Entry and Exit of firms explained by trigger points: Dutch glasshouse horticulture

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Abstract

The entry and exit decisions, considered as investment decisions, are investigated in the paper. Taking into account the heterogeneity of entry and exit, the analysis is based on two types of entry-exit: real (related to the establishment or closing of a firm), or entry-exit in a new sector (indicating the diversification or changing specialisation). The theoretical model is based on Marshallian trigger points with Real Option trigger points as an alternative. The estimation exploited the negative binomial model to investigate the role of trigger points (thresholds) on the observed number of entry or exit firms in Dutch glasshouse horticulture over 25 years. Firms should overcome different thresholds depending on types of entry and exit. Marshallian trigger points function as good as the ones based on Real Option theory. The estimation of the model, which takes into account expected output prices, uncertainty and the interest rate, however, provides the best explanation of entry and exit. That model can be considered of a flexible variant of Real Option theory. The model provides plausible elasticities of entry and exit, either real or in changing specialisation.

Keywords: entry and exit, trigger points, glasshouse horticulture

1. Introduction

Entry and exit decisions of firms belong to the most interesting, but also highly intricate steps of individuals or firms. Moreover there are at least three different types of entry or exit decisions (Goncharova, 2007: 110-113); each of them with their own dynamics.

Decisions about entry or exit are accompanied by investments that are likely to be irreversible. These two different decisions, which are crucial for the firm, have profound implications for economic growth. Entry and exit of firms can be beneficial for productivity growth, technological upgrading and employment generation. According to the OECD (2003), the entry and exit of firms accounts for 20-40% of total productivity growth in eight selected OECD countries.

By considering entry as an investment decision and exit as disinvestment (=negative investment), investment theory contributes to explain industry dynamics. The economic literature suggests different theoretical and empirical approaches to explain choices of entry, exit and size of firms (for an overview see, for example, Siegfried and Evans, 1994). This paper is based on Marshall's model of long-run and short-run equilibria, which assume that firms are induced to enter if current revenue exceeds sunk costs ("Marshallian trigger point") and to exit if revenue falls below sunk costs.

However, it is observed that firms sometimes prefer to delay an entry or exit decision, in the expectation that prices and revenue (or costs) can change in the future. The real option theory postulates that uncertainty will affect the entry-exit investment decisions in such a way that it will change trigger points In the model of Dixit (Dixit, 1989; Dixit, 1992), a wedge between the Marshallian trigger point and "observed" trigger point produces a zone of "hysteresis" in which firms do not respond to price signals.

The objective of this paper is to investigate whether investment trigger points contribute to the explanation of the number of entering and exiting firms for Dutch glasshouse horticulture. We try also to answer the question whether trigger points based on real option theory explain entry and exit behaviour better than Marshallian trigger points.

Dutch glasshouse horticulture can be characterised as a dynamically changing, highly competitive, and capital intensive sector. The evolution and adaptation of the sector to new technologies and market requirements are reflected in the process of firms' entry and exit.

Section 2 presents first the theoretical model and then the empirical models of entry and exit. The negative binomial econometric model is used for estimation. *Section 3* discusses the data, and provides an analysis of changes in trigger points over time as well as the comparison of different types of trigger points. *Section 4* provides estimation results indicating the effect of trigger points on entry and exit. Finally, *Section 5* closes a short discussion, and some concluding and qualifying remarks.

2. Modelling of entry and exit investment decisions

2.1. Theoretical model

The long-run competitive equilibrium is determined not only by the price and output levels of the firms but also by the number of operating firms. Following MasCollel *et al.* (1995, p. 335) the central assumption is: "A firm will enter the market if it can earn positive profits at the going market price and will exit if it can make only negative profits at any positive production level given this price."

