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Barnes, AP; Hansson, H; Manevska-Tasevska, G; Shrestha, S; Thomson, SG

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Barnes, A.P. *1, Hansson, H.[2], Manevska-Tasevska. G.[2], Shrestha, S. S.[1], Thomson, S.G.[1]

[1] Land Economy, Environment and Society Team, SRUC, Edinburgh, EH9 3JG
[2] Department of Economics, Swedish University of Agricultural Sciences, P.O. Box 7013, SE-75007 Uppsala Sweden

*Main Author Contact: Dr Andrew Barnes, Reader in Innovation and Behavioural Change, Land Economy, Environment and Society Research Group, SRUC, West Mains Road, Edinburgh, EH9 3JG. T: 0131 5354042. E: Andrew.Barnes@sruc.ac.uk

Highlights

- Farm viability is measured for Sweden and Scotland
- Long-term and short-term viabilities are calculated
- Probabilities of remaining viable are higher in Scotland
- Agricultural diversification positively affects viability
- Other influences on viability are regionally distinct

1 Introduction

Diversification of farm businesses outside of what may be viewed as conventional agriculture is strongly promoted in the European Union's rural development policy, and therefore various policy measures related to this have been developed (European Commission, 2005). Indeed, supporting farmers to use their under-exploited or idle agricultural resources in new ways to obtain revenue is considered a strategy to reduce farm household income risk, encourage diversification of rural economies and, thereby, accomplishing goals concerning economic growth in rural areas, as well as creating job-openings and encourage in-migration. Farmers seem to have largely responded to the calls of policy makers, for instance in a 2000 – 2007 longitudinal study of a sample drawn from about 40% of the largest farms in Sweden around three quarters of the sample reported revenue originating from activities such as renting out of equipment and buildings and contract work (Hansson et al., 2010). These activities constituted between 12 to 15% of total revenue of the reporting firms.

There has been a considerable interest in the phenomenon of diversification, especially during the last two decades (e.g. Barbieri and Mahoney, 2009; Chaplin et al., 2004; Gorton et al., 2008; Hansson et al., 2012; Hansson et al., 2013; Ilbery, 1991; Maye et al., 2009; McNally, 2001; Vik and McElwee, 2011).

In particular, researchers have been interested in the determinants of farm diversification and farmers' underlying motives for diversifying their farm businesses outside conventional agriculture. There has also been a significant interest in the different types of incomes (e.g. off-farm employment and other business-holdings) of the farm family, in terms of the so called pluriactivity of the farmer and his/her family (e.g. Alsos et al., 2003; Lagerkvist et al., 2007; McNamara and Weiss, 2005; Serra et al., 2004). While the knowledge produced by previous studies is essential for the formulation of successful policy, the underlying assumption that diversification can function as a strategy for farm businesses to become more viable seems to have been largely taken for granted. Indeed, testing the assumed positive relationship between farm diversification and the favourable economic situation of the farm business has, to the best of our knowledge, not received attention in the scientific literature.

Nevertheless, there has been some interest in how the degree of specialization in the major farm enterprise affects the performance of farms in terms of both economic or technical efficiency (e.g. Barnes et al., 2011; Brümmer, 2001; Hadley, 2006; Hansson, 2007; Latruffe et al., 2013; Solís et al., 2009), where findings have consistently shown the negative impact of specialization on efficiency. This lends some support for a negative relationship between specialization and the overall economic performance of the farm. Although this may infer the economic contribution of farm diversification, its existence cannot be taken for granted.

Considering the motives for farm diversification found by previous literature further accentuates this. Whilst reduction of risk (Barbieri and Mahoney, 2009; Hansson et al., 2013; Northcote and Alonso, 2011) appears a prominent motive, as does reduction of uncertainty (Barbieri and Mahoney, 2009) other motives are important, such as a desire for making use of idle resources (Hansson et al. 2013) and motives of social and/or lifestyle type (Barbieri and Mahoney, 2009; Hansson et al., 2013; Northcote and Alonso, 2011; Vik and McElwee, 2011). This means that diversification activities may be undertaken for economic reasons but may also be due to other factors not related to the economic situation of the farm, making its impact on the financial situation of the farm less obvious.

Accordingly, this paper adds to these literature by providing an analysis of the empirical relationship between farm diversification and the economic performance of the farm. Specifically, this provides insights into how farm diversification strategies affect metrics of economic performance at the farm level. In the vast literature related to farm diversification, this relationship has to the best of our knowledge not been previously studied. Such insights would, however, contribute to facilitating the successful formulation of policies aimed at strengthening farm resilience and offer a more robust empirical base for dictating interventions on farm diversification. Furthermore, an analysis of the economic contribution of farm diversification would facilitate advice given to farmers about business development.

The paper is based on longitudinal financial data obtained from both the Scottish and Swedish farm accounting surveys, and covers the period 2000 – 2012. This allows us to analyse the patterns of individual economic outcomes over this time period where diversification became more prominent within Government decision making. We consider economic outcomes in terms of the financial viability of the farm (Vrolijk et al., 2010) which relates individual farm income against a threshold minimum wage rate and, thereby, considers how well the farm business can generate income against established criteria. Furthermore, recognizing that the definition of farm diversification is based on what is considered conventional farming and is thus empirically, rather than theoretically driven, we also assess how diversification of conventional agricultural enterprises of the farm business affects the viability of the farm. Diversification in this sense may also contribute to the positive economic development of farm businesses, for instance through its possible positive effects on risk reduction. However, the strong policy interest in farm diversification outside conventional agriculture motivates us to keep two separate definitions of diversification in our analysis. The paper is structured as follows. The next section outlines the conceptual framework for our approach to both diversification and viability. Section 3 introduces the data and methods used. Section 4 reports findings and discussion and Section 5 provides both conclusions and discussions of the more salient issues of this approach.

2. Conceptual Framework

2.1 Farm diversification and diversification of agricultural enterprises

As is implied from the literature, farm diversification has been investigated by several previous studies. In building our conceptual framework, we start by discussing the *farm diversification* concept, and then relate this to diversification of the agricultural enterprise, i.e. *agricultural diversification,* in order to distinguish between these two categories of diversification.

The literature suggests that a number of authors (e.g. Barbieri and Mahoney, 2009; Hansson et al., 2012; Hansson et al., 2013; Ilbery, 1991; McNally, 2001; Turner et al., 2003) take farm diversification to imply that a farm business uses its agricultural resources, such as land holdings, buildings, machinery and labour, to produce income from activities that are not defined as conventional farming, or to process its raw material on-farm, often in order to pursue a marketing strategy based on value-added products.

This definition has several implications. First, and compared to the strategic management literature, where a firm's diversified activities can be addressed within the so called Ansoff product market growth matrix (Ansoff, 1957; see e.g. Johnson et al., 2011). Hansson et al. (2013) argued that the definition of farm diversification implies that activities which the strategic management literature consider vertical integration (such as on-farm processing of raw material), would fall under the definition of farm diversification. Within the Ansoff product market growth matrix, there exist three types of diversified activities, namely:

i) developing new products for the firm's existing market;
ii) introducing existing products to a new market; and
iii) entering new markets with new products.

