Analysis of Farm Development in Dutch Agriculture and Horticulture

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Analysis of Farm Development in Dutch Agriculture and Horticulture

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Abstract

This paper analysis the effects of farmer characteristics, firm structure and firm performance on firm renewal and firm growth. The data set used in this research consists of panel data from the Dutch Farm Accountancy Data Network of firms specialized in plant production extended with a data from survey among those firms. Probit models were used to determine the likelihood of the changes. Results show that the degree of mechanization increases the probability of firm growth and firm renewal. Family labour input and solvency have a negative impact on firm growth. Firm size is positively correlated with firm renewal. No indications of the influence of the life cycle have been found.

Key words: decision making, diversification, farm growth, farm structure, innovation, panel data

1 Introduction

Worldwide, agricultural production is currently undergoing major structural changes. Changes in U.S. agriculture include the transformation from an industry dominated by family-based, small-scale and relatively independent firms to an industry that is structured in line with the production and distribution value chain. Other important changes include the adoption of process control technology. Agricultural production is changing from growing commodities to manufacturing biologically based specific attribute raw materials (Boehlje 1999). Comparable developments are taking place in Europe, thereby stimulating the development of large-scale farms. As a consequence, in many countries across the world, the number of farms is decreasing, whereas the average farm size is increasing. Yet another development is that many governments (especially in Europe) stimulate the transformation from conventional to organic farming, mainly as a result of environmental and food-safety concerns.

Developments described here can be seen as external and internal forces that agriculture and horticulture must respond to. Goddard (1993) distinguishes eight major causal factors: technology, prices, human capital, economic growth, demographics, off-farm employment, related market structure and public programs. The adjustment of agriculture and horticulture is the result of all individual firm responses together. The structural change in agriculture is characterized by heterogeneous responses of firms. Gow (1995) reviewed the variety of adjustment responses at the farm level and distinguishes two categories, i.e. farm-related and household-related responses. Farm related responses include postponement, restructuring, firm growth, diversification, exit and other factors. Household-related responses refer to activities to save money by lowering expenses, or increasing off-farm income. Most empirical studies about farm-related adjustments focus on explaining one type of farm adjustment, i.e. firm growth, diversification or innovation. Some studies have focused on incremental improvements (e.g. Zachariasse, 1974). However, there is evidence that certain interrelations exist between different types of radical adjustments (e.g. Boehlje, 1999). For example, some innovations have economies of scale and will support farm growth. Few studies deal with more than one direction of farm development (Goddard, 1993; Gow, 1995; Boehlje, 1999). However, to understand the whole process of radical adjustments, those adjustments have to be studied in an integrated way.

The objective of this paper is to analyse the effects of characteristics of the farmer, farm structure and performance on farm renewal and farm growth. The data set used combines panel data from the Dutch Farm Accountancy Data Network of firms specialized in plant production and data from a survey among those firms. Binary choice models were used to determine the likelihood of the changes.

The remainder of this paper is structured as follows: Section 2 presents a review of the literature. This is followed in section 3 by a description of the branch characteristics. In section 4 the empirical model, data and estimation methods are discussed. Section 5 presents the results and the paper concludes with comment in section 6.

2 Literature review

Empirical studies at farm level beyond testing Gibrat's Law of Proportionate Effects are rare. In essense Gibrat's Law implies that farm growth is determined by random factors and that it is independent of initial farm size (Weiss 1999), i.e. proportionate changes in size are independent of current size and past history. Firm growth refers to increases in business size (Barry, 2000). Clark (1992) found that Gibrat's Law was not rejected for several regions in Canada. Correspondingly, diseconomies of size found little support in their study. In Austria, Weiss (1999) found two separate "centers of attraction" of farm size. Part-time farms tend to grow to a lower farm size than full-time farms. He suggests to account for additional economic determinants like farm income, debt, profitability, productivity and farmer's attitude towards risk in order to explain firm survival and growth. On the base of longitudinal analysis of farm size over the farmer's life cycle, Gale (1994) concluded that firms of young farmers grow faster than farms of more experienced farmers. Old farmers rather tend to decrease farm size. The studies mentioned here use acreage as a measure of firm size.

