Determinants of Food Industry Performance – Empirical Evidence Based on a Survey

William Hartley Furtan[1] **and Johannes Sauer**[2]

[1]University of Saskatchewan, Saskatoon, Canada

[2]Kent Business School, University of Kent, Imperial College at Wye, United Kingdom
and University of Copenhagen, Denmark (j.sauer@imperial.ac.uk)

Selected Paper for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008

Abstract

This paper empirically investigates the determinants of firms' performance in the agri-food sector by using recent survey data for Denmark. Treating sales per employee as a proxy for value addition we estimate several bootstrapped regression models to draw conclusions on the marginal effects of potential performance determinants such as the form and nature of ownership, stage of the food chain and commodity sector, new product development, staff quality, firms' competitive stance, and elements of firms' strategy. To draw robust inferences we apply, besides the ordinary heteroscedasticity corrected Tobit ML-estimator, a nonparametric least absolute deviations estimator (LAD/CLAD) based on a quantile regression procedure. The results indicate that we cannot reject the hypothesis of no influence of dominant orientation on value added. Rather, firms' focus on human capital, stage and commodity sector better explains their value addition. We can reject the hypothesis that regional networks have no influence on value added. Differences in location, emphasis on human capital and the negative influence of outsourcing on value added all provide supporting evidence. We reject the hypothesis of no influence of FDI, and moreover propose that FDI has targeted the domestic Danish market as a source of value added.

Keywords: value added, innovation, organizational type

JEL classification: Q13, O31, O33

1. Introduction

There is a perceived need to increase the rate at which food industry firms add value to food products. In a world of increased global competition the competitiveness of firms can be enhanced by innovation. Traill and Muelenberg (2002) lists a number of hypotheses regarding the relationship between innovation and firm performance in the food industry as a means of formalizing a research agenda on this topic. There has been surprisingly little research into the attributes of firms that can, do, or might deliver such value added benefits. Moreover, much of the research to date has used case studies with limited recourse to statistics and theoretical models of firm behaviour. This paper uses a theoretical model of innovation and employs a recent survey of Danish food industry firms to identify relationships between value added and the attributes and behaviour of the firms.[1]

Christy and Connor (1989) have proposed that changes in value addition are associated with structural and behavioural change in the food marketing system. Focusing on structure, Rogers (2001) found that market shares of the largest firms in the US food industry were highly correlated with those large firms' shares of industry value added. Conversely, Gould and Carson (1998) as well as Buhr (2004) both identified small firms' value-adding activities that are essentially defensive: adding value as an alternative to cost and logistics saving through economies of scale. Buhr's interviews with food industry firms revealed that they view product differentiation as being the key to adding value. Branding (as a product differentiation tool) was investigated by Baker et al. (2006) and Brester and Schroeder (1995) for linkages to value addition, and in both cases the relationship was found to be associated with vertical relationships in the marketing channels. Bressler (1999) examined cases of vertical integration as a means of adding value, and found linkages to a broad range of management variables including human resource management, asset acquisition and the form and extent of sales growth.

Coltrain et al. (2000) examined a selection of firms with various differentiation strategies, and defined "innovation" and "co-ordination" as the two main sources of value addition. In that study, these two activities tended to focus on relations within the supply chain. Bosworth and Loundes (2002) also found strong links between several forms of innovation within the marketing channel and value added. Given the apparent significance of innovation in value addition, it is somewhat surprising that research and development (R&D) actions and expenditures have generally not been found to be closely associated with value addition (Heshmati and Pietola, 2004; Bosworth and Loundes, 2002).

---

[1] The ongoing research programme "Outlook and perspectives for the Danish Food Industry" is funded by a grant under the Danish Innovation law.

Jungnickel et al. (2004) and Walkenhorst (2001) examined relationships between international features of firms (foreign direct investment (FDI), export performance, staff located abroad) and measures of productivity and value added. Both found a positive relationship between value added and FDI, and between value added and exports. Those studies used publicly-available databases that did not contain information on some key variables on these themes, such as the characteristics of staff and the use of outsourcing.

Strong links between value added and choice of marketing channel, and channel relationships, have been identified by Brown (1995, in a Canadian study) and Sonobe et al. (2004, in a Chinese study across several sectors). Baker et al. (2006) found evidence that value generated at one stage of the chain might be expropriated by other firms by applications of branding behaviour, particularly where such behaviour was related to interactions between retailers and other firms. Lawrence at al. (1997) found that inter-stage relationships were important in value addition, particularly when allocation of production, processing, distribution and retailing space were concerned.

2. Danish Food Sector

There has been substantial consolidation in Danish food sector over the period 1995-2000 (Baker, 2003). Baker (2003) reports that consolidation of food processing firms has been more pronounced in Denmark than in other parts of Europe. The reason for this rapid consolidation is driven by the need for firms to gain economies of size in order to compete with cheaper imports and a highly competitive export market. This consolidation has impacted the profitability of the Danish food processing firms. Similarly a reduction in the number of food industry wholesale firms has been more rapid in Denmark than other parts of Europe (Baker 2003). Finally, in terms of industry concentration levels the Danish food sector is similar to other parts of Europe (Baker 2003). Denmark has a CR5 of about 56% while the CR4 in the US is about 27% at the national level.

One strong trend that has occurred in the Danish food marketing chain is the increase in the share of the wholesale market controlled by non-specialized stores. This trend is apparent in most EU countries, but Denmark has the largest increase (Baker 2003). In contrast the US has shown a strong increase in all types of food retailing outlets.

3. Model and Hypotheses

The idea of a 'knowledge production function' was first suggested by Griliches (1979). This idea has been expanded by social scientists interested in knowledge spillovers and location theory (Bode 2004, Breschi and Lissoni 2001, and Feldman 1999). In this paper we too build on the idea of a knowledge production function. We start by assuming that the firm wants to maximize expected profit subject to a technology constraint (knowledge production function). We also assume that the firm has no pricing power in either the output or input market. In the simplest form we specific this as

$$MaxE(\Pi_{it})$$

Subject to

$$N_{it}Y_{it} = h[X_{it}A(Z_{it})] + \phi_{it}$$

where expected profit is $E(\pi_{it})$ and can be written as $E(P_N NY\text{-}wX\text{-}R\&D)$, N_{it} is a vector of the number of products produced by the firm, Y_{it} is a vector of output levels for each of the N products, and X_{it} is a vector of traditional inputs such as physical capital and labour, w the cost per unit of the traditional inputs, and $R\&D_{it}$ is the expenditure on innovation all for firm *i,* all in period *t*. The knowledge production function is specified as an innovation function $A(Z_{it})$ and φ_{it} is a random variable. In tradition production function $A(Z_{it})$ is a productivity shifter, which may augment specific inputs in a biased manner (biased technological change) or in a neutral manner (neutral technological change).