Within this framework farm diversification can be seen as activities outlined in points ii) and iii). Furthermore, and as pointed out by Hansson et al. (2013) farm activities related to vertical integration often involve processing activities that add value to farm products, implying that new products are developed and sold to new markets, at least for the farm business. An example can be on-farm processing of milk, as opposed to selling milk to a dairy plant processor, whereby the milk is often marketed in terms of localised production and traceability is considered to gain added value and is perceived by the consumer as being a different product compared to the original milk produced, but not processed, at the farm.

Second, this definition of farm diversification is fluid in the sense that there is a need to empirically define '*conventional farming'* in order to determine whether or not a farm is diversified. As noted by Turner et al. (2003) the definition of conventional farming is likely to be time-dependent and reflects what is currently considered the mainstream activities of a farm business. There are also likely to be geographical dependencies in what can be considered mainstream farming. While this is likely a necessary condition of the definition of farm diversification, with its interest in activities outside conventional agriculture, it calls for cautious comparisons between studies over different periods in time.

Third, the definition of farm diversification provided above is clearly distinguished from the adjacent concept of pluriactivity, depending on the unit of analysis used in the two concepts. The farm diversification definition builds on the farm business and its use of its resources to generate income, while pluriactivity refers to all the income-generating activities of the farmer and the farm household and thus includes off-farm work and additional businesses run by the farmer and the farm household.

Fourth and finally, the notion of farm diversification as used in the literature and referring to activities outside conventional agriculture, excludes diversification in the sense that the farm business runs several agricultural enterprises, such as grain and milk, and is diversified in that sense. This notion of diversification has only merited limited study. Nevertheless, Hansson et al. (2010) found that around 70% of the larger Swedish farms are diversified in this sense.

In this study the point of departure is taken from the farm business, and diversification is considered in terms of the revenue-generating activities the farm business produces from its resources (including available family and other paid labour). In particular, we distinguish between the following two types of diversification, that is: farm diversification, according to the definition above, and diversification of the agricultural enterprises (agricultural diversification). The first type of diversification implies that a farm business is considered diversified if it uses any of its farm resources to produce income from activities outside conventional agriculture, such as farm shops and tourism, and renting out of machinery, buildings, and livestock for insemination, or where farm products are processed on-farm. This notion of farm diversification is thus similar to that of numerous other studies Barbieri and Mahoney (2009); Hansson et al. (2012); Hansson et al. (2013); e.g. Ilbery (1991); McNally (2001); Turner et al. (2003). Furthermore, following Hansson et al. (2010) a farm business is considered involved in diversification of the agricultural enterprises (agricultural diversification) if it obtains income from two or more agricultural enterprises, such as grain and milk. For completeness, specialized farm businesses are defined as farms obtaining their agricultural income from only one agricultural enterprise. The definitions of diversification outlined here implies that farm businesses obtaining income from on-farm processing of their own raw material would be considered diversified even though their production may be specialized in a single agricultural enterprise to provide new products to new markets.

2.2 Farm viability

Viability underlines the evolution of a system to defined constraints (Aubin et al., 2011) Financial viability defines the ability of a business entity to continue to achieve its operating objectives and fulfil its mission over the long term. Implicit within this definition is the capacity of business entities to meet their operating expenses and financial obligations and also, if this matches business objectives, to accommodate growth within the business enterprise.

Securing a stable income for farmers has been a concern for policy makers within the EU since the inception of the Common Agricultural Policy (CAP) in 1957. Whilst national and EU policies have broadened over the recent decades to include community-based and environmental goals, ensuring financial viability is still maintained as a central aim for support policies within EU agriculture.

Ultimately studies on agricultural viability have attempted to understand the criteria for failure at the farm level and identify factors which determine a switch from being viable to non-viable as well as the subsequent consequences of consistent under-performance within the sector. Failure can be defined in a number ways and identifying indicators for failure is a non-trivial task (Murdock and Leistritz, 1988) Most studies tend to use a partial measure of change, for example changes in net worth may be indicative of overall asset value change (Carley and Fletcher, 1988; Lines and Zulauf, 1985; Melichar, 1995; Wadsworth and Bravo-Ureta, 1992). However, the temporal element of change and farm level biophysical planning requires a multi-indicator approach to assess both a threshold for failure and determinants for avoiding this failure. Frawley and Commins (1996) provide a useful definition in that viability is determined by comparison with minimum agricultural wages but also the capacity to provide an additional return on non-land assets.

Within the farming enterprise (Vrolijk et al., 2010) argue that viability is determined by the level of income, but also by the fluctuations in incomes and the level of leverage, that is the ability to obtain capital for investment. Agricultural incomes vary widely and are significantly affected by exogenous biophysical and global financial factors. As such most studies of farm level viability incorporate a temporal element to accommodate these fluctuations in financial viability. Work by Cordts et al. (1984) found that income variability tends to be reduced when a three-year period is considered. This could, of course, vary given the severity of the particular shock and the time lag applied for re-adjustment. Vrolijk et al. (2010) used the farm account data network (FADN) to identify viability after reform of the Common Agricultural Policy. Their indicator of viability rested on family farm income being higher than zero. They then tested this further by including opportunity costs, reflective of income foregone, set at local interest rates for 10 year government bonds, to classify farmers into different viability types. Accordingly, this multi-period element needs to be considered within any index of viability and we propose two interchangeable indicators to accommodate the effect of farm-level decision-making and response to variability, that is short-term and long-term viability.

Concerns around farm viability solely based on low farming income have been debated by a number of economists (e.g. Ahearn et al., 1993; Hill, 1982; Salant et al., 1986). Mishra et al. (2002) and Hill (2012) argue that low income farmers, especially those on owner occupied farms, may hold substantial wealth on farm which should be included in determining farm viability. Hill (1982) has suggested using an annuitisation formula to include farm assets within the total income flow of the farm. This provides an indication of the economic well being of the farm which, he argues, will be a better representative measure in determining farm viability than using farm income alone. More recently, Hill (2012) claims that a meaningful comparison between farm incomes must accommodate wealth. The selection and valuation of the farm assets to be included as farm wealth however, depends on the context of the study and availability of data. Wealth, as measured by Mishra et al. (2002) allocates changes in net worth from both farming and non-farming sources, such as pension funds and returns from shares available with US sources of farming accounts. However Agra CEAS (2007) point out the current constraints and economic costs for adequate data collection to fully reflect these dimensions of income within European farm accounting systems. As such we follow the common approach of a 5% return to non-land assets for determining farm viability (Dillon et al. (2010); Frawley and Commins (1996); Hennessy and O'Brien (2006) and Hennessy et al. (2008) who used As such the use of a long-term indicator of viability, imputed through a balanced average of net farm income plus a rate of return on assets to capture the opportunity cost of investing farm asset values, accommodates some of these changes in wealth.

2.3 Hypotheses about diversification and viability

Given the literature reviewed above any type of diversification implies a process where revenue is obtained not only from the original source but also from additional sources. Obtaining revenue from multiple sources would be a strategy to ensure the more steady flows of revenue over time periods because it can be a means to account for both seasonal variations in income and to variations over business cycles. Therefore, we may expect diversified farms to be more viable compared to farms that are not engaged in diversification strategies.

