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Abstract

This paper develops a non-separable household production model capable of analysing the effects of the 2003 CAP reform, and especially EU farm payments, on individual Dutch dairy farms. Model results show that the 2003 CAP reform farm payments do not fully compensate the income loss caused by the milk price decrease. This implies that savings, and therefore, investment decreases. Investment shifts away from on-farm investment to off-farm investment. On-farm investment in milk quotas falls compared to investment in capital and land because the shadow price of milk quotas decreases relatively to the shadow prices of land and capital.

Keywords: Direct income payments, investment, household production model.

1. Introduction

Direct income payments are a common and increasingly used policy instrument in developed countries to support farm incomes. Direct income payment can be coupled, linked to production, or decoupled, not linked to production. The European Union (EU) introduced in the 2003 Common Agricultural Policy reform (2003 CAP reform) farm payments, replacing all other existing direct income payments (European Commission, 2003). Farm payments are direct income payments linked to land and based on historical support levels. These farm payments are claimed to be decoupled because they are not linked to actual production levels. Be-

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cause farm payments are made tradable without the actual transfer of land the link to land is also weak. To provide really decoupled direct income payments is probably impossible because direct income payments influence income levels, and therefore, savings. Savings in turn affect investment decisions, and therefore, future production. Through the influence of direct income payments on income, on-farm and off-farm labour supply decisions could also be influenced. This also has an effect on production. The degree of decoupledness is an important issue in WTO trade liberalisation negotiations where especially developing countries question the decoupledness of the direct income payments in both the EU and US. To understand and quantify the effect of direct income payments on production it is necessary to develop theoretical and empirical models that take into account not only production behaviour of farms but also savings and investment behaviour of farm households and labour supply decisions of farm households. These models have to be farm-specific because of large differences in the level of farm payments, income and investment behaviour. Non-separable household production models are a possible candidate (see Löfgren and Robinson, 1999; Taylor and Adelman, 2003). Although household production models are common in the development economics literature they are scarce for developing countries. Moreover, to the best of our knowledge we do not know examples of household production models that focus on investment.

The aim of this paper is to develop a non-separable household production model to simulate the effects of the EUs 2003 CAP reform and especially the farm payments on investment behaviour by individual dairy farms in Dutch dairy farming. Analysis of investment behaviour gives insight in the degree of decoupledness of farm payments.

Section 2 describes the empirical model used to analyse the effects of the 2003 CAP reform and especially introducing farm payments in Dutch dairy farming. Section 3 describes data and calibration procedure applied. Model simulations and results are the subject of section 4. The paper concludes with the main findings and a general discussion of the model used.

2. *Empirical model*

This section presents an empirical static household production model for individual Dutch dairy farms. To simplify notation the subscript indicating individual farms is omitted. The subscript t indicates years (although the model is static).

Production

We assume that technology can be represented by a constant returns to scale CES production function (e.g. Sato, 1967). A CES production function implies that all inputs are substitutes and the substitution elasticities between all possible combinations of inputs are equal. To simplify the analysis we assume a single fixed output (milk). Inputs defined are capital (i=1), labour both hired (i=2) and self-employed (i=3), land (i=4), dairy cattle (i=5), feed (i=6) and other input (i=7). Cost minimisation leads to the following input demand functions and zero profit conditions respectively:

$$x_{i,t} = y_t \Gamma^{-1} \alpha_i^{\sigma} w_{i,t}^{-\sigma} \left(\sum_{i=1}^{M} \alpha_i^{\sigma} w_{i,t}^{1-\sigma} \right)^{\frac{\sigma}{1-\sigma}} \qquad i=1,\ldots,M \qquad (1)$$

$$\sum_{i=1}^{M} w_{i,t} x_{i,t} + rent_t = p_t \bar{y}_t \qquad (2)$$

with: $x_{i,t}$: input i; Γ: efficiency parameter; y_t: output; $w_{i,t}$: price of input i; p_t: price of output; α_i: distribution parameter; σ: substitution elasticity; $rent_t$: quota rent. A bar indicates fixed.

We assume capital, hired labour and land fixed. This implies that equation (1) gives the inverse shadow price equations for these inputs.

Capital depreciation and paid factor costs

Paid factor costs (e.g. paid interest and lease costs of milk) are assumed exogenous within a year. However, there will be an increase if extra capital is borrowed or milk leased. We assume capital depreciation also to be exogenous. Capital depreciation is relevant for capital but also for milk quotas. If the latter are bought than they can be depreciated (in 8 years time). Paid factor costs and capital depreciation equal:

$$B_t = \overline{B}_t \qquad (3)$$

$$WAF_t = \overline{WAF} \qquad (4)$$

with: B_t: paid factor costs; WAF_t: capital depreciation (value).