In our model we specify the change in productivity to be a function of four variables i.e. A(*R&D, C, F, L*). *R&D* is the level research expenditure made by the firm and captures the effect of the investment made by the firm in innovation. *C* is a vector of contractual arrangements i.e. types of contracts the firm has entered into for the purpose of marketing the output or purchasing inputs. Different types of contracts can make the firm more efficient and thus represent a form of 'business' innovation. *F* is the presence of foreign direct investment in the firm and captures the formal spillovers that occur from foreign direct investment. Variable *L* captures local spillovers and is measured by the proximity of the firm to other firms in the country.

An increase in research expenditures will increase the level of innovation. This has been shown extensively in the economics literature and has been the main focus of numerous studies estimating rates of return to research investment. The impact of increasing the level of contractual arrangements is to make the firm more efficient by reducing transaction costs. The level of foreign direct investment is thought to increase the level of innovation. Foreign investment brings with it new techniques, opens up markets, and increases the level of business capital (contacts). Local spillovers occur through agglomeration effects in the supply of specific inputs such as skilled labour and the local availability of specialized services such as international tax lawyers, accountants, and engineers.

The impact of innovation on the output level of the firm is shown in figure 1. A change in the level of A(.) shifts the function in a non parallel fashion. The larger the level of traditional inputs used by the firm the greater is the impact of innovation on the total output value of the firm. The change in A(.) can increase the level of output of existing outputs (Y) or it can increase the number of products produced (N) or both (NY). For this reason the first order conditions for profit maximization are not tractable.

Because the model is not tractable we do not work out the first order conditions and develop a comparative static analysis to test hypotheses. As an alternative we use the above model to test five hypotheses (see table 1) drawn from the agribusiness and economics literature, using Danish food industry data. To the best of our knowledge none of the hypothesis shown in table 1 has been tested using an innovation model with firm-level data from the food industry.

In order to test the stated hypotheses we use three different econometric models. We approach hypothesis 1-4 by specifying the following functional relationship (model 1):

$$VA_{it} = f\left(N_{it}, emp1_{it}, emp2_{it}, dFDI_{it}, dR_{ijt}, dCO_{it}, dMS_{ikt}, dFS_{ilt}, dO_{imt}\right) \qquad (1)$$

where VA_{it} is value added or a proxy for profits measured by sales per employee, N_{it} is the number of new products introduced, $emp1_{it}$ is the percentage of employees outside Denmark, $emp2_{it}$ is the percentage of employees with university education, $dFDI_{it}$ is a dummy variable for foreign direct investment in the firm, dR_{ijt} is a dummy variable for location in region *j,* for firm *i*, all in period *t.*[2] The variable dCO_{it} is a dummy variable for cooperative form, dMS_{it} a dummy variable for marketing stage k[3] and the dummy variable dFS_{ilt} denotes firm i's operation in sector l.[4] Finally we include a dummy variable to denote firm i's dominant orientation m.[5] The data set did not include research expenditures made by the firm.

We do not measure the innovation activity of the firm directly rather include those variables which make up the 'knowledge production function' and the traditional production relationship. Intuition concerning human capital leads us to expect that the

---

[2] $j \in \left\{ \begin{array}{l} \text{København, Århus, Sønderjylland, Fyn, Viborg, Nordjylland, Vejle, Storstrøms, Frederiksborg,} \\ \text{Ringkøbing, Ribe, Roskilde, Vestsjælland} \end{array} \right\}.$

[3] $k \in \{\text{primary, processing, wholesale, retail, ingredients}\}$

[4] $l \in \{\text{fruits and vegetables, dairy, pork, poultry, meat, unspecialised}\}$

[5] $m \in \{\text{market, process, product}\}$

percentage of employees with a university education has a positive influence on value added. The percentage of employees outside Denmark is (a proxy for off-shoring), as a cost-lowering activity, is expected to increase value added. We expect that firms with some foreign direct investment will be more productive, and so exhibit higher value added than firms without foreign direct investment. We anticipate a cluster or agglomeration effect, which will be indicated by the location dummy variable, and following (Asheim and Coenen 2005) expect that the co-operative form will have a negative influence on value added. We expect retail and processing firms to show greater value-added than other firms. We have no particular expectations about different levels of value addition by separate commodity sectors. Our examination of co-ordination within the marketing chain centres on vertical integration, which is expected to be positively associated with value added. This effect may, however, be difficult to detect due to its association with other factors.

To test hypothesis 5 we propose a second model (model 2)

$$\Delta VA_{it,t-1} = f(\Delta N_{it,t-1}, \Delta emp1_{it,t-1}, \Delta emp2_{it,t-1}, \Delta dFDI_{it,t-1}, \Delta dO_{imt,t-1}, \Delta dCO_{it,t-1}, R_i, MS_i, FS_i,) \quad (2)$$

where Δ denotes the difference of (t)-(t-1) for each variable, with t = 2005 and t-1 = 2000.[6] Model 2 allows us to test for the variables' marginal contribution to growth in value added for each of the firms. In addition to the variables defined above, a selection of other variables was included in the models at various stages of specification. The variable $\Delta dCO_{it,t-i}$ drops out because there was no change in the number of firms of the cooperative type over the time period. Only the most statistically significant variables, as well as those important for testing the hypotheses listed in table 1, remained in the final models' specification.

4. Data and Estimation Procedure

[6] We did estimate a model with Δ*N* as a variable but it was insignificant. We have not included the results to save space.

The data used in this study are drawn from a survey of 444 Danish food industry (non-farm) firms.[7] The survey questionnaire addressed several elements of strategy and behaviour, and sought responses for 2005 (the current year) and 2000 (in retrospective). The interview-based survey was conducted between November 2005 and March 2006 and resulted in 131 valid responses (i.e. 30% response rate and a total sample of 262 observations). Descriptive statistics for the data set employed in the models are shown in table 2.

