bendiksen, 2002) and the number of plants have been reduced. All this pointing at an industry characterised by heterogeneity, concerning both number and size of firms, together with choice of input.

Secondly, the industry must consist of firms that vary in degree of implemented VI. We have earlier argued that the choice of appropriate degree of VI is another than the pure dichotomy between to 'make or buy' or 'use or sell' (Dreyer *et al.*, 2001). In Dreyer *et al.* (1998) the state of vertical integration in the Norwegian fish processing industry is examined to a greater detail, where one of the main problems appearing is how to establish the state of VI in an heterogeneous industry like this. The recommendation, when attacking the supply side, is a firm level approach, where one assesses the level of self-sufficiency, i.e. how much of the main inputs stem from controlled affiliated businesses. By applying such an approach one ends up in a relative measure, rating from 0 to 1, where unintegrated firms, i.e. those receiving no inputs from firms in upstream stages that they own (partly or full) receives 0, and fully integrated firms, i.e. where all fish entering the production process come from affiliated units, are given the value 1.

As underlined by (Casson, 1984), limiting our study to one industry overcomes the difficulties occurring as variations across industries are mispercepted as affecting the explained phenomenon. However, variations within the same industry – especially when heterogeneity is exceedingly present like here – may also be difficult to account for. For instance, industry attributes in the Norwegian fish processing industry might give the

impression of an industry in which vertical integration only appear to a minor degree. One such feature is the fact that out of a total production about 90 percent is exported, of which a large share is semi-finished products and raw material entering production and distribution processes abroad, i.e. leaving it to the market. Another feature can be found among processors of farmed fish, i.e. salmon. While domestic fish processing firms utilising salmon only to a limited extent own fish farms, thereby making the impression of a minor degree of vertical integration, the opposite is in fact true, as aquaculture firms on their own have set up plants to process the farmed fish. In this way, the imperative made by Joskow (1988)¹ on thorough knowledge to the industry studied, becomes a necessity in order to comprehend what influence specific dependent variables. And in this particular industry, we find processing firms totally integrated towards their raw material base by means of common or sole ownership to their supply source, which stock the firm with all their needs, together with firms exclusively exploiting the market to secure their inputs.

The third claim when carrying out a study like this is the need for detailed data at firm level, from which the standing regarding both VI and profitability can be depicted. At our hands is a 'state of art' database – "Driftundersøkelsen" – which has been surveying the profitability and structure of the Norwegian fish processing industry on an annual basis since 1977, (Bendiksen (2002) and earlier years). In this, the same companies are observed each year, giving us the opportunity to construct time series as well as panel data sets. By the means of this source we have earlier presented analyses establishing the dynamic VI-P relationship by borrowing from organisational ecology and making 'survivors' and 'failures' a relevant proxy for long term profitability in this competitive setting (Dreyer *et al.*, 2001). In addition, general managers of a representative sample (geography, size, raw material use) of firms in the industry was interviewed, enabling us to construct another - not account based - measure of VI.

3.2. Measures of VI and performance

As noted above, our constructed measure of VI (supply share from own, SO) captures the level of inputs from subsidiaries, i.e. firms (fishing vessels or fish farms) in which the focal firm has proprietary interests in (majority or minority). It is a continuous measure including most vertical co-ordination (as recommended by Blair and Kaserman, 1983; de Koning, 1994; Frank and Henderson, 1992; Peterson *et al.*, 2001), as long as ownership is involved. It displays properties like MacDonald's (1985) measure, based as it is on internal transfers between stages tied together through (common) ownership, and Levin (1981) and Edwards *et al.* (2000) self-sufficiency ratio. And, interestingly, it includes two of the four dimensions brought forward by (Harrigan, 1984), namely *degree*, i.e. ratio of input from subsidiaries over total input, and *form*, i.e. the ownership level. Adding up, this measure can be labelled *use* of VI that is to what extent the ownership interests in adjacent stages is materialised into actual flow of goods. In our opinion, this is a well-suited measure for the setting studied and incorporates the core of the concept called vertical integration.