Consumption

The farm household derives utility from the consumption of goods and services and leisure. Consumption expenditure is assumed exogenous. The household supplies off-farm labour and on-farm labour. Total labour supply is assumed fixed. From the supply of off-farm labour the farms receives external labour income. The farm household supplies capital both to the farm and to non-farm activities. From the latter it receives external income. We assume this income from capital supplied to non-farm activities fixed. Revenue minus variable costs equal profits. Profits equal the sum of the quota rent and factor rewards from supplying household labour, capital and land on-farm. Household income from farming equals profits.

Expenditure on goods and services equals:

$$C_t = \overline{Y}_t^c \tag{5}$$

with: C_t : expenditure on goods and services; $\overline{Y}_t^c$: income spent on consumption of goods and services.

Assuming a CET transformation function and revenue maximisation leads to the following supply functions for on-farm and off-farm labour supply:

$$z_{L,t}^o = \overline{z_{L,t}^a}\Gamma_L^{-1}\left(\theta_L^o\right)^{\sigma L}\left(q_{L,t}^o\right)^{-\sigma L}\left(\left(\theta_L^o\right)^{\sigma L}\left(q_{L,t}^o\right)^{-\sigma L} + \left(\theta_L\right)^{\sigma L}\left(w_{3,t}\right)^{-\sigma L}\right)^{\frac{\sigma L}{-\sigma L}} \tag{6}$$

$$x_{3,t} = \overline{z_{L,t}^a}\Gamma_L^{-1}\left(\theta_L\right)^{\sigma L}\left(w_{3,t}\right)^{-\sigma L}\left(\left(\theta_L^o\right)^{\sigma L}\left(q_{L,t}^o\right)^{-\sigma L} + \left(\theta_L\right)^{\sigma L}\left(w_{3,t}\right)^{-\sigma L}\right)^{\frac{\sigma L}{-\sigma L}} \tag{7}$$

with: $z_{L,t}^o$: off-farm labour supply; $\overline{z_{L,t}^a}$: total availability of labour; $q_{L,t}^o$: effective wage; $x_{3,t}$: on-farm labour supply; Γ_L : efficiency parameter; θ_L^o : distribution parameter for off-farm labour supply; θ_L : distribution parameter for on-farm labour supply; σL : transformation elasticity.

Equations (6) and (7) show that on-farm and off-farm labour supply depend on total labour supply (which is fixed) and the relative prices of on-farm and off-farm labour supply. Labour supply is therefore assumed to be income independent. Equations (6) and (7) imply that if a farm does not supply off-farm labour it will also not do in any of the simulations.

Total household income equals profit (income from farming) plus income from labour supplied outside the farm plus external income (including income from capital supply) minus paid factor costs minus capital depreciation:

$$Y_t^L = q_{L,t}^o \times z_{L,t}^o \tag{8}$$

$$\pi_t = x_{1,t}w_{1,t} + x_{3,t}w_{3,t} + x_{4,t}w_{4,t} + rent_t \tag{9}$$

$$Y_t = \pi_t + Y_t^L + Y_t^E - B_t - WAF_t \tag{10}$$

with: Y_t^L : income from external labour supply; π_t :profits; Y_t : total household income; Y_t^E : external income.

Savings (S_t) equal income minus expenditure on goods and services:

$$S_t = Y_t - \overline{Y}_t^c \tag{11}$$

Investment

We assume a simple investment model in which a farm follows two possible strategies. First, the farm decides to invest its savings either on the farm or in non-farm activities. Capital depreciation is used to keep both capital and quotas at their initial levels. So, the farm finances net investments completely with its own savings. This strategy could be considered as defensive. Second, instead of using savings to finance net investments savings are used to attract as much as possible external financial means. However, investments are limited by a solvability requirement. It could also be the case that a farm attracts as much external financial means as the solvability requirement allows. So, investments are only partially financed with own capital and no off-farm investment takes place. This strategy could be considered as offensive.

In this static model we calculate investments for both options. However, because we have a static model we do not look at the dynamic effects (effect on production in next years).