Hence, we propose to explore the following two hypotheses which are central to future policy making with respect to diversification and securing viability within farming.

H_1) Farm diversification is positively related to long- and short-term viability.

H_2) Agricultural diversification is positively related to long- and short-term viability.

3.0. Data and Methods

3.1. Data

To test the hypotheses proposed in the previous section, we apply this approach to two Northern European countries, namely Scotland and Sweden. Data from both the Scottish and the Swedish Farm Account Surveys (FAS) were collated. These data cover a sample of around 500 and 1000 farms per year respectively and offers detailed indicators on inputs, outputs and socio-economic data on the farms themselves. The data are collected yearly under EU FADN quality guidelines and using these data comparable indicators of viability and diversification can be generated. Data collected under the farm accounts scheme allows for the long term analysis of individual farms. Mostly these panels are unbalanced due to attrition bias as farmers exit the industry, significantly restructure or simply leave the sample. However, it has been generally found that these samples tend to have relatively low attrition rates and farms remain in the sample for a reasonable length of time (Hennessy and O'Brien, 2006; Barnes et al., 2011; Bakucs et al., 2014). In order to further reduce some of this inter-temporal variance through attrition bias, any farms which did not have at least 3 consecutive years within the panel were removed.

In addition, these databases are traditionally biased away from smaller enterprises, which may be exhibiting high levels of diversification. The FAS represents farms which are the main targets for policy intervention which are arguably more commercial business entities and where the farmer is more dependent on the income obtained from the farm business. Consequently, including farms which are smaller than those available in the FAS data would bias our results by reflecting the outcome of decisions taken by people who run their farms primarily for hobby rather than for commercial reasons. Table 1 presents structural characteristics of the sampled farms in Scotland and Sweden respectively and show strong similarities in terms of size and activity levels.

Table 1. Structural characteristics of farms, Scottish and Swedish farm accounting surveys 2002-2012, mean

3.2. Methods

Identifying viability

The cost structures of farming provide a basis for harbouring fluctuations in short-term income. The total asset structure of the business provides the basis for understanding impacts of external and internal drivers on viability and this is our main discriminator between short-term and long-term viability.

Short term viability: Short-term viability is based on cash income as an indicator of yearly viability over time. Cash income is the difference between total revenue and total expenditure on a farm. This viability is measured based on exceeding an hourly minimum agricultural wage rate (O'Donoghue, 2013; Phimister, 1995). Cash income includes income from farm-diversification and off-farm income (e.g. off-farm employment and other business-holdings). However, as discussed above, we do not consider off-farm income here, as it defines a wider decision-making unit. Hence off-farm income is deducted from cash income to provide the general indicator of short-term viability. This was divided by the annual hours worked by the farmer and spouse on the farm and then compared to the minimum agricultural wage rate for each country in that year.

Long-term Viability: Long term viability is based on a 3-year moving average of Net Farm Income (NFI) plus a 5% rate of return on investment to represent the opportunity cost of capital. Net Farm Income represents the return to the farmer and spouse for their manual and managerial labour, adjusted for imputed labour and rent. In the farm accounts this measure does not include income for farm diversification and hence this is added to NFI to give an indication of long term viability. This was divided by the annual hours worked by the farmer and spouse and then compared to the minimum agricultural wage rate for each country in that year.

Accordingly, using the threshold of minimum agricultural wage within each year, three states of viability could be identified for each farm in each time point within the data set, namely:

> short-term and long-term viability (STV LTV), where both indicators are above minimum agricultural wage,
>
> short-term viable but long-term non-viable (STV LTNV), where only adjusted cash income is above minimum agricultural wages, and
>
> short and long-term non-viable (STNV LTNV), where both indicators are below the threshold.

Identifying Diversification

A range of activities are recorded over time for various diversification activities. Firstly, the degree of specialisation within the agricultural enterprises can be identified using the ratio of a single activity revenue (e.g. from cropping or livestock) to total agricultural revenues (Bosch, 1998). This is a straightforward task in farm accounts data. From this it follows that agricultural diversification can be defined as "*1 – degree of specialization"*.

Secondly, farm diversification can be identified in detail. In order to accommodate the definitions outlined above, farm diversification is the sum of income received from contracting work, rental incomes, farm shops, tourism etc. where agricultural resources are used in income-generating activities outside of what may be considered conventional farming. This is then divided by total income in the farm business to give a ratio running from 0 to 1. Notably, other sources of income collected within the farm accounts include financial investments and sundry grants received for forestry activities. However, these have not been traditionally defined as farm diversification and have been ignored here.

3.3. Estimation strategy

To understand and summarise the states of viability within the panel over the whole time period, transition probabilities were estimated using a Markov Chain framework. Markov Chain-type approaches have been commonly estimated on farm panel data, where the probability of changing the farm structure or the farm's performance stability can be observed (e.g. Bakucs et al., 2014; Barnes et al., 2010; Disney et al., 1988; Karantininis, 2002; Tonini and Jongeneel, 2009; Zepeda, 1995; Zimmermann and Heckelei, 2012). Effectively, given the set of viability states (V_t) we can estimate the probabilities $p_{i,j}$ of moving from viability state i to viability state j as a transition matrix.

$$P(V_t = j \mid V_0 = i_0, V_1 - i_1, \ldots V_{t-1} = i_{t-1}) = P(V_t = j \mid V_{t-1} = i_{t-1}) \quad (1)$$

A number of approaches are available to explain the reasons for membership of a particular viability state across panels. With respect to farm account data, studies have aimed to understand the temporal dynamics of the income state and, further analyse the drivers behind shifts in these states using survival analysis or augmented Markov transition states with covariates (e.g Ahituv and Kimhi, 2002; Corsi and Findeis, 2000; Phimister et al., 2004; Zepeda, 1995; Zimmermann and Heckelei, 2012). Zimmermann et al. (2009) used both micro and macro level data within a Bayesian framework to understand transition change. Nevertheless, the most common approach to determine probability of membership of a particular state have been logistic and probit regression (e.g. Gocht et al., 2012; MacRae, 1977; Zepeda, 1995; Zimmermann and Heckelei, 2012). Storm et al. (2011) considered both ordered and unordered Markov states and argued that for the former an ordinal logistic regression is superior for both model assumptions and from a computational point of view, whereas for the latter they argued that the more common multinomial logistic regression is a suitable specification. In our case, when categorical responses exceed a binary outcome and are not ordered we apply this approach to explore the influence of diversification on a particular viability state.

The farm will have one viability outcome at a particular time point. Let *J* be the number of nominal outcomes and *m* the state of *v* outcomes, representing the viability state. Thus, considering the range of outcomes (*v*), the predicted probability of the i-*th* farmer entering a particular viability state (*v* = 0, 1, 2) is:

$$\Pr(v_i) = m | x_i' = \frac{\exp(x_i'\beta_m)}{\sum_{j=1}^{J} \exp(x_i'\beta_j)} \quad (2)$$

Where $\beta_0 = 0$

This provides indications of the probability of a change in the independent variable (*x*) affecting membership of one of the three states of viability. The base outcome state of viability ($y = 0$) was used for referencing against the two non-viability states.