The long-run equilibrium price (p^*) equates demand with long-run supply, where the long-run supply takes into account firms' entry and exit investment decisions. Consider an industry initially in a long-run equilibrium position, which assumes number N_0 of operating firms and long-run cost c *(Figure 1, a)*. Suppose that demand shifts upward, then the industry will immediately move to a new short-run equilibrium position. The shock in demand causes an increase in prices to p_S and the output per firm increases to q_S; this can influence the investment decision of firms. Because firms' profits increase, operating firms earn more in the short-run (due to $p_S>c$) and can even be induced to make investments to expand; inactive firms can be induced to invest in entry.

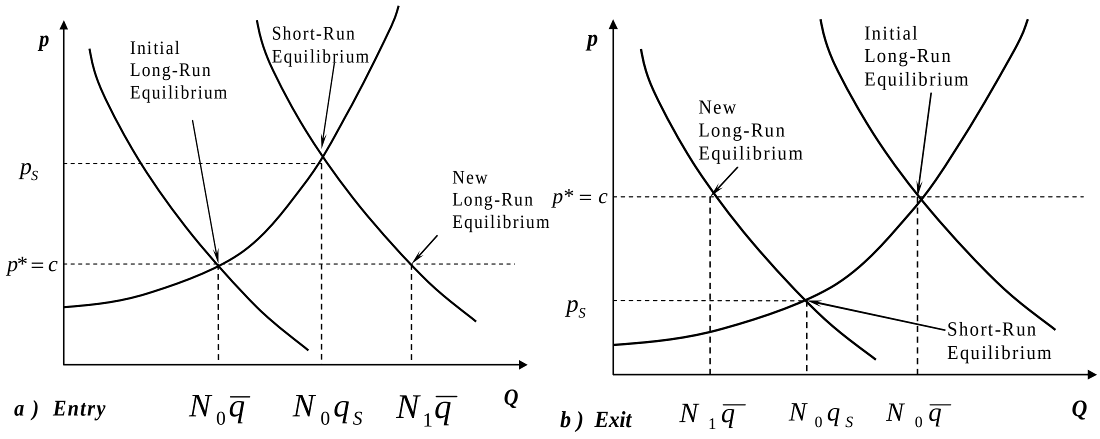

Figure 1: **Impact of trigger points on Entry and Exit**

In the long run, firms enter in response to the increase in profit, with the number of firms increasing to $N_1>N_0$; the industry will then move to the right along a new demand curve until it reaches the new long-run equilibrium.

The graph *(b)* demonstrates the change in the number of firms as a result of the exit of firms as an adjustment to the new long-run equilibrium. In the long run, firms exit in response to the decrease in profit, with the number of firms falling to $N_1<N_0$.

Now, consider that a firm's profit-maximising investment decision is to enter or to remain inactive. A firm has to invest a lump sum *k* and will have a variable cost *w* for the production of output. In the case of an exit decision, it must also pay a lump sum *l*, which it loses due to the exit of the firm, and a variable cost *w*, which will be saved. The goal of the firm is to maximise expected net present value (NPV). The standard Marshallian theory (Marshall, 1920) postulates that a firm will invest (and enter) if expected NPV is greater than zero, and in the case of an operating firm a decision to exit will be undertaken when NPV is negative.

Then for the entry investment of a firm, the trigger point W_H is Marshall's long run cost (when NPV>0), which is the sum of the variable cost and the interest on the sunk costs:

$$W_H \equiv w + \rho k \quad (1)$$

where ρ is interest rate.

The Marshallian trigger point for exit disinvestment of a firm (NPV<0) becomes:

$$W_L \equiv w - \rho l \qquad (2)$$

Dixit (1989) and Dixit and Pindyck (1994) introduced a discussion concerning a difference between Marshallian trigger points and Real Option trigger points. The difference can be explained by the presence of uncertainty that causes a firm to consider the option of waiting. Dixit (1989) provides the following relationships for the Real Option entry P_H and exit P_L trigger points:

$$P_H > w + \rho k \equiv W_H \qquad (3)$$

$$P_L < w - \rho l \equiv W_L \qquad (4)$$

Dixit (1989) derives analytically a closed form solution for trigger points that take into account uncertainty and the effect of changes in expectation of output prices (μ), uncertainty (σ^2) and interest rate (ρ) on trigger points.