Gertler (1996) links firm growth directly to specialization by stating that the government's efforts in the Canadian Plains have been directed towards increasing production and labour productivity by their positive effect on firm size, capitalization and specialization of surviving farms. Specialization, enables a farmer to concentrate management and capital on production of fewer commodities at a larger scale, and thus to spread fixed costs over more acres of crop, or head of livestock. Diversification includes production of other products (horizontal) and introduction of complementary business such as food processing (vertical). Initiatives to diversification can be located within firms and in joint-ventures. In a sociological study, Anosike (1990) tried to explain the rate of diversification of Kentucky farmers and found a positive relationship between the rate of diversification, firm size and the level of education. Also regional differences in land and soil types were found to have an impact on diversification. Although this study aimed at providing more insight in the decision making process and thus in diversification decision, the approach was focused on explaining the rate of diversification instead of the process.

The diffusion and adoption of innovations have been widely studied in agriculture. Innovation is defined as an idea, practice of object that is perceived as new by an individual of other unit of adoption. Diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system. Adoption is the individual decision to make use of an innovation (Rogers 1995). These approaches assume that farmers and growers are (hardly or) not involved in the development of innovations. This corresponds to the taxonomy of innovations by Pavitt (1984), who classifies the innovation process in agriculture as a process that is dominated by suppliers. As a consequence, in most empirical studies the innovation process has been studied in relation to a certain innovation mature for application. The question which factors support investment in the development of innovative concepts has remained largely out of consideration.

Diffusion studies provide some useful information on this issue. On the base of the innovation adoption speed, Rogers (1995) divided firms into several adopter categories. On the base of this division, characteristics of the ideal types of these adopter categories have been studied. Considering the socio-economic status, Rogers states that a positive relationship exists between wealth and the degree of innovativeness, although not all wealthy farmers are found to be innovative. The question about the causal relation remains question to answer. Some new ideas are costly to adopt but provide, if successful, first-mover advantages. A positive relationship also exists between education and the degree of innovativeness. Early adopters generally have larger firms than late adopters. Rogers (1995) did not find relationships between innovativeness and age.

Yaron et al. (1992) have developed a method to determine the innovativeness of farmers based on the extent of use of a divisible technology, the time of adoption and the thoroughness of adoption. Aggregation of indexes for single innovations results in a total index of innovativeness. They found that innovativeness is not affected by education, positively affected by risk tolerance and extension contacts, and negatively by farm size. An explanation of the latter outcome is that farmers strive to increase their income by adoption of input-intensive innovations, due to lack of firm growth possibilities. This finding supports the induced innovation hypothesis of Hayami (1985), who hypothesize that the direction of innovation is affected by (changes in) relative prices of production factors. Labor scarcity results in high labor costs, which supports the development of labor saving techniques. Land scarcity results in high land prices which supports the development of products and techniques which increase production per ha.

All studies have in common that they try to explain changes on the base of firm structure or personal characteristics of the farmer. The diversity in explanations does not provide a blueprint for a general theory. In this paper we define two main categories, i.e. renewal and firm growth. Renewal covers all changes at the firm requiring the application of new knowledge and includes diversification and innovation. By combining diversification and innovation into one category, potential overlap between the two is avoided.

3 Branche characteristics

This study is applied to a broad range of firms specialized in plant production in arable farming and horticulture. A summary of the characteristics of these branches is presented in table 1. The total production value indicates the economic importance of the branches in Dutch agriculture. The number of specialized firms and the average firm size are an indication how production is structured. The annual average change of the number of firms reflects the speed of restructuring and the average profitability indicates the economic performance of the branches.