In addition to the diversification variables, discussed above, some common drivers of income viability were also examined which have been related to viability status, as well as indications of policy change. These are shown in Table 2 below.

Table 2. Independent variables used within multinomial logistic regression

A single payment scheme variable is included as a dummy to represent the significant shift in activity requirements under the 2003 Fischler reforms. From 2005 onwards farmer subsidies in Scotland and Sweden became based on a historic reference period decoupled from present production levels (Sorrentino and Henke, 2011). The removal of pressure on maintaining the fixed costs to service agricultural activities may therefore lead to more viability within the industry. However, managing growth with respect to the single payment scheme is based on trading these historic 'entitlements' and these have fluctuated in value over the time period due to exchange rate variations and other factors.

Less Favoured Area (LFA) status is a significant part of the land classification of both Sweden and Scotland and covers around 55 to 70% of land in these countries. It is designed to reflect biophysical disadvantage and support payments are directed specifically at compensating farmers for this disadvantaged land (Lindberg et al., 2012; Terluin et al., 1995). For efficiency of estimation, an approach is to compress these categories into a binary variable reflecting farms with land within LFA and farms without LFA land (Latruffe et al., 2013). By definition, we would expect the LFA variable to be negatively related to viability outcomes.

Land tenure is generally considered a significant factor in determining income mobility. However, in high income countries with well-established subsidy support mechanisms researchers have found these effects to be less significant (Phimister et al., 2004). This is due to access to capital being less restrictive to tenanted farmers in these countries. Aligned to this, studies of efficiency at the farm level do find a negative relationship with owner-occupation, relative to tenancy (Ezcurra et al., 2011; Karagiannis and Sarris, 2005; Manevska-Tasevska and Rabinowicz, 2015). Accordingly, this may indicate that ownership would have a negative relationship towards ensuring viability.

Stocking density is a proxy for intensification within the production system and will also be reflected by the cost structure of the farmer, in terms of higher capital and labour investment to accommodate these systems (SRUC, 2013). Conversely, higher viability is implied by more intensive systems due to the reduction of per unit cost that such systems provide. Hence, it could be argued that the rationale for pursuing intensification of a system would be to at least ensure short-term viability and we would expect this variable to have a positive influence on this outcome.

The data were constructed for each country and estimated using a common set of independent variables across the two countries. Explanatory variables were either categorical or continuous. Categorical responses were converted into dummy variables and presented conditional on a base reference value. The dependant variable was estimated against the short term and long term viable state as the reference. Estimation was conducted using (StataCorp, 2014).

4. Results and discussion

4.1. Dynamics of Viability

Figure 1 shows the proportion of the yearly sample recorded as viable, non-viable or short-term viable/long-term non-viable. There are clearly differences between the two countries in terms of both the spread of viability outcomes within the farms, but also the trend in viability over the time period. The Scottish sample shows a fall from 80% to 73% between 2000 to 2007. However, from 2007 onwards this slowly grew to over 80%. Conversely, an average of only 46% of the farms in Sweden were considered viable using the same criteria. This also fluctuates but the proportion of the sample which are viable grows and then falls to 43% in 2009, which then shows recovery. This latter phenomenon could be ascribed to the price and cost fluctuations within agricultural commodities around this time.

Figure 1. Distribution of viability states over time, proportion for Scotland and Sweden

These differences could be explained in a number of ways. Firstly, of course, whilst farms are at least in the panel for 3 years there may be some 'noise' from drop outs and entries over the period. However analysis of panel replacement found this to be minimal as, whilst not fully balanced, the median time spent per farm within these panels was 7 years. Secondly, even though both countries adopted the single payment scheme and relatively the same decoupling rationale, the rural development plans differ in terms of their focus in these countries. More specifically, the Scottish Rural Development Plan (SRDP) stated a desire to ensure farm viability (Lindberg et al., 2012). To our knowledge this seems unique across European state implementation of rural development plans and it would be expected that schemes and interventions are framed around this ambition. Nevertheless, opinions towards success of the implementation of the SRDP are mixed (e.g. Cook, 2009; EKOS and Cook, 2010).

In order to examine the dynamics of the panel further a balanced Markov transition matrix was estimated. This estimates transition probabilities on farms across, at least, 2 corresponding years, in order to accommodate the unbalance within the data set. Table 3 shows the balanced transition probabilities for the Scottish and the Swedish farms over time.

Table 3. Markov Chain transition probabilities for Scottish and Swedish viability index

The highest probabilities relate to remaining in the same viable state between two time periods. This means that if a farm has been viable in the previous time period it is highly likely that it will remain viable in the current period. This applies for both Scotland and Sweden. The probability of remaining within either of the two non-viability states is lower but still substantial, as around 50 to 60% of farms will remain non-viable over the two periods. This agrees with a range of studies that observe consistent under-performance of certain farming units and identify constraints to mobility within the agricultural sector (Barnes et al., 2010; Finger and El Benni, 2014; Meuwissen et al., 2008; Mishra and Sandretto, 2002; Phimister et al., 2004). The underlying characteristics of these non-viable types category is a slightly, but not significantly different, higher proportion of land ownership and higher levels of LFA membership.

Transition probabilities of moving from a non-viable to a viable state are around 0.30 for Scotland and Sweden with respect to short-term indicators. In particular the probability of transition from long-term non-viability to viability is only 0.09. This further implies the constraints to movement within the industry towards achieving improved performance. Comparatively, the Swedish sector shows more resistance to movement towards viability states and this is perhaps compounded by structural changes experienced within Swedish farming since the last reforms of the Common Agricultural Policy in 2005 (e.g. Manevska-Tasevska and Rabinowicz, 2015). Those farms which are more likely to shift towards a viability state have a higher, yet not significant, proportion of tenanted to land ownership levels, perhaps inferring more variability in performance, but they also generally tend to have higher levels of mixed income sources. In order to explore these characteristics further the next section explores the influence of farm characteristics on determining viability states.

4.2. Impact of Diversification on Viability

Table 4 shows the results of multinomial logistic regressions for both Scotland and Sweden. For ease of understanding it presents results as relative risk ratios (RRR) which are the exponents of the log-odds. The reference outcome state is short-term and long-term viable. Hence, if an RRR is greater than 1 then an increase in the value of that variable is more likely to predict membership of a non-viable state relative to the viability state, all other things being equal.

Generally, RRRs are of the same size and magnitude across the two countries for the long term non-viable state (outcome 2), but differ with respect to the more intermediate viability state (outcome 1). These differences relate to biophysical characteristics (LFA allocation), subsidy and ownership status (the Single Payment Scheme, tenure status) and the influence of diversification on viability status.

Table 4. Multinomial regression of farm viability states, relative risk ratios

With respect to both types of diversification relative risk ratios are below 1 for the two viability states, indicating that higher amounts of diversification activity will lead to more likelihood of becoming viable. This seems to provide support for our first hypothesis, as we find a positive relationship between farm diversification and long-term and short-term viability. The magnitude of the effect does change over the two countries, which reflects differences in the extent of diversification between Scotland and Sweden.