When comparing it to other measurements applied in the literature, the most obvious and reasonable counterpart would be the 'Value Added over Sales' (VA/S) measure. In order to liberate it from the apparent connection to profitability, profits are subtracted in numerator

¹ "[G]ood empirical work aimed at testing theories (...) requires that we know a lot about the characteristics of the firms and products that we are relying on in the empirical work." (Joskow, 1988, p. 111)

and denominator. Holding the two measures together one deficiency comes forth: While our measure only reveals upstream VI, value added to sales also embodies effects from downstream integration, i.e. towards the customers. However, in the setting studied here, which in fact is an export industry where as much as 90 per cent is exported, many firms hold an export licence, though for many holders (as with ownership of fishing vessels) this licence is only to a minor degree utilised and sales are set out to ‘professional’ exporters/sales organisations.

Measuring performance is relatively straightforward, as market based measures are disqualified since shares in firms in this industry are not subject to market transactions, i.e. a well functioning stock exchange. Therefore account-based measures have to be applied, where we use return on investments (ROI), i.e. the yield of the total capital employed, independent of funding, and profit margin (PM), i.e. the ratio of pre-tax net profits to sales, that is what is left to profits from total sales.

3.3. Data

When approaching the VI-P relationship of the Norwegian fish processing industry, a decision must be made on which year comparisons should be based on. As mentioned before, the dynamic nature of VI (see e.g. Langlois and Robertson, 1989) makes it necessary to limit the scope of our analysis. In 2000 we conducted a survey among 100 general managers in the industry, establishing the firm specific state of backward VI in this setting. Together with account data from “*Driftsundersøkelsen*” (Bendiksen, 2001), we have appropriate information to assess the VI-P connection in this setting.

When assessing the state of VI and overall performance in 2000, some industry characteristics should be mentioned. Among other factors, the traditional white fish industry struggled with low prices in the markets for frozen and salted fish at the same time as quota reductions led to an increase in the first hand prices. For this segment the overall profitability was low in 2000. The market for farmed fish, especially salmon, reached its peak in 2000 when looking at market prices, and this branch was attended with high profitability. The processing of salmon, however, was still connected with low profitability. The various ways to organise the processing activity of salmon within the firm boundaries makes it necessary for us to distinguish between groups of processors. We have therefore isolated those who process a) only white fish, b) only red fish (e.g. salmon and trout) and c) both red and white fish. Descriptive statistics follows from Table 2 beneath.

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

| Industry segment | SO | VA/S | VA/S (π -adj) | ROI | PM |
|--------------------|------|------|--------------------|--------|---------|
| White fish (n=55) | 17 % | 16 % | 15 % | 4.4 % | - 1.8 % |
| Red fish (n=18) | 76 % | 26 % | 23 % | 9.9 % | 2.6 % |
| Red & white (n=18) | 29 % | 20 % | 17 % | 10.1 % | 2.9 % |
| TOTAL (N=91) | 31 % | 18 % | 17 % | 6.6 % | 0.0 % |

Computing Pearson’s correlation tests reveals that the whitefish and redfish groups significantly differs in terms of all three VI-measures, while red fish and the combined white/red fish only differ in terms of SO. The whitefish and the combined white/red fish group differ significantly in terms of profit margin. In addition, all the VI measures are

significantly correlated to each other, where VA/S and the profit adjusted VA/S – due to 46 firms with negative profit, and therefore not adjusted – are almost perfectly correlated (0.944 on a one-percent level). It seems like the measures used are capturing some of the same phenomenon. Further, Table 2 exhibits that firms utilising farmed (red) fish on average are more integrated than those processing white fish, and that they are more profitable. Even though the tendency is weak, it seems as if the ‘generalists’ – producing both white and red fish – are the most profitable. The average ROI for this industry is about the same as for the total of Norwegian on shore industry (6,7 per cent in 2000).

Before carrying out a regression of the level of VI to performance, we have to examine the data more closely than merely establishing the means of the distributions. In Table 3 we present some key statistics to our variables for the whole population (N=91).