2.2. Empirical model

From equations *(1-2)* we can numerically calculate Marshallian entry and exit thresholds.

In the case of Entry, firms consider parameters of a potential sector to enter, consequently ρ is an average value indicating the current profitability of the sector as perceived by a potential entrant. w, k are operating costs in the first year and the costs of capital; they represent the sunk costs of entrant firms. These individual characteristics of a firm are also important, because when the firm decides on entry it takes into account the level on which it is going to operate.

In the case of Exit, ρ is the same as for entry firms, but w and l are operating costs of the previous year and irreversible costs of capital; this represents sunk costs of the exit of firm *j*. To calculate losses *l* due to exit, we also include loss of profit because the firm no longer operates.

The changes in the number of entering or exiting firms indicate investment (or disinvestment) decisions of firms. According to the empirical model represented in *Equations 5-6,* we estimate the impact of investment trigger points on entry *(5)* or exit *(6)* decisions:

$$Entry^t = \gamma_{1,i} TR^t_{H,i} + \eta^t_i \qquad (5)$$

$$Exit^t = \gamma_{1,j} TR_{L,j} + \eta^t_j \qquad (6)$$

where $TR^{t}_{H,i}$ is the calculated threshold of a firm *i*, that entered in time *t*, and $TR^{t}_{L,j}$ is the calculated threshold of a firm *j*, that exited in time *t*.

Marshallian trigger points (W_H and W_L) are calculated as shown in *Equations 1-2*; Real Option trigger points (P_H and P_L) are calculated as shown in Dixit (1989) and Goncharova (2007: 126). Additional variables, following Real Option theory, have an impact on trigger points and perception about the profitability of the sector. They are the trend rates of growth of the market price of output μ and its variance σ^2.

$Entry^t$ is the number of firms entering in the year *t*; $Exit^t$ is the number of firms that were previously observed to be in operation in the year *t*. η^t - is an error term, a subscript *i* indicates an entering firm, *j* indicates an exiting firm, and γ - is the parameter to be estimated.

As a possible modification of the model based on Marshallian trigger points, we include μ, σ^2, ρ as additional variables in the *Equations 5-6*, thereby assuming that these parameters have an impact on the firm's decision concerning entry/exit, but their impact is more flexible than assumed by Real Option theory.

2.3. Econometric model

Since the dependent variable in the entry (exit) equation is the number of firms entering (exiting), this can take only nonnegative integer values. A count is understood as the number of times an event occurs. The ordinary least squares (OLS) method for even count data results in biased, inefficient, and inconsistent estimates (Long, 1997). Thus, various nonlinear models that are based on the Poisson distribution were developed for this type of "count data".

The Poisson regression is

$$y_i \sim Poisson(\mu_i) \tag{7}$$

$$\mu_i = \exp(x_i) \tag{8}$$

for observed count y_i with covariates for the *i*-th observation.

The Poisson model assumes that its mean is equal to its variance, which is unlikely in reality. This leads to a problem of overdispersion, i.e. that the observed variance is greater than the mean ($\mathrm{var}(y_i) > E(y_i)$). One reason for this is the omission of relevant explanatory variables. Estimates of a Poisson model for overdispersed data are unbiased, but inefficient with standard errors biased downward (Cameron and Triverdi, 1998; Long, 1997). The most common alternative is the Negative Binomial model, which introduces an individual, unobserved effect into the conditional mean.

$$y_i \sim Poisson\,(\mu_i^*) \quad (9)$$

$$\mu_i^* = \exp(x_i \beta + u_i) \quad (10)$$

$$e^{u_i} \sim Gamma\,(1/\lambda, \lambda)$$

λ is the overdispersion parameter. The larger α is, the greater the overdispersion. If λ =0 then the model converges to the Poisson model. A more detailed description of the Poisson model and the negative binomial model can be found in Cameron and Triverdi (1998: 59) or Greene (2003: 744).