The second hypothesis, which relates agricultural diversification to viability, is strong when examined against long-term non-viability. In this case, both countries have a significant RRR of below 1 and the same conclusion as above can be drawn.

However, in the short-term viable/long-term non-viability state this holds for Scotland but is not significant for Sweden, though the RRR is below 1. The lower R^2 value for Sweden may explain the higher level of heterogeneity within the data which could be affecting this result. Few studies have developed indicators of viability but tend to focus on short-term income indicators and these find that whilst diversification reduces risk, the effect on incomes has been mixed (Jetté-Nantel et al., 2011; Katchova, 2005; Nartea and Barry, 1994; Purdy et al., 1997; Schoney et al., 1994; Summer and Wolf, 2002). Nevertheless, comparison with these studies is difficult given different definitions of on-farm and off-farm diversification and these studies generally pertain to other policy environments from the one studied here. However these do at least confirm a causal link between diversification and income viability status (Bateman and Ray, 1994; Eikeland and Lie, 1999; Maye et al., 2009; Walford, 2003).

Tenure status is significant across both viability outcomes and mostly above 1, indicating that tenanted farmers are more viable than owner-occupied farmers. Very few studies have directly related tenancy status to income viability, though some studies have argued that tenanted farmers are more innovative, proxied by indicators such as technical and cost efficiency (Barnes et al., 2010; Manevska-Tasevska and Rabinowicz, 2015). Some studies argue that extra rented land might be a way for achieving a technically optimal size (Ezcurra et al., 2011; Karagiannis and Sarris, 2005) or that farmers having rented land may be more willing to use optimal resource management practices (Ezcurra et al., 2011; Llewelyn and Williams, 1996).

The Single Payment Scheme variable also seems to have had a mixed effect on these two countries and this may be indicative of their implementation, reflecting the underlying aims and rationale for agricultural industry development at national level. For Sweden this has had a negative effect, as evidenced also by Figure 1, and reform has depressed rates of viability. For Scotland, the effect was insignificant which may infer the long-term structural resilience of the Scottish sector with respect to the allocation of historic entitlements or the implementation of Pillar 2 measures which aimed to support viability within Scotland.

The LFA variable is indicative of spatial disadvantage, which is a defining characteristic in both countries and for Sweden this positively relates to non-viability status. However, the significant amount of area dedicated to Less Favoured Areas and their support schemes may have had a mixed effect on viability within Scottish farms. Generally, farm size has been found to be a strong predictor of wider diversification activities (Jetté-Nantel et al., 2011; McNally, 2001) and stocking density, the ratio of grazing units to area, was used to provide a proxy for a number of size related and enterprise effects within the estimation. This variable, whilst significant, only seems to have a marginal effect on viability states and, hence, generally indicates nominal impacts on changing the relative size to production on viability.

5.0 Conclusions

Achieving farm level viability has been a long-standing ambition for agricultural policy. However the attainment and maintenance of financial viability has proven a particularly intractable problem for policy makers due to fluctuations in external markets and cost pressures, but has also been compounded by no overall agreement on what constitutes viability across the range of systems operating in Europe. The heterogeneity of farms, the varied influence of farm and off-farm income and the role of wealth within farmer well-being may explain the lack of progress toward accepted viability thresholds for European agriculture. In addition there is a compelling argument for a need to extend current accountancy frameworks to fully capture the multiple dimensions of financial performance within the farming sector (Agra CEAS, 2007; Hill, 2012)

Applying long-term and short-term criteria accommodates some of these dimensions and reveals how structural constraints and business decision making determine an individual farm’s viability state. Examining across two regions highlights similarities in the magnitude of the problems faced by farmers but also the differences in response to regionalised policy prescriptions aimed at alleviating long-term structural inadequacies. Clearly, despite similar agreements on the administration of CAP support regimes, the translation at national level and the focus on differing goals over both Pillar 1 and Pillar 2 funding has contributed to a divergence with respect to viability between Scotland and Sweden. Additionally, the operationalisation of these policies differ across country and, in some cases, the ambitions for policy do not match the intended effects (e.g. Cook, 2009; EKOS and Cook, 2010; Hansson and Waldenström, 2010). In identifying long-term states of viability we have included underlying asset structures which will be affected by changes in policy, as well as the inherent motivations of farmers to remain within the sector. The chief findings however, are that focusing on diversification offers a trajectory towards viability. This adds to the considerable literature on diversification by identifying its influence on the economic situation of the farm business. Understanding this effect is essential for evaluating the rationale of a policy aiming to support business diversification.

Nevertheless, we are constrained in exploring other aspects of diversification, specifically off-farm activities, as the spatial unit of interest is the farm itself. Hence pluriactivity of the farmer and other members in his/her household, in the sense that they run additional businesses and may be employed outside the farm business, is not included within our definition. This could also be a predictor of viable status amongst these farms. We are also limited by the time frame of study as only in recent years have detailed data been collected on activities which would adequately widen our definition of farm diversification, for example to include processing activities. This also emphasises the temporal nature of definitions within Government data sources of diversification, which reflects the changing nature of the farming system and the data collected to characterise them. Nevertheless, the likelihoods of farm diversification predicting viability seem to fit within the current literature on viability at the farm level. Further work should seek to compare data sets, Government definitions of agricultural diversification and results across wider sets of countries in order to compare these findings. Finally, while diversification is a strategy to account both for seasonal variations in business income and for variations over business cycles, it should also be acknowledged that the decision to diversify may reflect differences between farmers, for instance in their underlying reasons to diversify (e.g. Barbieri and Mahoney, 2009; Brunåker, 1993; Hansson et al., 2013) or in their managerial abilities. These are also aspects that may lead to differences in farm viability and would also merit future investigation.

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References

Agra CEAS, 2007. Feasibility study on the implementation of income of agricultural households sector (IAHS) statistics. Eurostat, Luxembourg.

Ahearn, M., Perry, J.E., El-Osta, H.S., 1993. The economic well-being of farm operator households, 1988-90. US Department of Agriculture, Economic Research Service.

Ahituv, A., Kimhi, A., 2002. Off-farm work and capital accumulation decisions of farmers over the life-cycle: the role of heterogeneity and state dependence. Journal of Development Economics 68, 329-353.

Alsos, A.G., Ljunggren, E., Pettersen, T.L., 2003. Farm-based entrepreneurs: what triggers the start-up of new business activities? Journal of Small Business and Enterprise Development 10, 435-443.

Ansoff, H.I., 1957. Strategies for diversification. Harvard business review 35, 113-124.

Aubin, J.-P., Bayen, A.M., Saint-Pierre, P., 2011. Viability theory: new directions. Springer Science & Business Media.

Bakucs, Z., Ferto, I., Latruffe, L., Desjeux, Y., 2014. Technical efficiency and determinants of mobility patterns in European agriculture. Outlook on Agriculture 43, 19-24.