An interview-based survey of Danish food industry firms was conducted November -December 2005 and March - June 2006. Draft questionnaires were prepared, and repeatedly circulated to 15 relevant organisations and numerous researchers during the period May-October 2005. Six food industry firms were used to test the later drafts of the questionnaire through mock interviews.

The questionnaire comprised 5 sections. In the first, basic descriptive numeric information about firms was requested. The second section requested information about firms' strategic emphases and actions, the third addressed new product introduction and branding, the fourth firms' views on their competitive environment and the final section firms' views on actual events and possible future ones. Each interview took around 50 minutes and targeted the firms' marketing manager or person responsible for marketing and purchasing.

To identify target firms, a commercial database of firms' contact details was purchased, with stratified sampling based on size (across size groups but excluding firms with less than 5 employees) and sector (just 8 sectors included), and across three stages of the marketing chain (retail, wholesale and processing). This sampling procedure yielded 986 firms, in many cases being the total number of eligible firms, given the stratified sample. After eliminating defunct firms, incorrect contact details and subsidiaries of other

[7] Further details of the survey and data are available from the authors.

firms in the sample, telephone contacts were made with 444 firms. The survey procedure yielded 131 valid responses (a 30% response rate on 444 firms).

Econometric Model 1 - Bootstrapped Random-Effects Tobit Estimation

The dependent variable in model 1, VA_{it} - sales per employee, is censored at zero and thus violates a classical assumption of the linear regression model. Consequently, we use a censored regression (also known as Tobit) model (see Maddala, 1994; Greene, 2003). By choosing a random-effects (RE) approach the unobservable factors that differentiate the two cross-section units (2000, 2005) are assumed to be best characterized as randomly distributed variables. The cross-sectional units of our analysis - agri-food companies - vary quite a lot with respect to size, business focus and management style as well as strategy, risk aversion etc. By assuming that these differences are randomly distributed the general form of a RE model is given as

$$VA_{it}^{*} = \boldsymbol{\beta}'\mathbf{x}_{\mathbf{it}} + \mathbf{u}_{it} + \varepsilon_{it} \tag{3}$$

where VA^{*}_{it} denotes the latent variable (value added) for firm i at time t, $\mathbf{x}_{it}$ as a vector of the observable explanatory variables for firm i in period t, $\mathbf{u}_{it}$ as a vector capturing the effects of relevant unobservable variables and time-invariant factors characterizing firm i in period t, and ε_{it} as the stochastic disturbances of the model for firm i and period t. The two randomly distributed stochastic elements of [3] form the composite error term as

$$\xi_{it} = u_{it} + \varepsilon_{it} \tag{4}$$

which is assumed to be normally distributed with the following characteristics

$$\xi_{it} \sim N(0,\Sigma), \quad \Sigma = \begin{bmatrix} \sigma_{\mathrm{u}}^{2} & \sigma_{u}\sigma_{\varepsilon} \\ & \sigma_{\varepsilon}^{2} \end{bmatrix} \tag{5}$$

with σ denoting the standard deviation as usual. The dependent variable in [3] VA^*_{it} denotes the latent variable and VA_{it} as the proxy sales per employee for firm i at time t. Hence, we construct the left-censored variable VA_{it} used in estimation as

$$VA_{it} = \begin{cases} VA^*_{it} \text{ if } VA^*_{it} > 0 \\ L \text{ if } VA^*_{it} \leq 0 \end{cases} \tag{6}$$

where L denotes the lower censoring bound, and use a RE Tobit ML estimation procedure to obtain estimates of the parameters of the vector **β'** in (3) by maximizing the log-likelihood function

$$L(\boldsymbol{\beta}, \sigma) = \sum_{i=1}^{n} \left(\ln \frac{1}{\sigma} \phi \left(\frac{VA - \mathbf{x}\boldsymbol{\beta}}{\sigma} \right) + \ln \Phi \left(\frac{\mathbf{x}\boldsymbol{\beta} - \tau}{\sigma} \right) \right) \tag{7}$$

where ϕ and Φ are the probability density function and the cumulative density function, respectively, for the standard normal distribution, σ as the standard deviation for ξ, and τ as the threshold of censoring, here zero (see also Maddala, 1993). As is common econometric knowledge, robust inference requires that the distribution of the error terms follow a homoscedastic pattern. Hence, we use the heteroscedasticity-consistent covariance matrix estimator proposed by White (1980) and report the corrected standard errors and t-statistics.

To test for small-sample bias we further investigate the robustness of our estimates obtained by (1) by applying a simple stochastic re-sampling procedure based on bootstrapping techniques (see e.g. Efron 1979 or Efron/Tibshirani 1993). This seems to be necessary as our panel data sample consists of a (rather) limited number of observations and time units. If we suppose that $\hat{\Psi}_n$ is an estimator of the parameter vector ψ_n including all parameters obtained by estimating (1) based on our original sample of 229 observations $X = (x_1, ..., x_n)$, then we are able to approximate the statistical properties of $\hat{\Psi}_n$ by studying a sample of C = 1000 bootstrap estimators $\hat{\Psi}_n(c)_m, c = 1, ..., C$. These are obtained by re-sampling our 229 and 110 observations respectively – with replacement – from X and re-computing $\hat{\Psi}_n$ by using each generated sample. Finally the sampling characteristics of our vector of parameters is obtained from

$$\hat{\Psi} = \left[\hat{\Psi}_{(1)m}, \ldots, \hat{\Psi}_{(1000)m} \right] \quad (8)$$

As is extensively discussed by Horowitz (2001) and Efron and Tibshirani (1993), the bias of the bootstrap as an estimator of $\hat{\Psi}_n$, $B_{\tilde{\psi}} = \tilde{\Psi}_n - \hat{\Psi}_n$, is itself a feasible estimator of the bias of the asymptotic estimator of the true population parameter ψ_n.[8] This holds also for the standard deviation of the bootstrapped empirical distribution providing a natural estimator of the standard error for each initial parameter estimate. By using a bias corrected bootstrap we aim to reduce the likely small sample bias in the initial estimates. To examine the validity of the final model specifications we finally test for a joint insignificance of the parameters in (1) by a generalized likelihood ratio testing procedure. Further diagnosis tests were conducted to test for possible serial correlation in the panel data used (following basically Wooldridge, 2002) as well as non-normality of the residuals (see Jarque and Bera, 1980).