Table 1 Charactistics of Dutch plant production

Branch	Total prod value (* 10^9 Euro, 2000)	Number of specialized firms, with average annual change (%) (1990-2000)	Av. Dutch size Units per firm based upon gross standard margin (2000) 1 unit = 1.390 Euro	Av. Profitability. 1996 – 2000 (revenues/costs *100%)	Average of Total Agr. Work units per firm (2000)
Arable farming	2.2	13.749 (-1.7%)	57	86	1.37
Mushroom	0.3	516 (-4.1%)	234	93	5.97
Field vegetable prod.	1.2	2.644 (-4.6%)	212	102	5.38
Cut flower prod	3.5	5.264 (-1.3%)	197	98	5.24
Pot plants prod				99	
Vegetable under glass prod	0.4	1.459 (-5.3%)	64	86	2.68
Fruits	0.3	2.211 (-2.4%)	55	78	1.95
Flower bulbs	0.6	2.879 (-1.1%)	172	98	3.15
Nurseries stock	0.5	2.430 (-1.5%)	78	93	2.77

LEI, CBS (2000)

Arable farms mainly grow potatoes, sugar beets and cereals. The Dutch arable farming sector is internationally of minor importance. The average farm cultivates 50 hectares of land. Arable farms are faced by decreasing profitability, mainly caused by lower support of the European Union. Increase of firm size is desirable to benefit from economies of scale, but is difficult to achieve because of the large demand for land for nature development, infrastructure, industries, growth of cities and other agricultural sectors. Alternative strategies are to grow products with higher net added value per ha, like vegetables and flower bulbs. The number farms is decreasing by 1.7% per year (Anonymous, 2001). The profitability of arable farming is rather low compared to other branches. An explanation is that the solvency is rather high due to the fact that a large share of the total capital consists of the value of farmland. Yet another explanation for low profitability is that a large share of the labour input is supplied by the farmer and his family.

Internationally, Dutch horticulture plays an important role. The majority of the products grown under glass, nursery stock and flower bulbs are exported, mainly to European countries. Producers of fruits and field vegetables are structurally faced with decreasing profitability, which has resulted in a large decrease of the number of firms. In the early nineties, the production of vegetables under glass has suffered a major crisis due to a bad environmental product image in Germany. The large decrease of the number of firms, market and product innovations have led to a higher profitability in the late nineties. The share of non-food products in total production is increasing. Producers of ornamental products like flowers, bulbs, ornamental trees, are less vulnerable to the market situation.

4 Empirical model and data

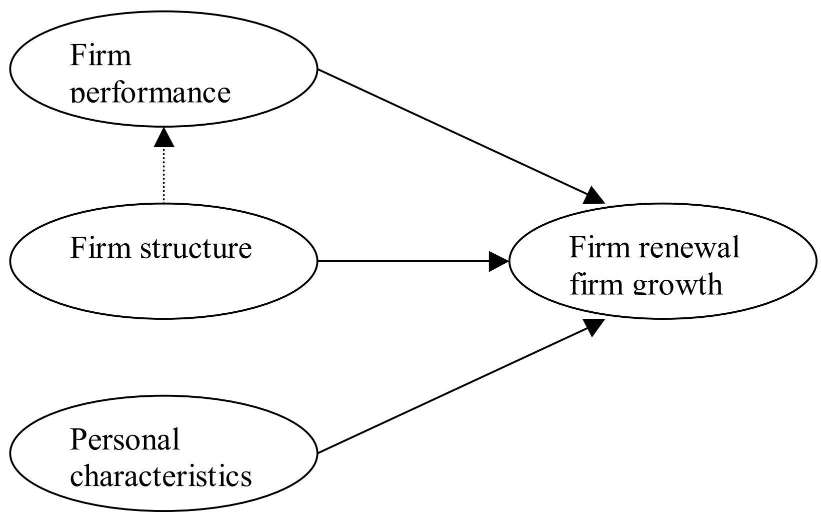

Figure 1 Conceptual model.

Conceptual model

The dependent and independent factors that have been mentioned in the literature review have been summarized in the conceptual framework in Figure 1. Also, the figure indicates the assumed causality of the relationships. It is hypothesized that decisions to change the firm by renewals or firm growth are influenced by personal characteristics, (financial) performance and the firm structure. Personal characteristics refer only to objective aspects like age of the entrepreneur and education. Subjective aspects like risk attitude and personal objectives have not been included of the research due to lack of data.