3. Data

This section first gives a description of the data used in estimation and then presents an analysis of calculated trigger points, which are used as independent variables in the model.

We combine two data sets: FADN (Farm Accountancy Data Network) and “Meitelling” data[1], provided by the LEI. *Table 1* gives the variables used for estimating thresholds, and for the econometric specification of the model.

“Meitelling” data provide us with information about all firms in the glasshouse horticulture sector, but also other sectors, during the period 1975-2004. If a firm exited and entered during these time periods then we have the complete record of the “firm’s life”: from “birth” to “death”. Although the coverage of glasshouse horticulture firms is good, the data content is fairly small. Basically, only the land and the numbers of employees are available.

[1] Meitelling is the Register of Enterprises and Establishments of agriculture firms in the Netherlands. The register covers all firms with a size equal to or bigger than 2 nge (Dutch Size Units). www.lei.nl

Table 1: **Descriptive Statistics for Glasshouse Firms, Thresholds and Number of Entry and Exit**

Variable	Description of Variable	Mean	Standard Deviation
Ha_tot	Land per firm, ha	2.31	0.33
Ha_glass	Land under glass per firm, ha	0.62	0.11
Profit_ha	Profit per ha, 1000 Euros*	59.0	17.7
Cost_mat_ha	Material cost per ha, 1000 Euros*	234.8	44.3
Lab_tot	Number of workers per firm, annual workers	3.4	5.4
Cost_lab	Labour cost per annual worker, 1000 Euros*	20.3	0.5
Inv_ha	Investments per ha, 1000 Euros*	26.9	8.3
μ	Trend rate of growth of output prices	0.06	0.01
σ	Standard deviation of output prices	0.14	0.02
ρ	Interest rate, %	7.63	1.67
$Entry_K$	Number of entering firms		
	K=1 as real entry	194.4	62.1
	K=2 as entry in horticulture	767.9	143.5
$Exit_K$	Number of exiting firms		
	K=1 as real exit	339.0	73.6
	K=2 as exit from horticulture	278.8	89.8
$W_{H,K}$	Marshallian entry threshold, calculated for entering firm, 1000 euros*		
	K=1 as real entry	437.3	153.1
	K=2 as entry in horticulture	190.1	77.8
$W_{L,K}$	Marshallian exit** threshold, calculated for exiting firm, 1000 euros*		
	K=1 as real exit	-235.6	61.1
	K=2 as exit from horticulture	-66.1	23.3

* Monetary values are normalised by 1985 prices

** Exit thresholds were used for estimation as absolute values for the simplicity of the interpretation of results of the econometric model

The FADN is an unbalanced panel data set, amongst others, on glasshouse horticulture firms during the period 1975-1999. Due to the rotation of firms, firms stay in the sample for an average of 3-5 years. These data provide a wide range of individual characteristics of firms such as revenue, capital, investments, variable costs, which we used for the estimation of the annual level of these variables. For the calculation of the trigger points, we used variables from both data sets; however, due to the time period of FADN data, the further estimation is limited by the period 1975-1999.

We distinguish and use for the analysis two different types of entry and exit: 1) the genuine (or real[2]) entry and exit, 2) the entry and exit by changing specialisation (e.g., when an existing firm shifts to or from glasshouse horticulture production).

The variables represented in *Table 1* are used for the calculation of trigger thresholds[3]. These variables characterise the average glasshouse firm, which earns 59,000 euros profit through the use of 2.3 ha of land (0.6 ha under glass) and employs 3.4 workers per year. The average firm invests 26900 Euros per ha in capital (such as land, glasshouses and installations). The salient characteristic of Dutch glasshouse firms is that they remain small-scale family firms (68.8% of family labour) with respect to labour and land, but they are highly capital-intensive, with an average capital per firm of 383,000 euros (at 1985 price levels).