Table 3 Descriptive statistics for our five variables

| Variable | Mean | Std. Error | Median | Minimum | Maximum | Skewness² | Kurtosis |
|---------------------|-------------|-------------------|---------------|----------------|----------------|-----------------------------|-----------------|
| SO | 0.3076 | 0.0349 | 0.2 | 0.0 | 1.0 | 0.836* | -0.508 |
| VA/S | 0.1844 | 0.0104 | 0.17 | 0.0 | 0.48 | 0.945* | 0.833 |
| VA/S (π -adj.) | 0.1674 | 0.0097 | 0.15 | 0.0 | 0.43 | 0.945* | 0.948 |
| PM | 0.0003 | 0.0082 | 0.0 | -0.17 | 0.3 | 0.982* | 3.326* |
| ROI | 0.0659 | 0.0123 | 0.06 | -0.17 | 0.44 | 0.664* | 0.805 |
| | | Std. Error | | | | 0.253 | 0.500 |

One critical feature in our data is the occurrence of negative profits in 43 cases, which aligns and equals VA/S and profit adjusted VA/S. In addition, the extent to which firms are not vertically integrated – as captured by our variable SO – also brings about more careful treatment. In fact, about one third of our firms has no ownership in the upstream industry and are given the value null on this variable. Therefore the median of SO is only 0.2, even though firms can be found all along the range from null to one. These problems will be dealt with to a greater extent under chapter 4.1/4.2 when the validity of our findings is assessed.

² Even though all of our variables are found skew by SPSS (a skewness value greater than twice the standard deviation), the computed Pearson’s index of skewness (see Byrkit, 1987; p. 75) is within acceptable limits for all variables.

4. RESULTS AND CONCLUDING REMARKS

To test for covariation between VI and performance, the OLS regression is applied for the variables mentioned, where profitability is the dependent, and VI the explanatory variable. In Table 4 test statistics from regressing the three VI variables on the two profitability variables are reported.

Table 4 Test statistics: Regressing (OLS) VI against profitability

| VI measure | Profitability measure | β | R ² | P-value |
|---------------------|-----------------------|---------|----------------|---------|
| Share from own (SO) | Return on Investment | 0.058 | 0.027 | 0.121 |
| VA/S | | 0.268 | 0.051 | 0.031* |
| VA/S (π -adj) | | 0.024 | 0.000 | 0.856 |
| Share from own (SO) | Profit margin | 0.052 | 0.049 | 0.035* |
| VA/S | | 0.236 | 0.089 | 0.004** |
| VA/S (π -adj) | | 0.024 | 0.001 | 0.793 |

*) Indicates significant effect at 5 per cent level

***) Indicates significance at 1 per cent level

The main findings from Table 4 is that VI – as measured by either share from own affiliates, value added over sales and profit adjusted value added over sales – can only to a very limited extent explain the inter-firm differences in profitability in the Norwegian fish processing industry in 2000. At the most, only nine per cent of the total variation is explained, which arises when value added to sales is regressed against profit margin. What does seem to influence the profitability, however, is the ratio of value added to sales. As noted by several authors, one major weakness attached to this measure is that it is positively correlated with profits, i.e. it is under influence by other factors than VI, leading to spurious results when regressing it against profit. This is in fact what we believe to see here. When regressing VA/S against profit margin (which is the regression given highest explanatory power), we merely state that pre-tax net profit should equal a constant multiplied by the value added, which in fact should hold since profit should be strongly correlated to value added. When deducting profits from both numerator and denominator, this measure loses its significant explanatory force, R-squared shrinks to nothing, and the coefficients (β) are decimated.

What is left then is our own measure, which seems to have a significant – though neglectable – effect on profitability as measured by profit margin. When performance is measured by return on investments, the effect is the same but not significant. Applying this measure in another sample using data from 1997 (Dreyer *et al.*, 2001) we found that VI had reverse – though non-significant – effects on the two measures for profitability. At that time, VI seemed to increase profit margins, while return on investments (ROI) was affected contrarily. That could be given the explanation that VI brought about positive profitability effects, but not sufficient enough to give a reasonable return to the additional funding required when obtaining proprietary interests in upstream supply units. Here the effects from VI (as measured by all three measures) go in the same direction for both performance measures.