Data

Panel data of firms in horticulture and arable farming have been obtained from a rotating panel of farms that participate in the Dutch Farm Accountancy Data Network (FADN). The FADN data contains an abundance of high quality data on firm structure, investments, performance etc. and have been collected by the Agricultural Economics Research Institute. A selection of firms has been made using a number of criteria. First, the sample has been restricted to firms that have participated for at least four years. Second, the last year of participation should be 1996 or later. The selected firms have been asked to participate in an additional survey in order to collect more detailed data about their strategic and innovative behaviour. This resulted in the participation of 141 firms: 55 arable farms and 86 horticultural firms. The response rate in the survey for arable farms was 75% and for horticulture 67%. The selected firms participated, on average 7 years in FADN. The only exception may be that the age of the entrepreneur is rather high.

Two explained variables are distinguished, i.e.firm renewal (diversification and innovation) and firm growth. As a general rule, firm renewal was observed from the available FADN data. However, innovation and diversification within the chain (integration) was only observed from the additional survey. An example of integration is a grower who starts breeding new varieties. Farmers and growers have been asked to mention the most important strategic changes and innovations at the firm. Afterwards the answers have been classified into different categories. The answers of the participants have been checked and compared with the investment level reported in the FADN data. To trigger horizontal diversification the farmer or grower has to expand his activities by growing a new genus. An arable farmer producing barley next to wheat is not diversifying. However, the same farmer starting to grow leguminous plants is diversifying.

Firm growth is measured as a dummy variable which takes the value 1 if the area and production size both increased by at least 5%. Explanatory variables have been selected in order to reflect personal characteristics, firm structure and firm performance.

To characterize the entrepreneur, age, time horizon, labour input of family members and off-farm income have been taken into account. Time horizon has been included as a dummy variable that takes the value of 1 if the time horizon is long, i.e. if entrepreneurs have a successor or have an age lower than 50. Labour input is measured as the number of hours per year the family of the entrepreneur is working on the firm. Off-farm income includes revenues from labour and capital outside the firm, social benefits etc. minus private costs (the off-farm income can be negative). Education is reflected by a dummy variable, that takes the value one for farmers that have finished at least secondary school and zero otherwise. No data about education were available from firms in horticulture.

Firm structure is reflected by the variables: soil type, location, firm size solvency and mechanisation. For arable farms, the soil type has been divided into two groups: sand and clay. For glasshouse cultivation, a regional dummy is included which takes the value one for firms in the Westland, i.e. the glasshouse district in the western part of the country, and zero for firms in other regions. Firm size is given by a standardized measure based upon the net value added per ha. This criterion allows for compare size of activities between different branches like arable farming and greenhouse cultivation. Solvency is given by the percentage equity capital of total capital. The degree of mechanization has been determined by the sum of replacement value of all durable goods per ha. To compare different sectors, the individual score has been divided by the average of the sector[1]. This average has been derived from all firms participating in the FADN.

Profitability is the only variable in the category performance and is measured as the ratio of revenues and costs. In order to correct for structural differences in average profitability between sectors, the individual profitability has been divided by the mean of the branch, which was obtained from the FADN.

Table 2. Descriptive statistics of the sample

Variable	Mean	St. dev.	Description
Explained variables			
EXP	0.084	0.28	1 if both area and firm size are increased by at least 5%
REN	0.114	0.32	1 if renewal of firm has taken place
Branch differences			
IVO	0.380	0.486	1 if protected production (greenhous cult., mushrooms)

[1] The invested amount of durable goods per ha is very high in cultivation under glass and very low in arable farm because of the intensity of land use.