The next step, as an extension of the conventional approach, will be to calculate Real Option trigger points and compare them with Marshallian ones. As can be seen, the investment thresholds (*Table 2*) vary over the years with the common tendency of growth. The gap between Marshallian and Real option trigger points varies and becomes bigger: if at the beginning of the analysed period the difference for entry was about 5,000 euros and for exit about 2,000 euros, then at the end it had risen to 30,000 and 14,000 euros respectively. Following the discussion in Dixit (1989), the difference between thresholds is caused by uncertainty. So the years with the biggest gap, namely 1981, 1987, 1993, and 1996 possibly exhibit the effect of "hysteresis", when firms prefer to wait and would need to overcome a higher threshold to make investments (in the case of entry) or disinvestments (in the case of exit). It can be also noted that the difference between entry trigger points is bigger than for exit trigger points; although in both cases the difference between Marshallian and Real Option thresholds is affected in the same years.

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[2] We use terms "genuine" and "real" interchangeably for the definition of one of the types of entry or exit

[3] A description of the calculation of trigger points by combining of two data sets is provided by Goncharova (2007: 127-128)

Table 2: **Marshallian and Real Option trigger points**

Year	**Real Entry Trigger Points, 1000 euros**		**Real Exit Trigger Points, 1000 euros**		**Horticulture Marshallian Trigger Points, 1000 euros**	
	Marshallian	**Real Option**	**Marshallian**	**Real Option**	**Entry**	**Exit**
1976	201.6	206.4	Na	Na	17.1	na
1977	222.8	228.6	-117.0	-119.2	91.8	-48.5
1978	224.7	230.3	-154.1	-156.6	110.3	-52.9
1979	274.1	280.9	-179.8	-182.9	140.4	-58.4
1980	431.3	441.4	-243.0	-247.5	178.3	-68.1
1981	544.5	557.5	-275.6	-280.8	164.3	-70.7
1982	315.8	324.0	-242.0	-246.8	206.6	-86.3
1983	344.3	354.4	-243.3	-248.9	175.8	-87.7
1984	475.5	488.2	-179.0	-182.3	173.8	-64.8
1985	342.6	352.5	-209.7	-213.7	184.6	-53.7
1986	358.0	369.0	-251.0	-255.7	181.1	-41.5
1987	385.0	400.1	-176.4	-181.8	191.8	-63.1
1988	305.0	317.0	-168.1	-173.2	161.8	-43.8
1989	366.2	380.6	-207.1	-213.9	235.3	-69.1
1990	429.4	443.9	-158.5	-162.9	220.8	-16.9
1991	521.9	539.7	-279.3	-287.4	243.4	-84.6
1992	555.9	575.5	-354.7	-365.1	na	na
1993	666.1	696.4	-284.1	-295.5	312.1	-43.9
1994	659.2	688.4	-264.2	-274.8	42.9	-72.8
1995	600.0	626.5	-254.8	-265.1	241.3	-65.3
1996	762.1	797.7	-344.2	-358.7	284.2	-90.3
1997	388.7	407.8	-252.2	-263.3	196.1	-60.7
1998	590.2	621.8	-292.8	-306.4	310.9	-134.5
1999	529.7	558.1	-286.9	-300.4	306.9	-76.8
Total	437.3	453.6	-235.6	-242.7	190.1	-66.1

- *Trigger points represent the annual average level*
- *na – not possible to calculate due to the absence of reliable data on horticulture entry/exit*

An existing firm that enters (exits) glasshouse horticulture has to overcome lower impediments compared to the real entry (exit). This is demonstrated by the difference in the investment trigger points: an existing firm that enters the horticulture sector should invest (on average, over the years) 190.1 thousand euros, but for a real entry a firm should invest almost twice as much, on average 437.3 thousand euros. For the real exit, a firm should overcome (on average) losses of 235.6 thousand euros, which is three times the threshold for the exit from the horticulture sector (loss of 66.1 thousand Euros).