Model 2 - Censored Least Absolute Deviations Estimator (CLAD)

Both violations – heteroscedastic error terms and a non-normal error distribution – lead to highly inconsistent Tobit regression results. However, there are alternative estimation procedures which do not require the adherence to these error related assumptions. Consequently, we choose as a second modelling approach for the pooled sample the nonparametric censored least absolute deviations estimator (CLAD) developed by Powell (1984, 1986) as a generalization of the least absolute deviation estimation for non-negative dependent variables. Different contributions (Arabmazar and Schmidt, 1981;

[8] Hence the bias-corrected estimator of ψ_n can be computed by $\hat{\psi}_n - B_{\tilde{\psi}} = 2\hat{\psi} - \tilde{\psi}$.

Vijverberg, 1987; Rogers, 1993) show that the CLAD estimator is robust to heteroscedasticity and is consistent and asymptotically normal for a wide class of error distributions. The CLAD estimator is more robust to outliers, which arise frequently in the case of survey data due to erroneous responses. If we re-write equations 3 and 6 as follows:

$$VA_{it} = \max(x_{it}\beta' + \varepsilon_i, L) \quad (9)$$

The CLAD estimator of β minimizes the sum of absolute deviations, $|\varepsilon|$, assuming a conditional median restriction on the error term. The objective function can thus be specified as:

$$S_n(\beta) = \min\left\{\frac{1}{n}\sum_{i=1}^{n}\left|VA_i - \max\left\{L, \beta' x'_i\right\}\right|\right\} \quad (10)$$

whereby the estimator uses the observations so that the median is preserved by monotonic functions. Hence, the CLAD estimator involves the minimization of an objective function that is not necessarily convex in β. Thus, obtaining a global minimum of (10) implies the usage of numerical minimization algorithms based on the approximations of the first derivative.[9] The optimization procedure follows Jonston and DiNardo (1997) suggesting the following steps: (i) estimating the median regression using the total sample to determine the initial values for β, (ii) calculation of the values for the dependent variable VA'_{it} based on the estimated values for β by neglecting the observations for which VA'_{it} takes a negative value, and (iii) estimating the median regression based on the adjusted sample to obtain new estimates for β. Steps (ii) and (iii) form the iteration process to determine the final values for β. A crucial weakness of the CLAD estimator is its finite sample bias resulting in mean-biased results for relatively small samples (see Paarsch, 1984). Since the estimator's asymptotic variance-covariance matrix involves the

[9] The iterative linear programming algorithm (ILPA) contained in STATA is used here.

estimation of the density function of the error term, we use bootstrap estimates of the standard errors with about 1000 draws following the re/sampling procedure outlined above.

Model 3 - Nonparametric Quantile Regression

Model 3 is based on the differences of the variables' values between the two time periods. Hence, the dependent variable ΔVA_{it} no longer has a censored distribution. However, due to the small sample size as well as the survey related frequency of outliers, we use again a nonparametric quantile regression procedure based on a least absolute deviation estimation (LAD). Equations (2) and (3) are estimated by following the procedure outlined in the previous section. Hence, (9) is adjusted to account for an uncensored dependent variable

$$\Delta VA_{it,t-1} = \max(\Delta x_{it,t-1}\beta' + \varepsilon_i) \tag{11}$$

The LAD estimator of β minimizes again the sum of absolute deviations, $|\varepsilon|$, assuming a conditional median restriction on the error term. The objective function is now

$$S_n(\beta) = \min\left\{\frac{1}{n}\sum_{i=1}^{n}\left|\Delta VA_{it,t-1} - \max\left\{L, \beta'\Delta x'_{it,t-1}\right\}\right|\right\} \tag{12}$$

Obtaining a global minimum of (12) implies again the usage of numerical minimization algorithms based on the approximations of the first derivative. We finally also bootstrap the quartile regression models for the differenced sample following the re-sampling procedure outlined above and obtaining the sampling characteristics of our vector of parameters as described by (9) after re-sampling the 110 observations with replacement.

5. Estimation Results

Tables 3, 4 and 5 summarize the results for the estimated censored regression models. The diagnostic tests conducted for the Tobit regression indicate no serial correlation, no rejection of the normality hypothesis with respect to the residual, and a rejection of the hypothesis of no joint parameter significance at the 5% level of test (see LR chi-squared value). The overall model significance is satisfactory (see adjusted McFadden's R^2, McKelvey-Zavonias R^2, and the Akaike information criteria value AIC), all given the modest sample size and the use of survey data. This conclusion is backed up by the bootstrapped bias-corrected standard errors confirming the robustness of the various estimations.

Overall, there is strong agreement between the results generated in models 1 and 2 in that the parameters estimated have in general, the same signs and pattern of significance. In table 3 we see both models 1 and 2 report that the number of new products introduced into the market place by a firm had no impact on the value added. Thus we find no relationship between the innovative activity of a firm, as measured by the number of new products introduced, and the size of the firm. However, both models (table 4)[10] deliver significant and positive parameter estimates for the influence of FDI on value added. Both models identify the wholesale stage of the chain and the dairy sector as having significant and positive influences on value added. Both models deliver a highly significant, and positive, parameter estimate for the influence of staff education levels. Neither model identifies firms' dominant orientation (product or market) as a significant influence on value added, nor the percentage of employees located outside Denmark. The two models disagree on the influence of regional location, with model 1 delivering a strongly positive influence of location in Århus. The role of sector is also ambiguous, with model 1's result indicating a significant negative influence of "unspecialised" firms and model 2 indicating the opposite.

The results for model 3 (two specifications, see table 5) generally support those of models 1 and 2.[11] FDI is a significant positive influence on growth in value added, as is

[10] Table 4 reports results for equation (1) after the variable for the number of new products, *N* has been excluded.

[11] The non-significance of new product introduction in value addition (from models 1 and 2) was also found in both specifications of model 3: neither the change in new product introduction nor the average for the two

firms' operation at the wholesale stage of the chain. Both specifications of model 3 indicate a negative influence on growth in value added of the number of employees outside Denmark. Although both specifications of model 3 deliver similar R^2 values, the second specification (using average number of new products rather than its first difference) delivers two more significant explanatory variables: a product orientation of the firm (a positive influence on growth in value added) and a market orientation (a negative influence). Neither of the two specifications deliver a significant parameter estimate for location in Århus, although in both cases the t-value indicates that the (positive) estimate is close to being significant at the 5% level of test.

