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An Empirical Analysis of Access to Finance for Danish Farms: Understanding Investment and the Absence of Risk Management

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Section 1 - Introduction

Investments have often been highlighted as playing a central role in economic growth (Hart & Lence, 2004). That is why a fundamental question in the financial literature is to what extent funds are allocated to the right investment projects. Financial constraints have been a central focus in the corporate finance literature because of, among other things, the possible public policy implications for mitigation of misallocation of investments, specifically underinvestment (Hubbard, 1998). In the development and agricultural economics literature, the existence and importance of financial constraints have been examined as well (Hubbard & Kashyap, 1992; Benjamin & Phimister, 1997; Petrick, 2005). Since the late 1980s, a large number of empirical studies have addressed the question of financial constraints using a variety of research strategies. Many models are based on Tobin's q as an investment opportunity proxy to test whether investment opportunities are exercised according to assumptions of the frictionless market or not. Tobin's q is essentially a measure of the market value to the book value. The use of q -based models is widespread in the corporate finance and investment literature. (Fazzari, Hubbard, & Petersen, 1988) (FHP); (Kaplan & Zingales, 1997) (KZ); (FHP, 2000); (KZ, 2000); (Reynolds, Bhabra, & Boyle, 2009). The majority of studies in the field address the case of binding financial constraints versus unbinding financial constraints as discontinuous measure, where Musso & Schiavo (2008) suggest a continuous measure capable of capturing different degrees of constraints over time.

Instead of providing further evidence of financial constraints, we wish to measure the development of financial frictions over time. We develop a non-parametric measure suited to track the development in access to finance over time. We use the "access to finance" concept to cover a broader spectrum of financial "states of nature" than financial constraints. Access to finance is also used in more qualitative surveys like the European Central Bank's surveys (ECB 2009) on access to finance of small and medium-sized enterprises in the Euro area. Our measure is a quantitative complement to this kind of qualitative survey. This is interesting because the opposite aspect of strictly binding financial constraints is of importance in Danish agriculture, that is, the relative unconstrainedness of the sector and individual firms. Whilst other studies measure the costs of being constrained, we are interested in the investments and risk management decisions being made when firms are (relatively) unconstrained. The overall measure is labelled the Debt Development index (DDi) which can be decomposed into four components. Investments in Danish agriculture have been larger in the past decades and they have, to a large and increasing extent, been financed by external funds. This suggests that the ease of access to external financial funds has been increasing over a long period of time. Due to the global financial crisis, it is expected that the ease of access to external funds will deteriorate for Danish agriculture. The shift from a period of relative ease of access to external funds to a period with harder access to external funds has not been a central focus in any studies to our knowledge. The shift may, however, be a likely development in the post crisis period.

The objective of the paper is, 1) to propose an alternative method to measure access to finance, 2) to measure the development in access to finance for Danish agriculture over time, and to test whether access to finance has become easier, as suggested above, 3) to propose that easy access to finance in the past decades has diminished the need for risk management in Danish agriculture.

The outline of the paper is as follows: Section 2 describes the relation between investment, risk management and finance and why it is of interest to determine the development of access to finance. Section 3 explains the method. Section 4 describes our data. Section 5 presents the empirical results. Section 6 presents our concluding remarks.