4. Results of estimation econometric models

The change in the level of trigger points can encourage or discourage exit and entry into glasshouse horticulture, as is shown in *Tables 3-4*. These tables give the negative binomial estimation results for entry and exit.

The results lend support to the negative binomial model, since the λ parameter is significantly different from zero. This is confirmed by the Likelihood-ratio test. The significance of overdispersion parameter λ confirms the presence of an individual, unobserved effect that means non constant mean and variance in the data. By this fact, the outperforming level of Log-Likelihood for Negative binomial regression over the Poisson model can be explained. The exit barriers were included in the model as the positive values for the purpose of easier interpretation.

The difference among models is in the explanatory variables: *Model 1* includes Marshallian trigger points, *Model 2* includes Real Option trigger points, which are corrected for the effect of expectation of prices, uncertainty, and interest rate; and *Model 3* explicitly incorporates the expectation of prices, uncertainty and interest rate in *Model 1,* that deviates from the specification of Dixit (1992). Based on Pseudo R2, it can be concluded that the Model 3 provides the best explanation of the variation of entry and exit out of three specifiations.

As can be seen from the estimation results, a higher level of entry thresholds has a negative impact on the number of firms that decide to enter. Increasing exit thresholds deters firms from exiting the sector. In agreement with the theory, positive expectations about the trend of output prices induce more firms to enter and fewer firms to cease operation.

Table 3: **Effect of Trigger Points on Real Entry and Exit**

Variable	**Real Entry**			**Real Exit**		
	Model 1	***Model 2***	***Model 3***	***Model 1***	***Model 2***	***Model 3***
	Trigger point $W_{H,1}$	*Trigger point* $P_{H,1}$	*Trigger point* $W_{H,1}$	*Trigger point* $W_{L,1}$	*Trigger point* $P_{L,1}$	*Trigger point* $W_{L,1}$
Dependent variable:	*Entry1*			*Exit1*		
Independent variables:						
TR	-0.002*** (0.0004)	-0.002*** (0.0004)	-0.001*** (0.0006)	-0.001* (0.0006)	-0.001* (0.0006)	-0.002*** (0.001)
μ			12.269* (6.776)			-19.020*** (3.785)
σ			1.459 (5.087)			-7.300*** (2.554)
ρ			0.095** (0.046)			0.012 (0.023)
Constant	5.372*** (0.203)	5.371*** (0.203)	3.402*** (1.142)	5.253*** (0.154)	5.245*** (0.152)	7.405*** (0.629)
λ	0.093 (0.028)	0.091 (0.027)	0.057 (0.018)	0.034*** (0.011)	0.034*** (0.011)	0.014 (0.357)
Likelihood-ratio test of λ = 0: Chi2(01)	334.79***	324.01***	183.13***	198.40***	199.20***	70.52***
Log likelihood:						
- Poisson model	-299.12	-293.37	-217.81	-227.44	-227.87	-154.24
- Negative binomial regression	-131.72	-131.37	-126.24	-128.24	-128.27	-118.98
Pseudo R2	0.06	0.06	0.10	0.01	0.01	0.08
N	24	24	24	23	23	23

1) estimated standard deviations in parentheses
*2) *** denotes coefficient significant at 1% level, ** at 5% and * at 10% level*

Higher interest rate, which is an indicator of the profitability of a sector, has a positive connection on entry, and a negative one for exit (except a real exit, which is not significant). Uncertainty (σ) has a positive (and not significant) result for real entry, but a negative one for entry into horticulture.