6. Discussion of Results

Firms that introduced new products into the market did not have a significantly higher value added then those that did not introduce new products. Thus we cannot reject our first hypothesis. (This result did not change when we looked at the growth in value added by firms.) There are at least three ways one can interprete this result. First, new product innovation is not always profitable, especially in the short run. Firms that have successful products in the market try to maintain the market for these products through advertising and driving down production and marketing costs. In such cases new products may be associated with higher costs of production at least in the short run. Second, food firms may be more likely to innovate through process innovation and thus lower the costs of production. Our data does not capture process innovation. Finally, innovation may occur through strategic alliances, such as with foreign direct investment. This may open up foreign markets allowing firms to drive down costs. The nature of the connection between new product introductions and other activities of the firms is the subject of on-going research, but at the current study cannot associate it strongly with value addition.

---

years is a significant driver of growth in value addition. We did not include a table showing this result in order to conserve on space.

There is an ongoing debate regarding the relationship between the size of firms and their innovativeness. In the food sector many of the new innovations are not as expensive to adopt as they are in very large capital intensive manufacturing industries, like the aerospace sector. Perhaps capital constraints are more important in determining which firms innovate, however we did not have data on the financial status of the firms.

The strong positive influence of staff education levels on value addition indicates an important role for high quality human capital. This is highly consistent with the negative influence of outsourced labour, and indicates a commitment to "knowledge-based" industry. It also appears to be consistent with regional networking amongst firms and with our inability to reject our second hypothesis: the insignificance of dominant orientation. Our results indicate that instead of such orientations, Danish firms employ sector (i.e. dairy), stage (i.e. wholesale) and educated employees to deliver value added. This is, of course, not to say that Danish firms do not have a dominant orientation: rather we claim that it is not an important determinant of value addition across a range of firms. This interpretation is reinforced by the model of growth in value added, where dominant orientations do play a role, but in this case they explain changes within a single firm, rather than between firms.

The lack of significance of the co-operative form of business organization as an explanation of value added is expected to some extent. However, we exercise caution in interpreting this result because the dummy variable used may be masking other effects. In particular, many of the processing firms in the sample are co-operatives and so the impact of both dummies may be diluted by co-occurrence.

We are able to reject the third hypothesis that regional innovation systems do not have an impact on a firm's performance. Asheim and Coenen (2005) examined the functional food 'cluster' in Scamia and found that the location of a university and research organizations provided the seedbed for innovation. Braadland (2003) and Avermaete and

Viaenne (2000) identified regional networks as sources of innovation in agro-industry, the bulk of it being organisational or involving the strengthening of existing brands and market positions. A major advantage of Århus is the University of Århus and the numerous food industry research facilities that have been built by both the public and private sector in the area. It is the spillovers between research individuals together with presence of university research that lead to new product and process innovation that increases the productivity of firms. These interactions support the successful food processing firms located in the Århus region. Our results support such an explanation of value addition, specifically by identifying Århus as a centre for innovative food networks. In addition to being an innovation centre, Århus' geographic location favours relatively lower cost access to export markets and the presence of an agro-industrial cluster (and the majority of Danish livestock production) is likely to contribute to superior added value.

The positive influence of FDI on value addition implies we can reject our fourth hypothesis. Thus we cannot rule out the importance that FDI has in the Danish food sector. Aitken and Harrison (1999) have outlined a number of targets of FDI in the manufacturing sector in Venezuela, including access to markets, general investment considerations and the introduction of specific skills, experience and capital. (Surprisingly little empirical research has been reported on how FDI impacts the economic performance of firms in the food sector.) Each one of these explanations appears to have good application to the data used here, and reinforces the impression gained from the strong influence of FDI in the growth of value added (model 3). This is a particularly important result given the pressure for Danish food companies to globalize because of reduced tariff and non-tariff barriers.

Our final hypothesis is built on the relationship between the growth of a firm (as measured by change in value added) and the number of new products introduced to the market. We found no relationship between innovation and the growth in company size.

This was an expected result. A lot of product and process innovation is done in smaller firms. Small firms without capital limitations are often more flexible and adaptable to new ideas. We point out that the inclusion of average new product introduction levels in model 3 are associated with significance of dominant orientations, which do not feature strongly elsewhere in the results.

What then does explain the growth of firm size? We found two variables to be significant, FDI and if the firm is wholesale marketing stage of the industry. The most important of these is FDI. Business networking is extremely important in a globalizing economy; however it is also very expensive in terms of management time. One way to achieve the benefits business networks is through FDI. This result is consistent with the observation that more a liberalized trading environment provides potential benefits to those firms that can increase exports or imports through strategic alliances.

The significance of the "wholesale" stage of the chain in value addition is likely to be associated with its rapid consolidation since 1995 (see Baker, 2003). Consolidation, *ceteris paribus*, is likely to raise the sales per employee for remaining firms. The dynamic nature of this result is further supported by its strong significance in model 3. In practice, value added is strongly contested between retailers and wholesalers, both of which have experienced consolidation since 1995, although it has been most pronounced at wholesale level (Baker, 2003). A similar within- *versus* between-firms argument explains the lack of significance of university education in model 3: although value added has increased for most firms between 2000 and 2005, the numbers of employees with a university education at any one firm probably has not.

The non-significance of several variables that is not reported in the results are worthy of note. First, export orientation of firms was dropped from the model for this reason. This unexpected result indicates that firms serving export markets face fewer opportunities for value addition than those concerned with domestic markets. More importantly, the result provides a clue about the purpose of FDI in the Danish food industry: it is unlikely to be motivated by access to EU and foreign markets, but rather addresses the Danish market.

Although the survey provided data on competitiveness of markets (for products and inputs), these also dropped out during specification. Value addition is likely to be influenced by the structure of markets, but it appears that the effects have been captured in the models by variables such as sector and stage of chain. This result requires examination in future work.