4.1. Concluding remarks

One intriguing question often noted is this: What came first: the egg or the hen? This rather evolutionary puzzle also underpin the background for considering how strategic changes in organisations impact their outcome as measured by performance (Parnell, 1998), and hence, also when measuring the impact of VI on performance like we do. Could it be that firms obtaining results outperforming their competitors, or that industries where supernormal profits are obtained, creates financial power and freedom to bring about the ability to invest in strategic changes like VI? For tax reasons or to create barriers to entry for competitors? Such a tautological explanation must be evolved further.

In our setting, this could in fact be the case. In 1998, the most prosperous year in the Norwegian fish processing industry for decades, we interviewed general managers of the largest fish processing firms in Norway, of which 68 per cent had proprietary interests in fishing vessels, 58 per cent considered the importance of such ownership to be more important for the future and 85 per cent considered increasing their participation in the fishing activity. Five years later, such optimism would hardly be recognised among the same managers, at least not to such an extent.

The use of vertical integration in this industry is not an easy thing to comprehend, due to the multiple ways to organising the buyer-seller relationship, and the variety in firms operating here. Whereas many businesses have invested heavily in minority shares of fishing vessels (sole ore majority ownership is prohibited by law) others attend the buyer-seller relationship by other means. One way is by offering local vessel owners loans to contract vessels, with an underlying tacit agreement that tie the landings to the lender when feasible. As stressed by Williamsson (1991b), p. 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 their disposal (for carrying out on shore related business like baiting, lodging and mending the fishing gear), while others again merely by ways of a common understanding of what is best for the local community, agrees tacitly on serving each other. As noted by Fine and Hax (1985), p. 32: *“The crucial element of success of integrating operations is not ownership, but management and co-ordination of the series of processes”*.

4.2. Implications

Although we have restricted our study to a single industry, there is, as demonstrated in the literature review, numerous ways of measuring VI. Our results indicate that the VI-performance relationship is sensitive for measures chosen to test the relation. Measures that easily can be applied in different settings are often based on data from financial accountings. As performance measures often origin from the same source, statistical validity is weakened since we meet multicollinearity problems. Here we manage this problem by applying a measure on VI based on production volumes rather than financial figures. Our conclusions regarding the VI-P relationship was not altered by using account based measures of VI, which indicates a high level of internal validity when applying different measures of VI at firm level.

The external validity is, however, at stake since the sample scrutinised here is collected in the same industry at one single year. The choice of industry has been undertaken to isolate

and disregard the possible industry effect and the firms entering the analysis all face the same external conditions. However, since our findings are based on the situation at only one point of time, some variation can be lost. As underlined earlier, VI is a highly dynamic and heavily varying concept, which makes comparisons over years both time and resource consuming when trying to assess the true degree of vertical integration among firms. In an earlier analysis, using a different operationalisation of the concept, where only fish freezing plants and their dependency of industry owned wet fish trawlers in the period 1977-1992 entered the analysis, the findings indicated no direct effect between VI and profitability in this segment (Dreyer *et al.*, 2001).

Due to the fact that one third of the firms state a share of input factors from subsidiaries to be zero, our operationalisation of VI violate the requirements for the normal distribution which the OLS relies on. Transforming the variable in one way or the other would not reduce the problem. One way of avoiding this could be to omit the 'zeros', which would have reduced our sample severely. Not to mention that it would imply that we refused to see the choice of VI strategy from a huge number of firms in this industry. A test where we divided only between those who were integrated and those who were not, gave no extra explanatory force. Neither did it do so when we omitted the 'zeros'. Therefore we have chosen to present our material 'as is'. Since the zero group can be argued to consist of two strategically different firms – one group choosing to use the market for transactions and another wanting to integrate vertically but lacking the financial capability – a way to separate these two would be recommendable for refining our findings in future 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, the conclusions concerning this relationship are sensitive for 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 origin from financial statements when analysing the VI-P relationship, to avoid possible spuriousness in regression results. Based on our findings we also recommend 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 in different industries.

A relevant question for future research is whether the VI-P 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 where profit is directed in firms' financial statements. 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, which remains to be further elaborated.

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