Defensive investment strategy

$$I1_t = S_t \qquad (12)$$

Assuming a CET transformation function and revenue maximisation leads to the following supply functions for on-farm and off-farm investment:

$$I_t^{on} = S_{I,t}\Gamma_I^{-1}\left(\theta_I^{on}\right)^{\sigma I}\left(w_{I,t}^{on}\right)^{-\sigma I}\left(\left(\theta_I^{o}\right)^{\sigma I}\left(w_{I,t}^{on}\right)^{-\sigma L}+\left(\theta_I^{of}\right)^{\sigma I}\left(w_{I,t}^{of}\right)^{-\sigma I}\right)^{\frac{\sigma I}{-\sigma I}} \qquad (13)$$

$$I_t^{of} = S_{I,t}\Gamma_I^{-1}\left(\theta_I^{of}\right)^{\sigma I}\left(w_{I,t}^{of}\right)^{-\sigma I}\left(\left(\theta_I^{o}\right)^{\sigma I}\left(w_{I,t}^{on}\right)^{-\sigma L}+\left(\theta_I^{of}\right)^{\sigma I}\left(w_{I,t}^{of}\right)^{-\sigma I}\right)^{\frac{\sigma I}{-\sigma I}} \qquad (14)$$

with: $I_{I,t}^{on}$: on-farm investment; $I_{I,t}^{of}$: off-farm investment; $S_{I,t}$ quantity to be invested; $w_{I,t}^{on}$: on-farm return; $w_{I,t}^{of}$: off-farm return; Γ_I: efficiency parameter; θ_I^{on}: distribution parameter for on-farm investment; θ_I^{of}: distribution parameter for off-farm investment; σI: transformation elasticity.

Equations (13) and (14) state that on-farm and off-farm investment depend on the level of savings and the relative return on on-farm and off-farm investment. Further it is true that:

$$I1_t = S_t = S_{I,t} \times S_{I,t}^{w} = w_{I,t}^{on} I_t^{on} + w_{I,t}^{of} I_t^{of} \qquad (15)$$

with: $S_{I,t}^{w}$: weighted average return on savings.

Given on-farm investment the farm either invests into capital (buildings and machinery), land or quotas. Assuming a CET transformation function and revenue maximisation leads to the following supply functions for investment in capital, land and quotas:

$$I_t^{cap} = I_t^{on}\Gamma_O^{-1}\left(\theta_O^{cap}\right)^{\sigma O}\left(w_{1,t}\right)^{-\sigma O} J^{\frac{\sigma O}{1-\sigma O}} \quad (16)$$

$$I_t^{land} = I_t^{on}\Gamma_O^{-1}\left(\theta_O^{land}\right)^{\sigma O}\left(w_{4,t}\right)^{-\sigma O} J^{\frac{\sigma O}{1-\sigma O}} \quad (17)$$

$$I_t^{quot} = I_t^{on}\Gamma_O^{-1}\left(\theta_O^{quot}\right)^{\sigma O}\left(w_{quot,t}\right)^{-\sigma O} J^{\frac{\sigma O}{1-\sigma O}} \quad (18)$$

$$J = \left(\theta_O^{cap}\right)^{\sigma O}\left(w_{1,t}\right)^{-\sigma O} + \left(\theta_O^{land}\right)^{\sigma O}\left(w_{4,t}\right)^{-\sigma O} + \left(\theta_O^{quot}\right)^{\sigma O}\left(w_{quot,t}\right)^{-\sigma O} \quad (19)$$

with: $I1_t$: net investments (value); I_t^{cap} : investment in capital;: I_t^{land} investment in land; I_t^{quot} investment in quota; $w_{quot,t}$: shadow price quota; Γ_O : efficiency parameter; θ_O^{cap} : distribution parameter for capital; θ_O^{land} : distribution parameter for land; θ_O^{quot} : distribution parameter for quota; σO : transformation elasticity.

Further it is true that:

$$w_{I,t}^{on} \times I_t^{on} = w_{1,t}I_t^{cap} + w_{4,t}I_t^{land} + w_{quot,t}I_t^{quot} \quad (20)$$

So on-farm investments in capital, land and quotas depend on the relative returns on these investments and the total level of on-farm investment.

Offensive investment strategy

$$I2a_t = \frac{S_t - \varphi VV_t}{(1-\vartheta)r_t + \varphi} \times r_t \quad (21)$$

$$I2b_t = ((1 - dVV_t) * TV_t - VV_t \quad (22)$$

$$I2_t = \min\left(I2a_t, I2b_t\right) \quad (23)$$

with: $I2a_t$: net investments when farm attracts as much as possible external financial means given interest and taxes; φ : share of the money that has to be paid back yearly; VV_t : money borrowed; ϑ : share of income that has to be paid on income taxes; r_t : interest; $I2b_t$: investment when the farm attracts as much external financial means given that the farm wants to maintain a certain level of solvability; dVV_t : solvability requirement; $I2_t$: level of investment when the farm invests as much as possible.