7. Conclusions

The contribution of this paper is that it brings together a model of innovation using a 'knowledge production function' and applies it to a set of data from the Danish food sector. This unique and new set of data requires specific econometric techniques due to a truncation of the distribution of the main dependent variable (a proxy for value addition) and the distribution of both the explanatory variables and the models' error terms. Overall, model performance is strong and consistent and several conclusions can be drawn. The model of growth in value added offers particular insights into within-firm emphasis and strategy, and when seen in this light, its results support those of the pooled data that focus on between-firm comparisons.

We cannot reject the null hypothesis of no influence of dominant orientation on value added. Rather, firms' focus on human capital, stage and commodity sector better explains their value addition. We can reject the hypothesis that regional networks have no influence on value added. Location in Århus, emphasis on human capital and the negative influence of outsourcing on value added all provide supporting evidence. We reject the hypothesis of no influence of FDI, and moreover propose that the FDI has targeted the domestic Danish market as a source of value added. Evidence on the importance of firms' dominant orientation is mixed at best, and we cannot reject the null hypothesis of no influence on value added.

References

Aitken B and K. Harrison (1999) "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela" *American Economic Review,* 89(3): 605-618.

Asheim B.T. and L. Coenen (2005) "Knowledge bases and regional innovation systems: Comparing Nordic clusters" *Research Policy,* 34(8): 1173-1190.

Avermaete, T. and J. Viaene (2002): "On Innovation and Meeting Regulations: the case of the Belgian Food Industry" Paper presented at the DRUID conference, Copenhagen and Elsinore.

Baker, D., K. Baltzer and A. Møller (2006) "The Branding Behavior of Danish Food Industry Firms" *Agribusiness* 22(1): 31-50.

Baker, D. (2003) "The Danish food marketing chain: developments and policy choices" Danish Institute of Food Economics, Rapport nr. 154.

Braadland, T. (2000): "Innovation in the Norwegian food system" STEP programme report, Norwegian Research Council.

Bode, E (2004) "The spatial pattern of localized R&D spillovers: an empirical investigation for Germany" *Journal of Economic Geography* 4: 43-64.

Bosworth, D. and J. Loundes (2002) "The Dynamic Performance of Australian Enterprises" Melbourne Institute Working Paper No. 3/02, Melbourne.

Breschi, S, and F. Lisson (2001) "Knowledge Spillovers and Local Innovation Systems: A Critical Survey" *Industrial and Corporate Change,* 10: 975-1005.

Brester, G.W. (1999) "Vertical integration of production agriculture into value-added niche markets: the case of Wheat Montana Farms and Bakery" *Review of Agricultural Economics* 21 (1): 276-285.

Brester, G. S. and T. C. Schroeder (1995) "The Impacts of Brand and Generic Advertising in Meat Demand" *American Journal of Agricultural Economics* 77 (3): 969-979.

Brown, W.M. (1995) "Competitiveness in a Resource Dependent Region: the case of food processing in Canada's maritime provinces" *Canadian Journal of Regional Science* 23 (3): 410-425.

Buhr, B.L (2004) "Case studies of direct marketing value-added pork products in a commodity market" *Review of Agricultural Economics* 26 (2): 266-279.

Coltrain, D., D. Barton and M. Boland (2000) "Value added: opportunities and strategies" Working paper of the Arthur Capper Co-operative Center, Kansas State University.

Christy, R.D. and J. M. Connor (1989) "Economic Forces influencing value-added food industries: implications for Southern agriculture" *Southern Journal of Agricultural Economics* 21 (1): 13-22.

Feldman, M.P. (1999) “The new economics of innovation, spillovers and agglomeration: a review of empirical studies” *Economics of Innovation and New Technology* 8:5-25.

Gould, B.W and K.A. Carlson (1998) “Strategic management objectives of small manufacturers: a case study of the cheese industry” *Review of Agricultural Economics* 20 (2): 612-630.

Greene, W.H. (2003). Econometric Analysis 5th ed. Prentice Hall, Upper Saddle River, New Jersey, USA.

Griliches, Z. (1979) “Issues in assessing the contribution of R&D to productivity growth” *Bell Journal of Economics* 10:92-1116.

Heshmati A. and K. Pietola (2004), “The Relationship between Corporate Competitiveness Strategy, Innovation, Increased Efficiency, Productivity Growth and Outsourcing”, mimeo, College of Engineering, Seoul National University, Seoul.

Jungnickel, R, L. Bellmann and P. Ellguth (2004) “Productivity in Foreign-owned Firms in Eastern Germany” New EIBA papers series, Brussels.

Lawrence, J.D., V.J. Rhodes, G.A. Grimes and M.L. Hayenga (1997). “Vertical Coordination in the U.S. Pork Industry: Status, Motivations, and Expectations” *Agribusiness* 13 (1): 21-31.

Maddala, G.S. (1983). Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press, Cambridge UK.

Rogers, T.R. (2001) “Structural Change in the U.S. Food Manufacturing, 1958-1997” *Agribusiness*, 17 (1): 3-32.

Sonobe, T. , D. Hu and K. Otsuka (2004) “From Inferior to Superior Products: an enquiry into the Wenzhou model of industrial development in China” Working paper, Foundation of Advanced Studies on International Development, Tokyo.

Traill, W.B., and M. Meulenberg. (2002) “Innovation in the Food Industry” *Agribusiness* 18 (1): 1-22.

Walkenhorst, P. (2001). "Determinants of Foreign Direct Investment in the Food Industry: the case of Poland" *Agribusiness* 17 (3): 383-395.