Section 2 – Investment, Risk Management and Finance in Danish agriculture

Farm investments are special in relation to finance, because return on investments can occur as operating profits as well as capital gains. The dual role of land as a production base and as collateral can cause profitability to be endogenous, in the sense that profitability rests on continuous capital gains. There are (at least) two distinct categories of investment goods for agriculture; land and depreciable assets. Land is not reproducible, which means that the supply is inelastic. Leveraged bidding for this good drives up the price, which increases collateral, which in turn increases lending, which then increases demand and so forth. (Kiyotaki & Moore, 1997). Other investment goods, such as buildings and machinery are reproducible; this means that the price elasticity of supply is lower. As in Kiyotaki and Moore (1997), land plays a central role as a collateral asset in Danish agriculture. Lenders and borrowers are strategic complements in the sense that the decision to lend affects the demand for land and the decision to invest affects the decision to lend. This is true for investment lending both in a boom and bust period of the credit cycle. In the bust, lenders are unwilling to lend, which makes the borrower unwilling and/or unable to invest, because of an expected fall in asset price or inability to finance, which makes the demand decline and the asset price fall. The dynamics of a credit cycle boom seem to be satisfied in the case of Danish agriculture during the 1990s and 2000s. Decreasing interest rates and new credit products introducing variable rate mortgages and interest only loans may have given a liquidity shock that (along with environmental regulation) stimulated demand for agricultural assets. The higher asset demand in turn increased the net worth of farmers and increased their debt capacity, stimulating demand for agricultural assets, which in turn increased the net worth of farmers and increased their debt capacity and so forth.

Structural changes in Danish agriculture have affected the way risk is managed during the past forty years. Danish agriculture was diversified on the farm level up to the 1970s when specialisation in pigs, dairy or cash crops began to dominate the sector, to the extent that hardly any diversified farms are left today (Hansen, 2010). However, diversification took another form in the 2000s, when some farmers increased their off-farm investments, often by leveraging their existing farm asset portfolio. While there are a lot of productivity gains from the specialisation in recent decades, there is also an increase in risk exposure. Paradoxically, the risk exposure was further amplified due to an increase in financial leverage. One reason for this development is likely due to the development of the EU (EC) Common Agricultural Policy (CAP), which stabilised prices and generally converted business risk to policy risk during the 1980s and 1990s. As we will show, access to finance increased during the 2000s, which may be another explanatory factor for the absence of risk management in Denmark.

A firm's internally generated cash flow is a key concern for risk management activity. A major rationale for hedging has been the increased ability to raise external capital in the form of debt due to more stable cash flows and lower default risk (Froot, Scharfstein, & Stein, 1993). Thus, the rationale for hedging as a risk management tool is that access to finance will increase and investment plans will be executed easier and thus the ability to reach strategic goals will improve. The results of Reynolds, Bhabra and Boyle (2009) suggest that smaller firms, which presumably face steep costs of accessing external funds, are hedging with derivatives to smooth cash flows to reduce default risk and in this way improve the availability of external funds for investment. Contracting is somewhat asymmetric in animal production in Denmark. Farmer's hedge inputs such as feedstuffs etc. but they do not hedge outputs, such as milk and meat. The expected behaviour of a risk averse farmer with weak positive correlation between input and output would be to hedge symmetrically or not to hedge at all (Pennings & Wansink, 2004). Given a high debt level in the sector, it can be assumed that hedging is a prerequisite for access to finance (Froot, Scharfstein, & Stein, 1993). However,

this has not been the case. The relatively easy access to finance may in fact have diminished the need for risk management and prevented risk management institutions from developing. If access to finance becomes harder in the future, it may be important to understand the background for the absence of an institutional framework and to stimulate the development of risk management institutions making it possible to handle risk at the farm level. We flip the argument of (Froot, Scharfstein, & Stein, 1993) and suggest that, in the presence of abundant access to external finance, there is little reason for the hedging of cash flows, whilst no financial institutions (products and markets), which have the ability to transfer risk between hedgers and other market participants, will develop, simply because of the lack of demand. Farmers may have been asking the rhetorical question: Why hedge, if you can borrow? Implying that a long period of relatively easy access to finance may devalue traditional risk management and explain why risk management institutions are not well developed in Danish agriculture. The recent development in agricultural finance and the overall credit supply calls for the institutional development of the area.