Table 4: **Effect of Trigger Points on Entry into and Exit from Horticulture**

Variable	Entry into Horticulture			Exit from Horticulture		
	Model 1	*Model 2*	*Model 3*	*Model 1*	*Model 2*	*Model 3*
	Trigger point $\boldsymbol{W_{H,2}}$	*Trigger point* $\boldsymbol{P_{H,2}}$	*Trigger point* $\boldsymbol{W_{H,2}}$	*Trigger point* $\boldsymbol{W_{L,2}}$	*Trigger point* $\boldsymbol{P_{L,2}}$	*Trigger point* $\boldsymbol{W_{L,2}}$
Dependent variable:		*Entry2*			*Exit2*	
Independent variables:						
- *TR*	-0.002*** (0.0007)	-0.002*** (0.0006)	-0.001 (0.001)	-0.007*** (0.003)	-0.007* (0.003)	-0.007*** (0.002)
- μ			-5.950 (4.682)			-17.941*** (7.048)
- σ			-3.115 (3.958)			-15.797*** (4.265)
- ρ			0.049* (0.028)			-0.066* (0.039)
Constant	7.639*** (0.148)	7.626*** (0.144)	6.433*** (0.813)	6.600*** (0.210)	6.597*** (0.205)	9.070*** (1.186)
λ	0.039*** (0.012)	0.039*** (0.012)	0.025 (0.008)	0.093*** (0.030)	0.092*** (0.030)	0.042 (0.014)
Likelihood-ration test of λ = 0: Chi2(01)	577.62***	574.98***	347.79***	487.20***	483.66***	210.08***
Log likelihood:						
- Poisson model	-424.10	-422.76	-304.86	-360.69	-358.84	-214.43
- Negative binomial regression	-135.29	-135.27	-130.97	-117.09	-117.00	-109.38
Pseudo R2	0.03	0.04	0.05	0.02	0.02	0.07
N	21	21	21	20	20	20

This can be explained by the statement of Wennberg *et al.* (2007) that the negative effect of uncertainty on the likelihood of entry will turn positive at a high level of uncertainty for real entry but not for the entry of existing firms. Therefore the results can be understood as an indication of higher uncertainty for the real entry, compared to the entry into horticulture. The higher variation of input prices deters firms from exits; this effect is larger for exiting due to a change in specialisation. This means that firms prefer to delay the decision to exit, because of expectations of positive changes in prices.

The presence of investment thresholds predetermines a certain number of firms that are able to overcome these thresholds and that decide to invest and enter (or to disinvest and exit). Changes in investment thresholds affect firms and change their behaviour in such a way that an additional number of firms will enter or exit. This effect of changes in trigger points can be demonstrated by analysing elasticities (*Table 5*).

Table 5: **Elasticities for trigger points after Negative Binomial Estimation (Model 3[4])**

	Real Entry	Real Exit	Entry in Horticulture	Exit from Horticulture
Dependent variable:	*En1*	*Ex1*	*En2*	*Ex2*
Independent variable:	$\boldsymbol{TR_{H,1}}$	$\boldsymbol{TR_{L,1}}$	$\boldsymbol{TR_{H,2}}$	$\boldsymbol{TR_{L,2}}$
- trigger point *W*	-0.270 (0.11)	-0.530 (0.18)	-0.733 (0.82)	-1.977 (0.64)

The establishment of a new firm can be expected if the real entry threshold decreases by 3,700 Euros. The real exit investment threshold should decrease by 1,900 Euros to induce an additional firm to cease trading. The difference in elasticities demonstrates the fact that existing firms respond more to changes in trigger points, because it is easier for these firms to overcome investment barriers. The changes in entry barriers should be bigger than for exit barriers to have an impact on a firm's decision as can be seen from smaller values of elasticities for entry compared to exit thresholds.

Another observation from the table is that the existing firms that enter or exit the horticulture sector are more sensitive to the changes in investment

[4] *Model 3* is represented in *Table 6*, because, as is shown in *Tables 4,5 and 7*, *Model 3* outperforms other specifications

thresholds. It can be expected that with a 2,700 Euro decrease in the horticulture investment threshold ($TR_{H,2}$), two more firms will enter the horticulture sector, while to encourage the establishment of the two additional firms the threshold ($TR_{H,1}$) should decrease by 7,400 Euros. The same holds true for the exit: we can expect the exit from the horticulture sector of the two additional firms if the investment threshold ($TR_{L,2}$) is bigger in absolute value by an amount of 1,000 euros; but for real exit $TR_{L,1}$ should change by 3,800 euros.