Barbieri, C., Mahoney, E., 2009. Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers. Journal of Rural Studies 25, 58-66.

Barnes, A.P., Revoredo-Giha, C., Sauer, J., 2011. A metafrontier approach to measuring technical efficiencies across the UK dairy sector, Evidence-based agricultural and rural policy making: methodological and empirical challenges of policy evaluation, February 17-18, 2011, Ancona, Italy.

Barnes, A.P., Revoredo-Giha, C., Sauer, J., Elliott, J., Jones, G., 2010. A report on technical efficiency at the farm level 1989 to 2008. Final Report to Defra, London.

Bateman, D., Ray, C., 1994. Farm pluriactivity and rural policy: Some evidence from Wales 1. Journal of Rural Studies 10, 1-13.

Bosch, J.M.A., 1998. Accounting information and the prediction of farm viability. Universitat Pompeu Fabra.

Brunåker, S., 1993. Farm diversification-new enterprises on competitive markets.

Brümmer, B., 2001. Estimating confidence intervals for technical efficiency: the case of private farms in Slovenia. European Review of Agricultural Economics 28, 285-306.

Carley, D., Fletcher, S., 1988. Financial soundness of Southern dairy farmers participating in the dairy termination program. Agricultural Finance Review 48, 86-93.

Chaplin, H., Davidova, S., Gorton, M., 2004. Agricultural adjustment and the diversification of farm households and corporate farms in Central Europe. Journal of rural studies 20, 61-77.

Cook, P., 2009. Scotland rural development programme: First stage review. P & L Cook and Partners, Aberdeen, UK.

Cordts, W., Deerberg, K.-H., HANF, C.-H., 1984. Analysis of the intrasectoral income differences in West German agriculture. European Review of Agricultural Economics 11, 323-342.

Corsi, A., Findeis, J.L., 2000. True state dependence and heterogeneity in off-farm labour participation. European Review of Agricultural Economics 27, 127-151.

Dillon, E.J., Hennessy, T., Hynes, S., 2010. Assessing the sustainability of Irish agriculture. International Journal of Agricultural Sustainability 8, 131-147.

Disney, W.T., Duffy, P.A., Hardy, W.E., 1988. A Markov chain analysis of pork farm size distributions in the South. Southern Journal of Agricultural Economics 20, 57-64.

Eikeland, S., Lie, I., 1999. Pluriactivity in rural Norway. Journal of Rural Studies 15, 405-415.

EKOS, Cook, P., 2010. An independent evaluation of the 2007-2013 at the mid-term stage. Conducted to meet European Commission requirements. Report. Scottish Government, Edinburgh.

European Commission, 2005. Concil Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), in: Union, O.J.o.t.E. (Ed.), No 1698/2005.

Ezcurra, R., Iráizoz, B., Pascual, P., Rapún, M., 2011. Agricultural productivity in the European regions Trends and explanatory factors. European Urban and Regional Studies 18, 113-135.

Finger, R., El Benni, N., 2014. A note on the effects of the income stabilisation tool on income inequality in agriculture. Journal of Agricultural Economics 65, 739-745.

Frawley, J.P., Commins, P., 1996. The changing structure of Irish farming: trends and prospects. Teagasc Dublin.

Gocht, A., Röder, N., Neuenfeldt, S., Storm, H., Heckelei, T., 2012. Modelling farm structural change: A feasibility study for ex-post modelling utilizing FADN and FSS data in Germany and developing an ex-ante forecast module for the CAPRI farm type layer baseline. Institute for Prospective and Technological Studies, Joint Research Centre.

Gorton, M., Douarin, E., Davidova, S., Latruffe, L., 2008. Attitudes to agricultural policy and farming futures in the context of the 2003 CAP reform: a comparison of farmers in selected established and new Member States. Journal of Rural Studies 24, 322-336.

Hadley, D., 2006. Patterns in technical efficiency and technical change at the farm-level in England and Wales, 1982–2002. Journal of Agricultural Economics 57, 81-100.

Hansson, H., 2007. Strategy factors as drivers and restraints on dairy farm performance: Evidence from Sweden. Agricultural Systems 94, 726-737.

Hansson, H., Ferguson, R., Olofsson, C., 2010. Understanding the diversification and specialization of farm businesses. Agricultural and food science 19, 269-283.

Hansson, H., Ferguson, R., Olofsson, C., 2012. Psychological constructs underlying farmers' decisions to diversify or specialise their businesses–An application of theory of planned behaviour. Journal of Agricultural Economics 63, 465-482.

Hansson, H., Ferguson, R., Olofsson, C., Rantamäki-Lahtinen, L., 2013. Farmers' motives for diversifying their farm business–The influence of family. Journal of Rural Studies 32, 240-250.

Hansson, H., Waldenström, C., 2010. Axel 3 – Utvärdering av åtgärder för att diversifiera landsbygdens ekonomi samt förbättra livskvaliteten på landsbygden. Report. NL-faculty and Department of Economics, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Hennessy, T., O'Brien, M., 2006. The contribution of off-farm income to the viability of farming in Ireland.

Hennessy, T., Shrestha, S., Farrell, M., 2008. Quantifying the viability of farming in Ireland: can decoupling address the regional imbalances? Irish Geography 41, 29-47.

Hill, B., 1982. Concepts and measurement of the incomes, wealth and economic well-being of farmers. Journal of Agricultural Economics 33, 311-324.

Hill, B., 2012. Farm incomes, wealth and agricultural policy filling the CAP's core information gap. CABI.

Ilbery, B.W., 1991. Farm diversification as an adjustment strategy on the urban fringe of the West Midlands. Journal of Rural studies 7, 207-218.

Jetté-Nantel, S., Freshwater, D., Katchova, A.L., Beaulieu, M., 2011. Farm income variability and off-farm diversification among Canadian farm operators. Agricultural Finance Review 71, 329-346.

Johnson, G., Whittington, R., Scholes, K., Pyle, S., 2011. Exploring strategy: Text & cases. Financial Times Prentice Hall Harlow.

Karagiannis, G., Sarris, A., 2005. Measuring and explaining scale efficiency with the parametric approach: the case of Greek tobacco growers. Agricultural Economics 33, 441-451.

Karantininis, K., 2002. Information-based estimators for the non-stationary transition probability matrix: an application to the Danish pork industry. Journal of Econometrics 107, 275-290.

Katchova, A.L., 2005. The farm diversification discount. American Journal of Agricultural Economics 87, 984-994.

Lagerkvist, C.J., Larsen, K., Olson, K.D., 2007. Off-farm income and farm capital accumulation: a farm-level analysis. Agricultural Finance Review 67, 241-257.

Latruffe, L., Dupuy, A., Desjeux, Y., 2013. What would farmers' strategies be in a no-CAP situation? An illustration from two regions in france. Journal of Rural Studies 32, 10-25.

Lindberg, G., Copus, A., Hedström, M., Perjo, L., 2012. CAP Rural Development Policy in the Nordic Countries: What can we learn about implementation and coherence?, Nordregio working paper 2012:6. Nordregio, Stockholm, Sweden.