Blancard *et al.* (2006) state that “farmers’ operations and investments heavily depend on internal financing,” which is consistent with the EU average self-financing rate. In 2007, the Farm Accountancy Data Network (2010) (FADN) data show debt-to-asset ratios of 14.6 percent for the UK consistent with Barry and Robison (2001), while the EU level average was 26.1 percent. The average Danish debt-to-asset ratio, however, was significantly higher at 64.5 percent, which is close to the level of non-agricultural firms in Denmark.

Figure 1. Self-financing rate

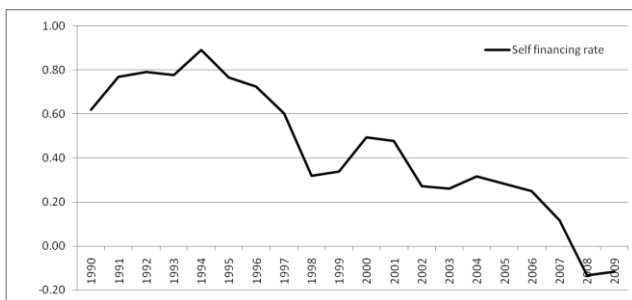
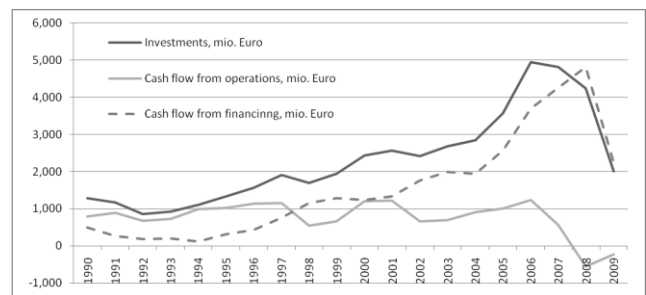


Figure 2. Cash Flows



Source: Figure 1 and 2 Statistics Denmark (2010)

Figure 1 and 2 illustrate the sector level self-financing rate in Denmark and the sector level investment, operations and external finance cash flows. The figures indicated an relatively unconstrained access to external finance.

Many characteristics of Danish agricultural finance are similar to those of agricultural finance in other developed economies. Agriculture is heavily reliant on non-depreciable assets, such as farmland, in which much of the economic return occurs as capital gains or losses. It has been shown (Barry & Robison, 1986) that the debt-carrying capacity of non-depreciable assets is considerably lower than that of depreciable assets under traditional loan repayment arrangements. It is, therefore, logical to expect lower aggregate debt-to-asset ratios for the farm sector (Barry & Robison, 2001). Danish agriculture does not, however, exhibit significantly lower debt-carrying capacity than other sectors. Following Terra (2003), there are two alternative explanations for the different indebtedness levels of one group compared to another. Higher indebtedness in Danish agriculture may be a pure financial decision, or an indication of easier access to finance in Denmark compared to other countries. If the first is true, Danish farmers simply choose to employ more external capital than

their colleagues around the world. If the latter is true, farmers around the world are generally more credit constrained than Danish farmers. The fact that Blancard *et al.* (2006) and (Barry & Robison, 2001), among others, indicate financial constraints among farmers around the world and the fact that Danish farmers have significantly more debt than farmers in other countries, suggest that the latter is the case and that Danish farmers have had relatively easier access to finance.

Section 3 – Method

A Data Envelopment Analysis (DEA) model is applied to measure the development of the frontier debt capacity and the credit capacity utilisation. This is a measure of the amount of debt on a single farm compared to the maximum debt of comparable farms, taken as a proxy for the maximum debt capacity. Data Envelopment Analysis is primarily used and developed in production economic settings. In the following, the production economic terminology is kept to introduce the DEA framework in the original terminology. Later, the method is explained in the debt capacity and debt utilisation application.