Table 6: **Predicted and Actual mean of Number of Entry and Exit firms**

	Real Entry	**Real Exit**	**Entry into Horticulture**	**Exit from Horticulture**
Number of Entry or Exit:				
- actual	194.4 (62.1)	339.0 (73.6)	767.9 (143.5)	278.8 (89.8)
- predicted by:				
Model 1	197.6 (46.1)	339.6 (37.5)	803.7 (133.5)	289.4 (56.7)
Model 2	197.4 (46.4)	339.5 (36.7)	802.5 (129.8)	289.1 (55.8)
Model 3	194.8 (46.9)	339.0 (57.5)	785.1 (86.7)	277.7 (51.3)

By analysing the *Table 6,* we can compare how close the prediction can be compared to the actual average of events. It can be seen that real entry and exit events have closer predicted values than horticulture entry and exit. This can be related to the slower reaction to changes in investment thresholds, as discussed above. As a comment to the discussion about the real option approach, we can see that the use of RO trigger points only slightly improves the prediction of entry and exit, while assuming that characteristics of the sector influence the firm's decision instead of changing trigger points *(Model 3)* gives the most accurate prediction. The preference for *Model 3* can be also supported by the differences in values of Log-likelihood and *Pseudo R2* provided in *Tables 3-4.*

5. Discussion, conclusions and further research

We have examined empirically the entry-exit process in Dutch glasshouse horticulture as an investment decision of a firm that should overcome an investment threshold. Clearly investment triggers barriers impact on a firm's decision to invest and enter, or to disinvest and exit. An increase in the barriers discourages firms from taking any action; they prefer to delay the decision, which is associated with irreversible investments.

The models that include Marshallian and Real Option trigger points were compared.

The explicitly calculated investment thresholds provide insights into the barriers that a firm should overcome and show the increase of competition in the sector, partially due to the use of capital-intensive technology in glasshouse horticulture.

We distinguished two types: real (or genuine) entry-exit; glasshouse horticulture sector entry-exit. The heterogeneity of entry and exit investments has two consequences. First, firms will overcome different thresholds that can induce or deter firms from entry or exit. Second, the change in thresholds results in a different number of entering or exiting firms, e.g. existing firms whose specialization changes, resulting in them entering horticulture are more sensitive to the change in investment thresholds compared to firms, which potentially can enter the sector and which are considering establishing a new business. The difference in degree of irreversibility of the different types of entry and exit can be one of the reasons for this.

The impact of thresholds can be a confirmation of the effect of irreversibility on an investment decision: if a threshold (as a sum of operational and fixed costs) is possible to be reversed, a firm will not take it into account.

The empirical results do *not* provide reasonably strong support to real option theory, while the model that suggests the direct impact of the sector-characterizing variables, such as expectation of output prices, uncertainty and interest rate, explains entry-exit decision better. The effect of these variables is larger for the real entry and exit compared to the change in specialization entry-exit. Moreover, uncertainty has a negative impact on exit and entry into horticulture, but turns out to be positive for the real entry. One of the possible suggestions, which can be further explored in future research, is that for a higher level of uncertainty, the negative effect of uncertainty on the likelihood of entry can turn positive.

The elasticities of changes in the level of trigger points on the number of entries or exits shows 'higher' elasticities for exits then for entries and also higher elasticities for shifts from and to horticulture than for real entries and exits: results which are intuitively very plausible.

Further research can be conducted on deepening the knowledge of the individual firm's decision for entry and exit which differentiates the heterogeneity of entry and exit. Thus it can have an important impact on the length of survival of firms, and on their post-entry performance. Investigating individual firms provide more opportunities to reflect on results.

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