Equation (21) gives the money that can be borrowed if savings can be used to pay interest and pay back the loan corrected for taxes. The first term in equation (22) gives the total money that can be borrowed given the solvability required. The second term gives the money already borrowed. The difference between both terms gives the extra money that can be borrowed. Equation (23) states that the actual investment level equals the minimum of the outcomes of equation (21) and (22) respectively.

From equation (23) total on-farm investment follows. Using equations (16-19) investments in capital, land and quotas can be determined.

3. Data and calibration

The model in the previous section is calibrated using data of a representative sample of Dutch dairy farms in the year 1999/00 that keep a financial bookkeeping for the Agricultural Research Institute (LEI). Calibration means that coefficients are chosen such that the model reproduces the actual data for 1999/00. All prices are set equal to one implying that all price changes are relative to base year prices. Equations (16-19) are calibrated using the distribution of invested capital in the different assets (capital, land, quotas and off-farm investments) in the base run. The actual investment levels in 1999/00 are not taken into given that we look in this paper at different possible strategies giving different outcomes.

Extra information is needed on the substitution and transformation elasticities. Given that the model is a short to medium-term model these elasticities are chosen to be small. Substitution and transformation elasticities are set arbitrarily equal to 0.4. For φ (share of the money that has to be paid back yearly) a value of 0.1 (10%) is chosen. For ϑ, the share of income that has to be paid on income taxes, a value of 0.5 (50%) is chosen. This is the highest marginal tax rate in the Netherlands. For the interest rate (r_t) we take 0.06 (6%). We set the solvability requirement dVV_t equal to 0.4 (40%).

4. Simulation and results

Scenario

Base scenario. The base scenario is the actual situation in 1999/00. This implies that the model calculates back the actual input use, income levels and savings of the farms. The model then calculates what investments would be under the two strategies defined (both on-farm and off-farm investment and investment equal to savings; investment only on-farm and investment equal to the maximum borrowing capacity).

2003 CAP reform. In this scenario we introduce the 2003 CAP reform (European Commission, 2003). We assume a milk price decrease of 15%. This is the expected milk price decrease in the Netherlands. Moreover, milk quotas increase by 1.5%. The third element is a decoupled direct income payment of 35.5 euro per tonne of milk production. This payment is modelled as an exogenous income transfer from the government to the farms (see equation 10).

Direct income payment. To isolate the effect of the direct income payment we introduce in this scenario a decoupled direct income payment of 35.5 euro per tonne of milk as in the 2003 CAP reform. At the same time we decrease the milk price with the same value of 35.5 euro per tonne of milk. This scenario keeps total household income unchanged.

The model is applied for a subset of 41 farms in the sample instead of all 464 farms in 1999/00 given lack of time.

Results

Results show that quotas are still binding after the 2003 CAP reform for all farms except one farm. For this farm the quota is only just not binding. This implies that changes in the demand of variable inputs and shadow prices of the quasi-fixed inputs are only determined by the 1.5% quota increase. Demand for variable inputs and shadow prices of fixed inputs increase (become scarcer). The increase in shadow price for household labour leads to a decrease in off-farm household labour supply of 1.1% (on-farm use is more profitable). The way off-farm labour supply is modelled implies that farms that in the base run do not supply off-farm labour (21 farms) cannot switch to off-farm labour suppliers. The higher shadow price also makes that household labour is partially substituted by variable inputs (including hired labour for those 23 farms that already in the base run hire labour). The increase in production leads to an increase in the shadow price of milk production (marginal cost of milk production) of 1.8%. This increase in the shadow price of milk production has a negative effect on the shadow price of the milk quota and quota rent. Although the milk price decrease does not affect production it has a (strong) negative effect on the shadow price of the milk quota and quota rent. The increase in quota and the milk price decrease lead to a milk quota price reduction of 57.2%. Given constant paid factor costs household income from farming is negatively affected. In the initial situation one farm has a negative income from farming, after the 2003 CAP reform this is 17 farms. The average reduction in income from farming is 30864 euro. The reduction in off-farm household labour supply negatively affects off-farm income. The direct income payments do not compensate for the full income loss. Total household income falls on average with 12500 euro. This results also in a reduction of average savings of average payback capacity of 12500 euro because the value of consumption expenditure is kept constant.