Data Envelopment Analysis

The non-parametric frontier method Data Envelopment Analysis (DEA) was originally proposed by Charnes, Cooper, and Rhodes (1978) and is here used to measure the debt capacity in Danish agriculture. Consider the production technology, \mathbf{S}^t , which models the transformation of inputs $\mathbf{x}^t \in \mathbb{R}_+^N$ into outputs $\mathbf{y}^t \in \mathbb{R}_+^M$ (Färe, Grosskopf, Norris, & Zhang, 1994), where N and M are the dimensions of the input and output vectors and t is time.

$$\mathbf{S}^t = \{(\mathbf{x}^t, \mathbf{y}^t): \mathbf{x}^t \text{ can produce } \mathbf{y}^t\} \quad (1)$$

The production technology, \mathbf{S}^t , is convex, bounded, and closed for all $\mathbf{x}^t \in \mathbb{R}_+^N$. Production of output requires some input and all inputs and outputs are strongly disposable. The production technology is unobserved hence; the distance to the frontier is unobserved and must be estimated (Wheelock & Wilson, 1999). The output distance function is estimated as:

$$\widehat{D}^t(\mathbf{x}^t, \mathbf{y}^t) = (\sup\{\theta: (\mathbf{x}^t, \theta\mathbf{y}^t) \in \mathbf{S}^t\})^{-1} \quad (2)$$

The output distance function is the inverse of the maximum proportional output expansion given the input bundle. The reference technology in DEA is based on the minimum extrapolation principle and the assumption of free disposability. Variations can be modelled on a number of different assumptions with regard to convexity and returns to scale. The DEA technology frontier can be used to estimate the dynamic Malmquist productivity index, which is employed to measure differences across periods.

The Malmquist productivity index is defined as (Wheelock & Wilson, 1999):

$$\widehat{M}_i^{t2}(y^{t2}, x^{t2}, y^{t1}, x^{t1}) = \left[\frac{\widehat{D}_c^{t1}(x_i^{t2}, y_i^{t2}) \widehat{D}_c^{t2}(x_i^{t2}, y_i^{t2})}{\widehat{D}_c^{t1}(x_i^{t1}, y_i^{t1}) \widehat{D}_c^{t2}(x_i^{t1}, y_i^{t1})} \right]^{\frac{1}{2}} \quad (3)$$

and it expresses the development in productivity for a farm i in period $t1$ to period $t2$ with reference technology CRS.

The Malmquist index is decomposed into four measures; efficiency change and the technology change; which are both further decomposed into a pure effect and into an effect of scale. The scale effect represents the change in efficiency and technology due to changing farm size (input and output are at different levels), (Wheelock & Wilson, 1999).

The estimate of the Malmquist productivity index can be decomposed as in equation 4:

$$\widehat{M}_i^{t2} = \underbrace{\left[\frac{\widehat{D}_v^{t2}(x_i^{t2}, y_i^{t2})}{\widehat{D}_v^{t1}(x_i^{t1}, y_i^{t1})} \right]}_{\Delta \text{Pure Efficiency}} \times \underbrace{\left[\frac{\widehat{D}_c^{t2}(x_i^{t2}, y_i^{t2}) / \widehat{D}_v^{t2}(x_i^{t2}, y_i^{t2})}{\widehat{D}_c^{t1}(x_i^{t1}, y_i^{t1}) / \widehat{D}_v^{t1}(x_i^{t1}, y_i^{t1})} \right]}_{\Delta \text{Scale}} \times \underbrace{\left[\frac{\widehat{D}_v^{t1}(x_i^{t2}, y_i^{t2}) \widehat{D}_v^{t1}(x_i^{t1}, y_i^{t1})}{\widehat{D}_v^{t2}(x_i^{t2}, y_i^{t2}) \widehat{D}_v^{t2}(x_i^{t1}, y_i^{t1})} \right]^{\frac{1}{2}}}_{\Delta \text{Pure Technology}} \times \underbrace{\left[\frac{\widehat{SE}^{t1}(x_i^{t2}, y_i^{t2}) \widehat{SE}^{t1}(x_i^{t1}, y_i^{t1})}{\widehat{SE}^{t2}(x_i^{t2}, y_i^{t2}) \widehat{SE}^{t2}(x_i^{t1}, y_i^{t1})} \right]^{\frac{1}{2}}}_{\Delta \text{Scale Technology}} \quad (4)$$

in which the estimate on scale efficiency is defined as:

$$\widehat{SE}^{t2} = \frac{\widehat{D}_c^{t2}(x_i^{t2}, y_i^{t2})}{\widehat{D}_v^{t2}(x_i^{t2}, y_i^{t2})} \quad (5)$$