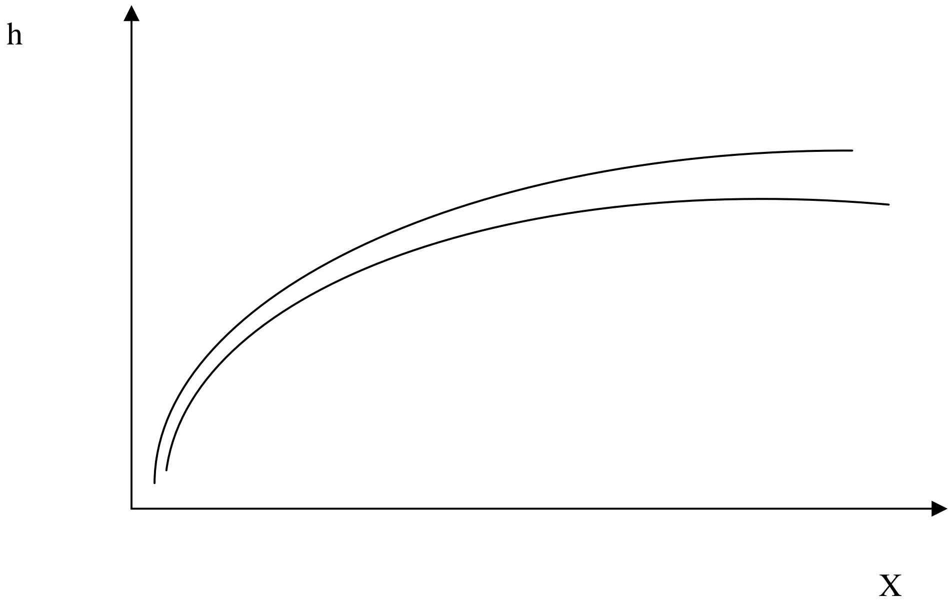

Figure 1: Effect of change in innovation activity on the firm profit

Table 1. Hypotheses tested

	Hypothesis	Reference
1	There is no relationship between company size and innovation	Traill and Muelenberg
2	Successful firms do not have a single dominant orientation to product, process, nor market	Traill and Muelenberg
3	Regional innovation systems do not have an impact on a firm's performance	Asheim and Coenen
4	Foreign Direct Investment has as no influence on a firm's performance	Aitken and Harrison
5	In product and market oriented firms, new product development does not drive firm growth.	Traill and Muelenberg

Table 2 – Descriptive Statistics

Variable	*Mean*	*Stdev*	*Min*	*Max*
sales per employee (mill DKK)	4.16	10.67	0.01	133.33
number of new products introduced (n)	93.15	417.86	0	5000
percentage of employees outside Denmark (%)	2.88	11.36	0	76
percentage of employees with university degree (%)	5.67	14.66	0	100
foreign direct investment in the firm (dummy: 1 - yes, 0 - no)	0.12	0.33	0	1
regional location of the firm (dummy: 1 - yes, 0 - no)				
- københavn (12 obs)	0.16	0.37	0	1
- århus (24 obs)	0.09	0.29	0	1
- sønderjylland (22 obs)	0.08	0.28	0	1
- fyn (36 obs)	0.14	0.34	0	1
- viborg (16 obs)	0.06	0.24	0	1
- nordjylland (26 obs)	0.10	0.29	0	1
- vejle (32 obs)	0.12	0.33	0	1
- storstrøms (6 obs)	0.02	0.15	0	1
- frederiksborg (8 obs)	0.03	0.17	0	1
- ringkøbing (6 obs)	0.02	0.15	0	1
- ribe (6 obs)	0.02	0.14	0	1
- roskilde (10 obs)	0.04	0.19	0	1
- vestsjælland (8 obs)	0.03	0.17	0	1
ownership of/by the firm* (dummy: 1 - yes, 0 - no)				
- owned by a farmer/farmer cooperative (22 obs)	0.08	0.28	0	1
- owned by a non-food firm (41 obs)	0.16	0.37	0	1
- ownership of a retail outlet (5 obs)	0.02	0.14	0	1
- owned by distributer/wholesaler (6 obs)	0.04	0.19	0	1
- ownership of a distributer/wholesaler (10 obs)	0.06	0.25	0	1
- ownership of a processer (11 obs)	0.04	0.20	0	1
- owned by services (6 obs)	0.02	0.15	0	1
- owned by ingredients (1 obn)	0.01	0.06	0	1
marketing stage of the firm (dummy: 1 - yes, 0 - no)				
- primary (8 obs)	0.03	0.17	0	1
- processing (108 obs)	0.41	0.49	0	1
- wholsale (78 obs)	0.29	0.46	0	1
- retail (54 obs)	0.21	0.41	0	1
- ingredients (10 obs)	0.04	0.19	0	1
sector of the firm (dummy: 1 - yes, 0 - no)				
- feeding (2 obs)	0.01	0.09	0	1
- fruits & vegetables (24 obs)	0.09	0.29	0	1
- dairy (46 obs)	0.18	0.38	0	1
- beef (10 obs)	0.04	0.19	0	1
- pork (6 obs)	0.02	0.15	0	1
- poultry (12 obs)	0.05	0.21	0	1
- meat (50 obs)	0.19	0.39	0	1
- unspecified (112 obs)	0.43	0.49	0	1
dominant orientation of the firm (dummy: 1 – yes, 0 – no)				
- market (85 obs)	0.32	0.47	0	1
- process (15 obs)	0.06	0.23	0	1
- product (64 obs)	0.24	0.43	0	1

*"ownership" refers to ownership of firms (or by firms) outside the stage of the marketing chain occupied by the firm.

Table 3: Results – Models 1 and 2 including 'number of products'

(n = 229) Independents	**Model 1** **Bootstrapped Heteroscedasticity Corrected Random-Effects Tobit Regression** (BHC Tobit)			**Model 2** **Cumulative Least Absolute Difference Quantile Regression** (CLAD Quantile)		
	Dependent: sales per employee (VA)					
	coefficient[1]	t-value	standard error 95% confidence interval[2]	coefficient[1]	t-value	standard error 95% confidence interval[2]
number of products introduced (np)	5.22-05	0.17	[5.25e-03; 0.002]	-7.69e-05	-0.42	[-4.26e-04; 1.96e-04]
foreign direct investment in the firm (FDI)	3.55***	2.52	[0.29; 5.08]	0.40*	1.62	[-0.15; 5.02]
regional location of the firm: Århus ($R_Å$)	12.08***	7.78	[0.78; 3.27]	-0.57	-1.55	[-1.18; 0.37]
ownership of the firm: farmer cooperative (CO)	-9.01***	-5.52	[0.95; 4.15]	0.55	1.01	[-0.27; 1.58]
marketing stage of the firm: wholesale (MS_{ws})	12.23***	9.77	[0.69; 2.60]	1.52***	2.54	[0.55; 2.87]
marketing stage of the firm: retail (MS_{ret})	4.08***	3.39	[0.71; 2.95]	-0.21	-0.61	[-0.94; 0.51]
sector of the firm: dairy (FS_d)	8.81***	6.21	[0.87; 3.31]	1.27***	2.33	[0.32; 2.42]
sector of the firm: unspecified (FS_{un})	-3.89***	-3.86	[0.66; 2.57]	0.54*	1.58	[0.04; 1.23]
percentage of employees with university degree (emp1)	0.05***	3.01	[0.02; 0.07]	0.03***	4.03	[-0.02; 0.34]
percentage of employees outside Denmark (emp2)	0.09***	2.60	[0.02; 0.10]	2.40e-05	0.12	[-0.03; 0.03]
dominant orientation of the firm: product (O_p)	1.98**	2.07	[0.58; 2.23]	-0.03	-0.09	[-0.51; 0.59]
dominant orientation of the firm: market (O_m)	2.99**	2.59	[0.53; 2.21]	-0.29	-1.21	[-0.77; 0.31]
constant	-3.25***	-3.82	[0.57; 2.02]	1.34***	4.49	[0.78; 1.89]
σ_u	10.44***	23.07	[0.13; 0.67]	Adj. McFadden's R2	0.0723	
σ_e	4.20***	16.59	[0.13; 0.38]	McKelvey and Zavonia's R2	0.5455	
ρ	0.86	LL	-791.323	Bootstrap Replications	1000	
Adj. McFadden's R2	0.0932	McKelvey and Zavonia's R2	0.3764			
Wald chi2(11)	475.89***	AIC	3.3244			
Bootstrap Replications	1000					