Lines, A.E., Zulauf, C.R., 1985. Debt-to-asset ratios of Ohio farmers: a polytomous multivariate logistic regression of associated factors. Agricultural finance review (USA).

Llewelyn, R.V., Williams, J.R., 1996. Nonparametric analysis of technical, pure technical, and scale efficiencies for food crop production in East Java, Indonesia. Agricultural Economics 15, 113-126.

MacRae, E.C., 1977. Estimation of time-varying Markov processes with aggregate data. Econometrica: journal of the Econometric Society, 183-198.

Manevska-Tasevska, G., Rabinowicz, E., 2015. Strukturomvandling och effektivitet i det svenska jordbruket, Policy Memo: 2015-01-15. AgriFood Economics Centre, Department of Economics, Swedish University of Agricultural Sciences Lund, Sweden.

Maye, D., Ilbery, B., Watts, D., 2009. Farm diversification, tenancy and CAP reform: Results from a survey of tenant farmers in England. Journal of Rural Studies 25, 333-342.

McNally, S., 2001. Farm diversification in England and Wales—what can we learn from the farm business survey? Journal of rural studies 17, 247-257.

McNamara, K.T., Weiss, C., 2005. Farm household income and on-and off-farm diversification. Journal on Agricultural and Applied Economics 37, 37-48.

Melichar, E., 1995. Farm financial experience and agricultural bankingeExperience, statement before the subcommittee on economic stabilization of the committee on banking, Finance and Urban Affairs, US House of Representatives, Washington DC.

Meuwissen, M.P., Van Asseldonk, M.A., Huirne, R.B., 2008. Income stabilisation in European agriculture: design and economic impact of risk management tools. Wageningen Academic Pub.

Mishra, A.K., El-Osta, H.S., Morehart, M.J., Johnson, J.D., Hopkins, J.W., 2002. Income, wealth, and the economic well-being of farm households. US Department of Agriculture, Economic Research Service Washington, DC.

Mishra, A.K., Sandretto, C.L., 2002. Stability of farm income and the role of nonfarm income in US agriculture. Review of Agricultural Economics 24, 208-221.

Murdock, S.H., Leistritz, F.L., 1988. The Farm financial crisis: socioeconomic dimensions and implications for producers and rural areas. Westview Pr.

Nartea, G.V., Barry, P.J., 1994. Risk efficiency and cost effects of geographic diversification. Review of Agricultural Economics 16, 341-351.

Northcote, J., Alonso, A.D., 2011. Factors underlying farm diversification: the case of Western Australia's olive farmers. Agriculture and Human Values 28, 237-246.

O'Donoghue, C., 2013. Modelling farm viability, Spatial microsimulation for rural policy analysis. Springer, pp. 177-191.

Phimister, E., 1995. The impact of borrowing constraints on farm households: A life-cycle approach. European Review of Agricultural Economics 22, 61-86.

Phimister, E., Roberts, D., Gilbert, A., 2004. The dynamics of farm incomes: Panel data analysis using the farm accounts survey. Journal of Agricultural Economics 55, 197-220.

Purdy, B.M., Langemeier, M.R., Featherstone, A.M., 1997. Financial performance, risk, and specialization. Journal of Agricultural and Applied Economics 29, 149-161.

Salant, P., Smale, M., Saupe, W.E., 1986. Farm viability: results of the USDA family farm surveys. United States, Department of Agriculture, Economic Research Service.

Schoney, R., Taylor, J., Hayward, K., 1994. Risk Reduction from Diversification and Crop Insurance in Saskatchewan, Economics of Agricultural Crop Insurance: Theory and Evidence. Springer, pp. 293-305.

Serra, T., Goodwin, B.K., Featherstone, A.M., 2004. Determinants of investments in non-farm assets by farm households. Agricultural Finance Review 64, 17-32.

Solís, D., Bravo-Ureta, B.E., Quiroga, R.E., 2009. Technical efficiency among peasant farmers participating in natural resource management programmes in Central America. Journal of Agricultural Economics 60, 202-219.

Sorrentino, A., Henke, R., 2011. The common agricultural policy after the Fischler Reform: national implementations, impact assessment and the agenda for future reforms.

SRUC (2013). The Farm Management Handbook. SAC Consulting, Edinburgh

StataCorp, L., 2014. Stata/IC 13.1 for Windows. College Station, TX: Author.

Storm, H., Heckelei, T., Mittelhammer, R.C., 2011. Bayesian estimation of non-stationary Markov models combining micro and macro data.

Summer, D.A., Wolf, C.A., 2002. Diversification, vertical integration, and the regional pattern of dairy farm size. Review of Agricultural Economics 24, 442-457.

Terluin, I.J., Godeschalk, F.E., von Meyer, H., Post, J.H., Strijker, D., 1995. Agricultural income in less favoured areas of the EC: a regional approach. Journal of Rural Studies 11, 217-228.

Tonini, A., Jongeneel, R., 2009. The distribution of dairy farm size in Poland: a Markov approach based on information theory. Applied Economics 41, 55-69.

Turner, M., Winter, D., Barr, D., Fogerty, D., Errington, A., Lobley, M., Reed, M., Whitehead, I., 2003. Farm diversification activities: benchmarking study 2002-final report to DEFRA. Centre for Rural Research, University of Exeter and Rural and Tourism Research Group, University of Plymouth.

Wadsworth, J.J., Bravo-Ureta, B.E., 1992. Financial performance of New England dairy farms. Agribusiness 8, 47-56.

Walford, N., 2003. A past and a future for diversification on farms? Some evidence from large-scale, commercial farms in South East England. Geografiska Annaler: Series B, Human Geography 85, 51-62.

Vik, J., McElwee, G., 2011. Diversification and the Entrepreneurial Motivations of Farmers in Norway*. Journal of Small Business Management 49, 390-410.

Vrolijk, H.C.J., De Bont, C., Blokland, P., Soboh, R., 2010. Farm viability in the European Union: Assessment of the impact of changes in farm payments. LEI Wageningen UR.

Zepeda, L., 1995. Technical change and the structure of production: a non-stationary Markov analysis. European Review of Agricultural Economics 22, 41-60.

Zimmermann, A., Heckelei, T., 2012. Structural change of European dairy farms–A cross-regional analysis. Journal of Agricultural Economics 63, 576-603.

Zimmermann, A. T. Heckelei, Domínguez, I.P., 2009. Modelling farm structural change for integrated ex-ante assessment: review of methods. erminants.
Environmental Science & Policy 12(5):601–618.