DEA method applied to measurement of access to finance

The traditional DEA setting is based on production, whereby the relation between inputs and outputs is examined. What we do is to simply substitute outputs with debt and inputs with collateral value factors. Instead of measures for best practice (the production frontier) and estimates of efficiency levels of the individual firms, we obtain measures for maximum debt capacity and estimates of individual debt capacity utilisation.

We present three variations of a single output model with nine (crop), twelve (dairy) or eleven (pigs) inputs (more on this in section 4). The single output is debt in all models and the inputs are collateral value items, or proxies for earnings.

The efficiency change part of the Malmquist decomposition is the change in utilisation of debt capacity, i.e. how large is the current debt compared to the maximum debt capacity approximated by the most indebted farmers who can reasonably be compared to the farm in question. The scale change is the effect related to efficiency change / debt capacity utilisation; this is denoted, ‘‘Scale related change in debt capacity utilisation.’’ The pure technological change is the change in debt capacity based on the same set of inputs in the model. The pure technological change is to be interpreted as the change in access to finance. The scale effect relating to technological change / debt capacity, scale technology change, is denoted ‘‘Scale related change in debt capacity.’’ Change in debt capacity and change in debt capacity utilisation are the pure effects of change in debt capacity and utilisation, adjusted for changes in scale.

The output oriented efficiency can be interpreted as the debt to debt capacity ratio. We assume that collateral and management/earnings are the fundamental factors, which determine the debt capacity or loan approval. The non-utilised value of debt capacity can be interpreted as the access to financial lending reserves. An important assumption in the model is that farmers can obtain as much debt

as the most indebted comparable farmers. This is a reasonable assumption in times of increasing credit supply (in a credit cycle boom). However, in a credit cycle bust, some path dependence could be expected, whereby farmers with a large loan arrangement can borrow more if necessary for going concern considerations, i.e. lender may extend credits to allow the farm to survive. Issuing more credit can reduce the expected loss for the bank if there is a fair chance that the farmer will make it through the farm crisis, that is extending credit may influence the probability of default. Furthermore, the bank may expect lower losses given default at a later point in time.

Section 4 – Data

The data set consists of an unbalanced panel of account data from 1996 to 2009. The data is retrieved from the Knowledge Centre for Agriculture’s accounting database, which stores a large sample of the accounts made in partnership with Danish Agricultural Advisory Service. The measure of access to finance is based on a benchmarking approach for farmers with homogenous production. To secure the homogeneity of the farms, they are split into the three main subsectors of Danish agriculture: crop, dairy, and pig production. All farms in the sample require a workload of at least 1,665 hours (full time) and focus should be on the farm production. Therefore, the non-farm assets are less than the farm assets and the farmland makes up at least half of the total amount of land (excluding farms comprised of mainly forest). These requirements are general to the crop, dairy, and pig models, but individual model constraints are applied to secure a homogenous production for each subsector. The inputs in the model are chosen as they convey the important factors of collateral value when issuing loans in the agricultural sector in Denmark. Surveying the literature of agricultural credit scoring models shows a long list of variables entering the models to account for the debt servicing ability of the farmer (Miller & LaDue, 1989; Turvey, 1991).