AVH.	0.627	0.484	1 if arable farming
Personal characteristics			
AGE	46.0	10.6	Age of the entrepreneur
SUC	0.825	0.380	1 if entrepreneur has a long time horizon
OFI	1.395	8.207	Off farm income * f 10.000
EDU*	0.320	0.467	1 if educational level is at least secondary school
Firm structure			
SIZE	501	405	Firm size (sbe)
FLI	636	785	Family labour input (total hours)
SOLV	0.61	0.34	Solvency (equity capital / total capital)
MECH	876	379	Degree of mechanization (replacement value per ha/ average replacement value per ha of branch)
Performance			
PROF	0.99	0.19	Profitability (total revenues / total costs)

* only for arable farming

A description of the data set that is used in this paper is given in table 2. Only a part of the explanatory variables (like costs, profitability) are continuous variables. The dependent variables are binary variables. Probit models are able to handle these dependent variables. Probit models allow for an assessment of the impact of different explanatory variables on the probability of an event (formulated as a binary choice) and assume that the error terms of the functions follow a normal distribution (Greene 1997).

The following functions in which firm renewal (REN) and firm growth (EXP) are endogenous variables have been estimated:

$$\text{Prob (REN=1)} = \phi\, (\alpha_0 + \alpha_1 AGE + \alpha_2 SUC + \alpha_3 EDU + \alpha_4 OFI + \alpha_5 SIZE + \alpha_6 LOC + \alpha_7 FLI + \alpha_8 SOLV + \alpha_9 MECH + \alpha_{10} PROF + e) \quad (1)$$

$$\text{Prob (EXP=1)} = \phi\, (\beta_0 + \beta_1 AGE + \beta_2 SUC + \beta_3 EDU + \beta_4 OFI + \beta_5 SIZE + \beta_6 LOC + \beta_7 FLI + \beta_8 SOLV + \beta_9 MECH + \beta_{10} PROF + e) \quad (2)$$

Where ϕ is the normal cumulative density function.

5 Results and discussion

Probit models consistent with (1) and (2) have been estimated using the statistical package LIMDEP (Greene, 19..). Marginal effects have been calculated using parameter estimates of the probit models and are presented in table 3. Two exogenous variables have been added to distinguish different types of production. The first variable (OVI) distinguishes protected production (production of mushrooms and cultivation under glass) from unprotected production. The second variable (AVH) distinguishes arable farming and horticulture. The results show that firm growth is much more likely at firms specialized in field production than at firms specialized in protected production. This can be explained by the fact that firm growth in protected production requires huge investments in buildings, which are largely sunk costs. In field production, expansion of the firm can be realised by renting additional land, which can be easily given up if profits drop. Therefore firm growth in protected cultivation more risky and thus less likely than in field production.

Table 3 Parameter estimates and goodness of fit of probit model based on all observations

Variable	Firm growth		Firm renewal	
	Marginal effect	Significance	Marginal effect	Significance
Const.	-0.1068	0.1580	-0.1832	0.0645*
IVO	-0.1196	0.0000***	-0.0129	0.6591
AVH	0.0553	0.0040***	0.0181	0.5325
AGE	-0.0475	0.5861	-0.1725	0.1423
SUC	-0.0218	0.3853	-0.0048	0.8830
OFI	0.0020	0.2052	-0.0003	0.7995
SIZE	-0.0514	0.1603	0.0774	0.0047***
FLI	-0.0277	0.0415**	0.0233	0.0720*
SOLV	-0.0614	0.0336**	-0.0467	0.1687
MECH	0.3707	0.0857*	0.6288	0.0295**
PROF	0.0187	0.6486	-0.0489	0.4113
		Goodness of fit		Goodness of fit
ZM R^2		0.355		0.299

* significant at < 10% level
**significant at < 5% level
*** significant at < 1% level

Personal characteristics, structure and performance

It is obvious from the results that firm structure has a larger impact on firm development than personal characteristics and performance. Contrary to prior expectations, no significant relationships have been found between age, succession, off-farm income and firm development indicating that the life cycle has no influence on firm development. The results indicate that the degree of mechanization has the largest marginal impact on firm development, i.e. it is positively correlated with both firm growth and renewal. A high degree of mechanization implies high investments in the past, encouraging firm renewal and firm growth. Family labour input and solvency are negatively correlated with firm growth. Renewal is more likely at big firms than at small firms, whereas, in accordance with Gibrat's Law, firm size has no significant impact on firm growth. These results indicate that firms that have invested in firm development in the past are also more likely continuing their efforts to renew or increase the firm. Profitability is not correlated with both forms of firm development, indicating that long term decisions are not induced by short-term variation in firm profitability.