Table 1. Effects of the 2003 CAP reform (results in percentage change or change in euros compared to the base run)

	2003 CAP reform
Percentage change in:	
Shadow price milk production	-1.8
Shadow price milk quota	-57.2
Off-farm labour supply	-1.1
Feed	2.2
Household labour	0.1
Absolute changes in:	
Income from farming	-30864
Total household income	-12500
Savings	-12500
Pay back capacity	-12500

Investment

In the base run 21 out of the 41 farms have positive savings. After the 2003 CAP reform 12 of them still have positive savings. In the case farms invest savings both on-farm and off-farm (defensive strategy) off-farm investment becomes more attractive in comparison to on-farm investment but both decrease. Total off-farm investment falls on average with 36.8% (for those farms still investing) while on-farm investment falls on average with 53.0% (for those farms still investing). The increase in the shadow price of land and capital make it relatively more attractive to invest in these two assets (capital -45.0% and land -44.7%). The large decrease in the shadow price of the quota, caused both by the milk price decrease and the increase in quotas, make it less attractive to invest in quota (-58.7%).

In the case farms invest only on-farm and investment equals the maximum lending capacity (equation 23) in the base run only 8 farms invest. The reason for this smaller number is that although more farms have positive savings (21) the solvability requirement prevents farms from investing. In case of the 2003 CAP reform only 4 farms want to invest. All these 4 farms also have positive savings. These farms average investment shows a decrease of 55.4% (capital -48.8, land 44.4, quota -61.1).

Direct income payments

A decoupled direct income payment of 35.5 euro per tonne of milk in combination with a decrease in the milk price with the same value of 35.5 euro per tonne of milk production, input use, shadow prices of fixed inputs, total household income and savings the same. The fall in income from farming (-18.4%) is fully compensated by the direct income payment. So, total investments are not affected. However, the milk price decrease reduces the shadow price of the milk quotas (-30.9%). This makes it more attractive to invest off-farm and in capital and land and less attractive to invest in milk quotas. In the case farms invest only on-farm, investments in capital, land and quotas change with 8.5%, 8.2% and -4.4% respectively. In the case farms invest both on-farm and off-farm, off-farm investments increase with 7.1% and on-farm investments fall with 1.1%. Investments in capital, land and quotas change with 7.4%, 7.4% and -5.3% respectively.

5. Discussion and conclusions

The aim of this paper is to develop a non-separable household production model that is capable of simulating the effects of the 2003 CAP reform, and especially EU farm payments, on individual dairy farms in Dutch dairy farming. Of special interest are the effects on investment as they affect future production levels, and therefore, give insight in the degree of decoupledness of direct income payments. Dairy farming operates under a supply quota regime implying that total milk production is not affected as long as quotas are binding and trade in milk quotas is not taking into account.

Model results show that the 2003 CAP reform farm payments do not fully compensate the income loss caused by the milk price decrease. This implies that savings are reduced. This implies investment decreases except for those farms that do not want to invest. Investment shifts away from on-farm investment to off-farm investment. On-farm investment in milk quotas falls compared to investment in capital and land because the shadow price of milk quotas decreases relatively to the shadow prices of land and capital.

Model results show that decoupled direct income payments without any other changes increase savings, and therefore, investment levels for some (but not all) farms. In the Dutch dairy sector where milk quotas are binding total production will not be affected but within the sector production will shift between farms (with quota tradability) and there will be an effect on input use (given the differences in technology between farms). In real world situations direct income payments will be accompanied by other measures, e.g. price decreases. Direct income payments that compensate exactly for the income loss will still have an effect on how investment takes place because the other measures will change the profitability of the alternative investment opportunities.

The model is subject to some qualifications. First, dynamic effects of investment on production and fixed inputs are not taken into account. The model calculates the value of investment in the different assets using the relative shadow prices of these assets. Actual investment levels also depend on the prices of the assets (acquisition costs). Second, the model is not econometrically estimated nor tested. Future research will be directed towards a dynamic version of the model and econometric estimation.

Despite the qualifications the model is a strong tool to analyse the effects of policy changes in Dutch dairy farming and analyse the potential effects of direct income payments.

References

European Commission (2002): Communication from the Commission to the Council and the European Parliament: Mid-Term Review of the Common Agricultural Policy - COM(2002) 394 final: Brussels. (http://europa.eu.int/comm/agriculture/mtr/comdoc_en.pdf)

Löfgren H. and Robinson S. (1999): "Nonseparable farm household decisions in a computable general equilibrium model", *Amercian Journal of Agricultural Economics*, 81-3: 663-670.

Sato K. (1967): "A two-level Constant-Elasticity-of-Substitution production function", *Review of Economic Studies*, 34: 201-218.

Taylor J.E. and Adelman I. (2003): "Agricultural household models: genesis, evolution, and extensions", *Review of Economics of the Household*, 2: 33-58.