Table 1. Number of farms in each subsector each year | number of years in the unbalanced dataset

Year	Crop	Dairy	Pigs	Years in dataset	Crop	Dairy	Pigs
1996	897	6,154	3,180	1	1,218	2,346	1,689
1997	842	5,592	3,072	2	643	2,130	1,522
1998	795	5,428	2,746	3	443	1,850	1,262
1999	728	4,760	2,538	4	364	1,573	1,017
2000	649	4,296	2,517	5	209	1,191	779
2001	602	4,093	2,552	6	183	1,536	725
2002	522	3,489	2,212	7	94	857	406
2003	418	2,338	1,448	8	62	469	237
2004	627	3,011	1,710	9	35	201	140
2005	719	3,048	1,858	10	34	166	97
2006	730	2,855	2,165	11	20	130	88
2007	793	2,697	1,632	12	16	135	53
2008	767	2,491	1,428	13	7	88	33
2009	683	1,411	1,251	14	2	45	34

Source: Knowledge Centre for Agriculture’s accounting database

Qualitative variables entering credit-scoring models are not applicable in this quantitative model. In our model, we use earnings before interest and taxes (EBIT) as a proxy for the quality of management and the inverse of farmer age is used as a proxy for management persistence.

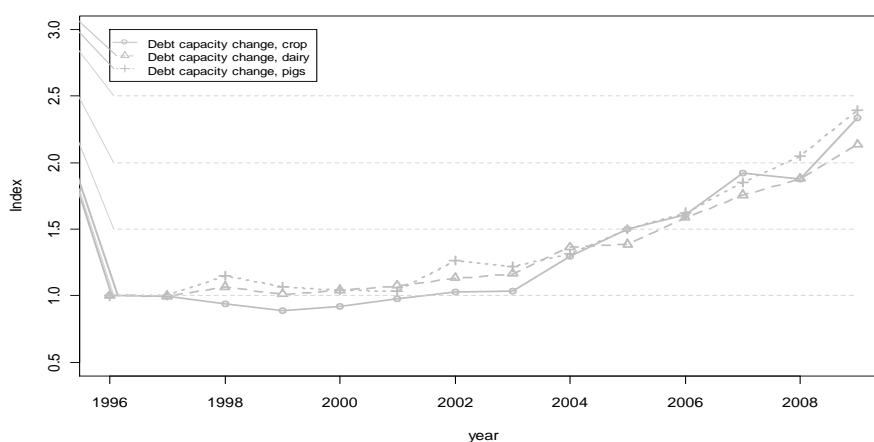
The main asset and the main source of collateral for farmers is land; there are four types of land in the model, soil type 1 (clay), soil type 2 (sandy), non-farmland (forest, meadows, roads, etc.) and farmland which is leased out. There are five other inputs in the crop model, assets outside agriculture (taken at book value), equipment (taken at book value), EBIT, operator age, and the number of slaughter pigs as a proxy for the value of buildings (it is not uncommon to see crop farms with some slaughter pig production). The model for specialised dairy farms includes the number of cows, the amount of milking quota and the number of heifers to adjust for the additional collateral value of the milk production related facilities and value of quota. The model for specialised pig farms includes the number of sows and the number of piglets produced to adjust for the additional collateral value of the pig production facilities.

Three inputs are measured monetarily; these are the assets outside agriculture, equipment, and EBIT, all are deflated. EBIT is used as a proxy for management. Equipment is taken at book value, since these highly depreciable assets' book values are relatively good approximations of the repurchase value, and is used to control for the collateral value of equipment. We have chosen not to correct for the development in the productivity through time or the price changes on farm products (crops, meat and milk). Any development in the productivity or prices, which explains a change in profitability, is captured by our management proxy, EBIT.

Section 5 – Empirical Results

Results show increasing average debt capacity over the period from 1996 to 2009. This is consistent with the hypothesis of increasing access to finance. A farmer with a debt capacity change of 2.0 in 2009 can borrow twice as much in 2009 compared to 1996 when controlled for earnings and when debt and other monetarily measures are deflated. The estimations are performed by package FEAR (Wilson 2008) for the statistical environment “R” (R Development Core Team 2010). Both the debt capacity change and the debt capacity utilisation change are central results from the model, while the scale related changes are minor. The debt capacity change is measured for the three subsectors, as illustrated in figure 3. The mean of the change in debt capacity scores from the reference year 1996 to the year in question is calculated for the farmers with a debt capacity change score defined both years.