The goodness of fit of the estimated models has been determined by computing a pseudo R^2 using the formula given by Zavoina and McKelvey (Greene 1997). The outcomes show that the model predicting firm growth (ZM $R^2 = 0.355$) is slightly better than the model predicting firm renewal (ZM $R^2 = 0.299$). A possible explanation is that firm renewal requires more knowledge and is a riskier strategy than firm growth. This may indicate that the model can be improved by including personal factors like objective, perceptions and risk attitude. An alternative measure of goodness of fit is given by the frequencies of actual and predicted outcomes (Appendix A: Table A.1). Generally, the results show that a large proportion of zero observations is predicted correctly, whereas the other observations are overall predicted incorrectly. The poor prediction of the occurrence of renewal and firm growth in this case is a common feature of probit models that are estimated on data containing a small share of one choice alternative. Most firms provide only five or six observations and firm growth and renewal take place in a limited number of years. A second reason may be that the incentive to change cannot be limited to one year.

Comparison of branches

Because of the significant impact of type of production on firm growth, the data have been split into three groups: arable farming, protected horticulture and unprotected horticulture. The latter category was excluded because of the high heterogeneity within this group and because the difference between arable farming and horticulture protected production is rather high. Afterwards, estimations have been repeated for these two groups. Results are summarized in table 4 for arable farming and in table 5 for protected horticulture. The most obvious result is that firm size has a negative effect on firm growth for protected production in horticulture and a positive effect on arable farming. This result indicates an increasing diversity in firm size in arable farming and a decreasing diversity in protected cultivation. This result is contrary to the currently observed trend towards large-scale firms in horticulture. The second significant result is that firm growth is positively correlated with the age of the entrepreneur in protected horticulture. This can be explained by the fact that firm growth requires huge investments, which can be paid after a period of good earnings. The negative relationship between profitability and firm growth in protected horticulture is caused by the fact that a time lag between investment and full capacity utilisation exists. The negative effect of profitability has to be considered as a result instead of a cause of firm growth. Differences in location do not effect firm development in protected cultivation i.e. firms in the glasshouse district (Westland) do not differ from other firms in terms of firm renewal and firm growth. Education is not an important factor for explaining differences in firm development in arable farming. The positive effects of firm size and degree of mechanization are expected a priori.

Table 4 Parameter estimates of probit model based on observations in arable farming

Variable	Firm growth		Firm renewal	
	Marginal effect	Significance	Marginal effect	Significance
Const	- 0.2620	0.0799*	- 0.2585	0.0491**
Age	0.0387	0.7961	- 0.0555	0.6532
Suc	- 0.0297	0.5812	0.0556	0.3529
Ofi	0.0029	0.1217	0.0011	0.3124
Edu	0.0085	0.8100	- 0.0285	0.3575
Size	0.1901	0.0884*	0.2579	0.0054***
FLI	0.0443	0.2169	0.0126	0.6065
Solv	- 0.0409	0.4710	- 0.0067	0.8899
Mech	0.6182	0.1958	0.9813	0.0204**
Prof	- 0.0408	0.6371	- 0.1237	0.1286
		Goodness of fit		Goodness of fit

ZM R^2	0.283	0.327

* significant at < 10% level
**significant at < 5% level
*** significant at < 1% level

According to Gale (1994) finding a negative relationship between age and firm growth, it can be hypothesized that a negative relationship exists between innovations and other types of renewals at the firm and the age of the farmer. It is more profitable to use the creativity for a young entrepreneur than for an entrepreneur who knows that his remaining time is limited, although the presence of a successor may have major influence. At the moment a successor enters the firm, he or she will more be interested in taking over the if the firm provides good prospects for generating income in the future. On the other hand, a farmer or grower who knows that there is no successor will not be interested in new investments if the time is too short to repay the investment. So it is assumed that the decision to innovate or expand the firm is positively related to the presence of a successor. This a priori expected relationship gets only little empirical support by a significant influence of the presence of a successor and firm renewal in arable farming. It is possible to consider firm growth in arable farming as a temporary strategy because of the reversible character. This view is supported by the positive relationship between age and firm growth in arable farming.