1: * - 10%-, ** - 5%-, *** - 1%-level of significance; 2: heteroscedasticity- and bias-corrected standard errors.

Table 4: Results – Models 1 and 2 excluding 'number of products'

(n = 229)	**Model 1** **Bootstrapped Heteroscedasticity Corrected Random-Effects Tobit Regression** (BHC Tobit)			**Model 2** **Cumulative Least Absolute Difference Quantile Regression** (CLAD Quantile)		
	Dependent: sales per employee (VA)					
Independents	coefficient[1]	t-value	standard error 95% confidence interval[2]	coefficient[1]	t-value	standard error 95% confidence interval[2]
foreign direct investment in the firm (FDI)	3.57***	2.56	[0.29; 5.08]	0.40*	1.62	[-0.15; 5.02]
regional location of the firm: Århus ($R_{Å}$)	12.08***	7.78	[0.78; 3.27]	-0.57	-1.55	[-1.18; 0.37]
ownership of the firm: farmer cooperative (CO)	-9.02***	-5.53	[0.95; 4.15]	0.55	1.01	[-0.27; 1.58]
marketing stage of the firm: wholesale (MS_{ws})	12.23***	9.77	[0.69; 2.60]	1.52***	2.54	[0.55; 2.87]
marketing stage of the firm: retail (MS_{ret})	4.08***	3.39	[0.71; 2.95]	-0.21	-0.61	[-0.94; 0.51]
sector of the firm: dairy (FS_d)	8.81***	6.21	[0.87; 3.31]	1.27***	2.33	[0.32; 2.42]
sector of the firm: unspecified (FS_{un})	-3.89***	-3.86	[0.66; 2.57]	0.54*	1.58	[0.04; 1.23]
percentage of employees with university degree (emp1)	0.08***	3.17	[0.02; 0.07]	0.03***	4.03	[-0.02; 0.34]
percentage of employees outside Denmark (emp2)	0.09***	2.60	[0.02; 0.10]	2.40e-05	0.12	[-0.03; 0.03]
dominant orientation of the firm: product (O_p)	1.98**	2.07	[0.58; 2.23]	-0.03	-0.09	[-0.51; 0.59]
dominant orientation of the firm: market (O_m)	2.99**	2.59	[0.53; 2.21]	-0.29	-1.21	[-0.77; 0.31]
constant	-3.25***	-3.82	[0.57; 2.02]	1.34***	4.49	[0.78; 1.89]
σ_u	10.44***	23.07	[0.13; 0.67]	Adj. McFadden's R2	0.0723	
σ_e	4.20***	16.59	[0.13; 0.38]	McKelvey and Zavonia's R2	0.5455	
ρ	0.86	LL	-794.516	Bootstrap Replications	1000	
Adj. McFadden's R2	0.0932	McKelvey and Zavonia's R2	0.3764			
Wald chi2(11)	475.89***	AIC	3.3244			
Bootstrap Replications	1000					

1: * - 10%-, ** - 5%-, *** - 1%-level of significance; 2: heteroscedasticity- and bias-corrected standard errors.

Table 5 Results – Model 3 excluding 'number of products'

(n = 110) Independents (difference 2000 to 2005)	**Model 3** **Least Absolute Difference Quantile Regressions** (LAD Quantile)		
	Dependent: difference in sales per employee ($\Delta VA_{it,t-1}$)		
	coefficient[1]	t-value	standard error 95% confidence interval[2]
foreign direct investment in the firm ($\Delta FDI_{it,t-1}$)	0.61***	7.46	[0.11; 0.20]
regional location of the firm: Århus ($R_{Åit,t-1}$)	0.13*	1.67	[0.06; 0.13]
marketing stage of the firm: wholesale ($MS_{wsit,t-1}$)	0.35***	5.15	[0.08; 0.13]
marketing stage of the firm: retail ($MS_{retit,t-1}$)	0.03	0.99	[0.08; 0.12]
sector of the firm: dairy ($FS_{dit,t-1}$)	-0.04	-0.53	[0.07; 0.16]
sector of the firm: unspecified ($FS_{un\ it,t-1}$)	0.04	0.57	[0.09; 0.16]
percentage of employees with university degree ($\Delta emp_{\ it,t-1}$)	2.28e-03	0.76	[1.32e-03; 6.36e-03]
percentage of employees outside Denmark ($\Delta emp2_{it,t-1}$)	-7.78e-03**	-2.88	[1.14e-03; 7.53e-03]
dominant orientation of the firm: product ($\Delta O_{pit,t-1}$)	2.27e-03	0.01	[-0.21; 0.22]
dominant orientation of the firm: market ($\Delta O_{mit,t-1}$)	-0.08	0.15	[0.14; 0.20]
constant	-2.27e-03	-0.05	[-0.03; 0.08]
Adj. McFadden's R2	0.0375	Bootstrap Replications	1000
McKelvey and Zavonia's R2	0.4854		

1: * - 10%-, ** - 5%-, *** - 1%-level of significance; 2: heteroscedasticity- and bias-corrected standard errors.