Figure 3. Debt capacity change for three production types



The last years of the 1990s did not add substantially to the debt capacity. In 2004, however, the increase in debt capacity in Danish agriculture accelerated. The results from the years 2007 to 2009 are presented in table 3. The Malmquist index is labelled the Debt Development index (DDi) and

the components are listed on the right-hand side. The debt capacity utilisation is close to one, except for pig producers for whom it is 1.2. The debt capacity utilisation can be interpreted as the change in debt to debt capacity ratio, which is closely related to the debt to asset ratio when controlling for management, age, and the lenders' assets valuation. The scale related changes for both debt capacity and debt capacity utilisation range from 0.905 to 1.198 for all three subsectors, which suggests that the change in scale is not causing changes in debt structure.

The main measure in table 3 is the debt capacity change, which has roughly doubled in the period, also shown in figure 3. The results in table 3 are the means of the scores for farmers in the sample in 1996 and the year in question. The measure is biased because it is only calculated for the farmers who were farmers in 1996. Operator age is used as input and the farmers in the measure for 2009 are older than the average farmer, hence it is expected that the debt capacity change is measured at the part of the frontier where the farmers are. Finally, the number of accounts included in the mean calculation is decreasing with time, which can also be seen in table 3. The debt possibility set in 2009 consists of 683 farms (see table 1) for the crop producers, and the efficiency estimates are calculated on the basis of that debt possibility set.

The average DDi change for crop producers is estimated based on the 35 farms in the data set in both 1996 and 2009. These farms are not representative, as the farmers have been in farming for at least 14 years in 2009, which precludes young farmers. We have considered a remedy for dealing with this issue and have constructed a fictitious farm which is the "mean farm" for each year. Each input and output in the mean farm is the mean of all farmers for the relevant year within the production type. Our fictitious farmer does not age. The results for the mean farm show no relevant difference, and are not reported. The benefit of constructing a farm as a proxy for sector average is related to the selection bias and the ease of interpretation of the DDi.

Table 3. Elements of Malmquist decomposition from 2004 to 2009 with 1996 as the base year for farmers in the dataset in 1996 and the year in question

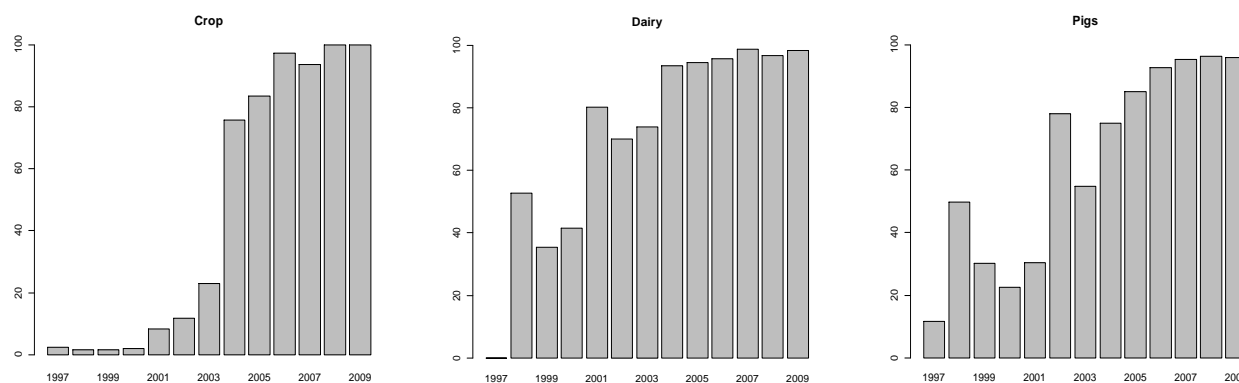
Year	No. of farms	Malmquist index	Pure efficiency change	Scale change	Pure technical change	Scale technical change
		Debt Development index	Change in debt capacity utilisation	Scale related change in debt capacity utilisation	Change in debt capacity	Scale related change in debt capacity
Crop						
2007	55	1.515	0.817	0.920	1.923	1.093
2008	46	1.654	0.918	0.919	1.875	1.070
2009	35	1.958	0.855	0.965	2.334	1.008
Dairy						
2007	364	1.772	1.021	0.918	1.756	1.181
2008	295	1.929	1.011	0.905	1.880	1.198
2009	152	2.385	1.176	0.905	2.137	1.139
Pigs						
2007	143	2.157	1.168	0.909	1.854	1.149
2008	99	2.501	1.221	0.941	2.051	1.090
2009	87	2.645	1.204	0.941	2.391	1.151