Table 5 Parameter estimates of probit model based on observations in horticulture protected.

Variable	Firm growth		Firm renewal	
	Marginal effect	Significance	Marginal effect	Significance
Const	-0.0005	0.5996	-0.1205	0.5853
Age	+0.0022	0.0726*	-0.3374	0.1946
Suc			-0.0540	0.3930
Ofi	+0.0000	0.3510	-0.0028	0.6762
Loc	+0.0002	0.5217	-0.0618	0.1585
Size	-0.0012	0.0920*	+0.0750	0.0908*
Fli	-0.0004	0.1224	+0.0229	0.3216
Solv	-0.0002	0.5200	-0.0690	0.2882
Mech	-0.0011	0.7763	+0.3880	0.5910
PROF t-1	-0.0021	0.0334**	+0.0126	0.9344
PROF t-2	+0.0016	0.0714*	-0.0000	0.9318
		Goodness of fit		Goodness of fit

ZM R^2	0.780	0.319

* significant at < 10% level
**significant at < 5% level
*** significant at < 1% level

For both groups, pseudo R^2 (ZM) have been computed (table 4 and 5). The goodness of fit of the models to predict firm growth (ZM R^2 = 0.283) and firm renewal (ZM R^2 = 0.327) in arable farming does not differ significantly from the models based on the total data set. Remarkably, the goodness of fit of the model predicting firm growth in horticulture (0.78) is rather high. The frequencies of actual and predicted outcomes, for both groups are presented in appendix A (Table A.2 and A.3). The results in Tables A.2 and A.3 show the same pattern as before, i.e. that zero observations are predicted correctly in a large number of cases, whereas the occurrence of renewal and growth is overall predicted incorrectly.

6 Concluding remarks

The purpose of this research was to analyse the impact of firm structure, firm performance and personal characteristics of the farmers on firm renewal and firm growth. Farm accountancy data from arable farms and horticultural firms have been combined with data from an additional survey. The effects of different variables on firm growth and firm renewal have been estimated using probit models.

The results show that firm structure has a larger impact on firm renewal and firm growth than personal characteristics and performance. This indicates a tendency towards increasing diversity within agriculture. The degree of mechanization has the largest marginal impact on both firm renewal and firm growth. In line with previous literature, firm growth is found to be independent of firm size. The absence of significant relationships between parameters considering the life cycle of the firm and time horizon are not in line with literature and need further analysis. Separate estimation of probit models for arable farming and protected horticulture shows that firm size has a negative impact on firm growth in horticulture and a positive impact in arable farming. Firm growth has a higher frequency in arable farming than in horticulture.

The frequencies of correct predictions show that the present models do not provide a satisfactory explanation for firm growth and firm renewal. The explanation of the process of firm growth and firm renewal may improve if the decision making process is incorporated in the model. This implies that the model should be expanded with long term objectives and risk attitudes of the entrepreneur, his information gathering and processing behaviour and his perception of firm and environment.

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Appendix A Frequencies of actual and predicted outcomes.

Table A.1 Frequencies of actual and predicted outcomes for firm growth and firm renewal, total data set

	predicted		
Actual	0	1	total
Firm growth			
0	730	0	730
1	66	1	67
Total	796	1	797
Firm renewal			
0	828	0	828
1	106	0	106
Total	934	0	934

Table A.2 Frequencies of actual and predicted outcomes for firm growth and firm renewal in arable farming

	predicted		
Actual	0	1	total
Firm growth			
0	271	0	271
1	26	0	26
Total	297	0	297
Firm renewal			
0	319	0	319
1	29	0	29
Total	348	0	348

Table A. 3 Frequencies of actual and predicted outcomes for firm growth and firm renewal in protected horticulture

predicted			
Actual	0	1	total
Firm growth			
0	254	0	254
1	5	1	6
Total	259	1	260
Firm renewal			
0	303	0	303
1	52	0	52
Total	355	0	355