Table(s)

Table 1. Structural characteristics of the farms in Scotland in Sweden, Farm accounting surveys mean 2002-2012

Sample characteristics	Scotland	Sweden
Total number of observations in the sample, in N°	6044	8712
Average Annual farms in sample, in N°	462	792
Average farm size (arable, pastures), in ha	127	108
Farm size < 50 ha, in %	15%	32%
Farm size >=50 < 100 ha, in %	34%	34%
Farm size >=100 < 200ha, in %	36%	21%
Farm size >=200 ha, in %	15%	13%
Land under less favoured area status, in %	72%	55%
Share of owner occupied land, in %	47%	53%
Average livestock units per farm, in N°	143	95
Total ivestock units per ha (arable and pastures), in N°	1.5	1.3
Total labour on the farm (farmer, spouse and paid), in hours	4,001	3,546
Share of own labour, in %	73%	88%
Average age of farmers, in years	56	53

Table 2. Descriptions for the independent variables used

Variable	Variable Name	Description
β_1	Agricultural Diversification	A continous variable representing the amount of agricultural diversification relative to total gross output within the farm.
β_2	Farm Diversification	A continous variable representing the amount of farm diversification
β_3	Tenure	A dummy variable representing tenanted relative to owner-occupied status
β_4	Single Payment Scheme	A dummy variable accounting for decoupling subsidy regime in 2005
β_5	Less Favoured Area Status	A dummy variable identifying land under Less Favoured Area status
β_6	Stocking Density	A continous variable representing the ratio of grazing livestock units to forage area.

Table 3. Markov Chain transition probabilities for Scottish and Swedish viability index

		Current State		
	Previous State	Viable	Viable / Non-Viable	Non-Viable
Scotland	Viable	*0.93*	0.04	0.03
	Viable/Non-Viable	0.33	*0.47*	0.20
	Non-Viable	0.33	0.16	*0.52*
Sweden	Viable	*0.81*	0.15	0.04
	Viable/Non-Viable	0.28	*0.47*	0.25
	Non-Viable	0.09	0.22	*0.69*

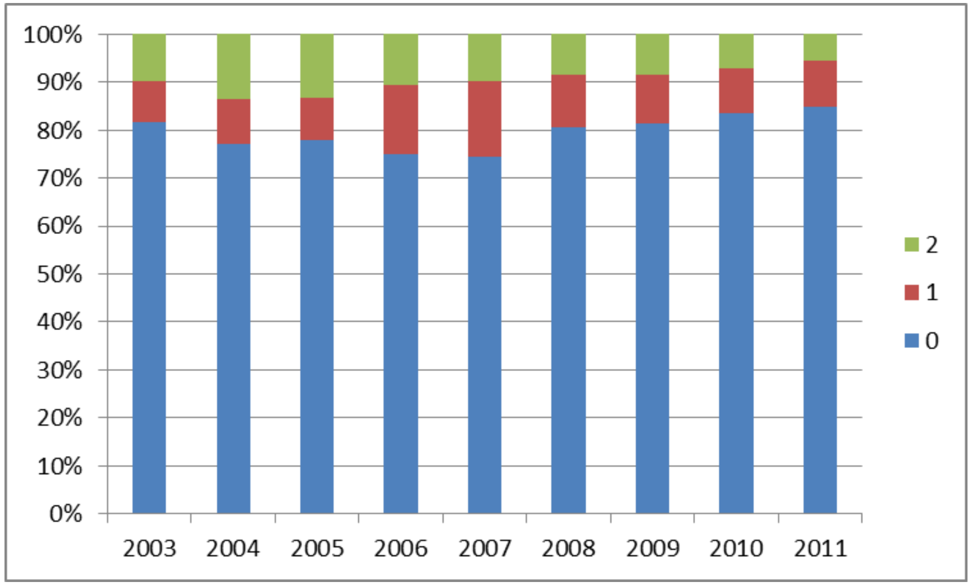
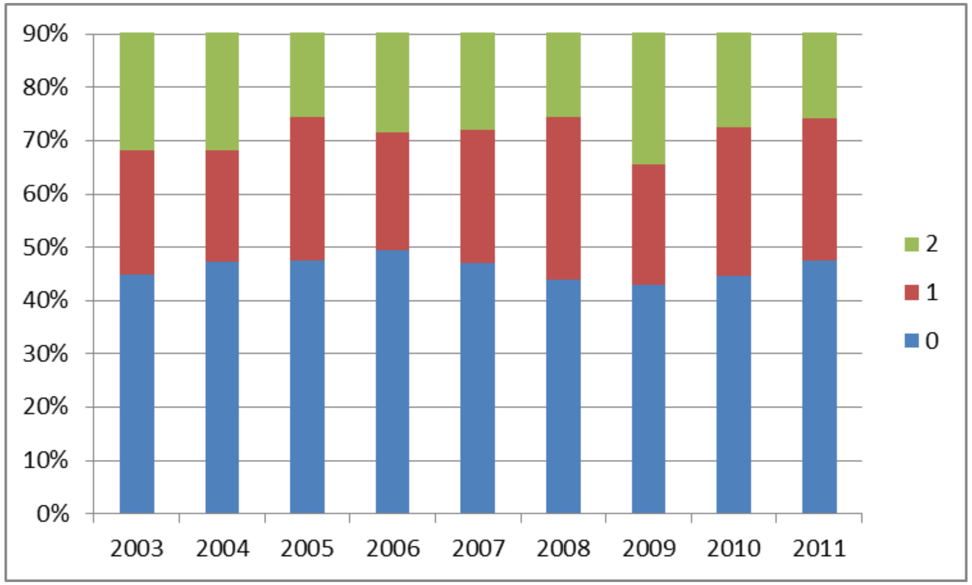
Table 4. Multinomial regression of farm viability states, relative risk ratios and standard errors

		Scotland	Sweden
Outcome 1: Short-term viable & long-term non-viable~			
		exp(β)	*exp(β)*
Intercept	α	0.148***	1.569***
		(0.046)	*(0.092)*
Agricultural diversification	β_1	0.391***	0.939
		(1.545)	(0.058)
Farm diversification	β_2	*0.061****	0.576***
		(0.032)	(0.088)
Tenure	β_3	0.519***	1.428***
		(0.080)	(0.083)
Single payment scheme	β_4	0.775	1.820***
		(0.122)	(0.128)
Less Favoured Area status	β_5	0.928	1.204**
		(0.246)	(0.073)
Stocking density	β_6	0.117*	1.002*
		(0.128)	(0.001)
Outcome 2: short term & long term non-viable~			
		exp(β)	*exp(β)*
Intercept	α	0.064***	0.962***
		(0.021)	(0.084)
Agricultural diversification	β_1	0.356***	0.643***
		(1.403)	(0.040)
Farm diversification	β_2	0.553**	0.216***
		(0.214)	(0.037)
Tenure	β_3	1.208***	1.263***
		(0.195)	(0.071)
Single payment scheme	β_4	1.380	1.319***
		(0.235)	(0.085)
Less Favoured Area status	β_5	0.775	1.555***
		(0.198)	(0.093)
Stocking density	β_6	0.0002***	0.995***
		(0.0004)	(0.001)
McFadden's R^2		0.053	0.025
Cragg & Uhler's R^2		0.088	0.058
Count R^2		0.827	0.528
LR		139.7***	448.7***

~Compared to base outcome: (0) Short term viable/ long term viable (*Sig: * = 0.05; **=0.01; ***0.001)*

Figure(s)

Figure 1. Distribution of viability states over time, proportion for Scotland and Sweden

Scotland	**Sweden**
	

Key: Viability State 0: Viable; 1: Short-term Viable/Long-term Non-Viable; 2 Non-Viable