The change in debt capacity is generally driving the change in the DDi over the years. Scale effects tend to be minor and the debt capacity utilisation has had some positive impact on DDi for dairy and pig farms and a negative impact on DDi for crop farms.

Bootstrap

The DDi estimates and the decomposed estimates are bootstrapped with Hall Percentile intervals based on differences (Simar & Wilson, 2000). The basic idea of bootstrapping is to mimic the original production set by drawing a random sample with replacement of the original data to create pseudo-samples conditional on outputs (Bogetoft & Otto, 2010). The random sample is biased, as it is a subsample of the original data. Hence, the data is bias-corrected prior to drawing the random sample and afterwards the DDi is calculated based on the random sample of bias corrected inputs and outputs. Furthermore, the bootstrap estimates are smoothed and the temporal correlation between periods is handled as in Simar and Wilson (1999). The bootstrap procedure is repeated 2,000 times for each observation. Bootstraps of the DDi estimates are used to analyse the sensitivity and to generate confidence intervals for each of the decomposed measures. Bootstrapping makes statistical inference possible based on the empirical distribution of the bootstrap estimates of the decomposed index. The bootstrap is used to identify the number of farms for which there is a statistical significant debt capacity change at the 5 percent level. Figure 4 shows the share of farms for which there is an expansion in the debt capacity (pure technical change > 1) at the 95 percent confidence level.

Figure 4. Share of farms with a significant increase in debt capacity since 1996



* Due to computational burden, results for dairy are not reported for 1997.

Section 6 – Conclusion

We suggest a non-parametric alternative to typical measures for access to finance based on Data Envelopment Analysis. Our measure is based on the decomposition of the Malmquist index known from productivity analysis. Our measure captures many aspects of access to finance and financial constraints based on a minimum of assumptions. Our alternative measure is a valuable complement to the qualitative surveys produced by central banks, for sectors where q-based models are not applicable. We apply our measure to Danish farm accounting data, as farming is one of the sectors for which we consider our measure to be superior to others.

We find that the debt capacity in Danish agriculture increased significantly during the period 1996 to 2009 and that the level has roughly doubled. We argue that investment and risk management behaviour have been affected by the access to finance. Access to finance has been a significant driver of investment and debt development in Danish agriculture during the past decade. Expected changes

in access to finance in the future will affect the investment and risk management practice. We find that the absence of development of risk management institutions may be explained by access to finance and that the development of an institutional framework concerning risk management in a future with harder access to finance, holds great potential.

Institutional development in themes of market, as well as non-market institutions, may stimulate a potential for risk management. The low value of risk management in the past may explain why institutions are not already in place. Agricultural policies and the relative ease of access to finance are reasons for the low value of risk management in the past. It seems likely, however, that the role of agricultural policy and the access to finance is diminishing, which suggests that the potential value of risk management increases. This potential may, however, be restricted by the lack of institutional development. Institutions must be formed in the near future to cope with the changing policy and financing environment around agriculture.

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