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PRICE VOLATILITY AND FARM INCOME STABILISATION

Modelling Outcomes and Assessing Market and Policy Based Responses

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Economic and environmental effects of an EU flat rate for the Dutch agricultural sector

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Abstract

The objective of this research is to give insights into the production, income and environmental effects of the introduction of an EU flat rate for Dutch agriculture. For this purpose, a detailed agri-environmental programming model for Dutch agriculture is used.

Results of the EU flat rate scenario are compared to a reference scenario that describes agricultural production in the Netherlands in 2020. Results show that total gross margin in Dutch agriculture decreases because of the EU flat rate with 7%. The supply of starch potatoes and cow milk decreases most. Production of seed and consumption potatoes, vegetables and intensive livestock products increases slightly. This is largely due to a shift of farm payments from milk and starch potatoes production to arable crops and vegetable production. It was found that including risk aversion of income volatility amplifies these effects. The flat rate decreases the total emissions of nutrients to the environment from agricultural production.

Keywords: EU flat rate, mathematical programming, income volatility

JEL classification: Q1, D8

1. INTRODUCTION

In November 2010, the European Commission presented three potential paths for the design of the Common Agricultural Policy (CAP) in the programming period 2014-2020 (European Commission, 2010). The outlined policy options for a future CAP include the status quo with some slight adaptations, a shift towards a greening of the CAP and a more radical reform with a phasing out of direct payments. A clear wish of the Commission is to strive for more equity in the level of farm payments between Member States (e.g. European Commission, 2007). Currently, farm payments per ha vary strongly among Member States. The average farm payment in the EU15 is 295 euro per ha against 187 euro per ha in the new Member States (Helming and Terluin, 2011). In the Netherlands the average farm payment equals about 470 euro per ha. It is to be expected that a CAP reform will lead for the Netherlands to less support and ~~more uncertainty about prices, and therefore, also to~~ an increase in income uncertainty.

In the Netherlands the farm payment per individual farm per ha can differ substantially from the national average. Farm payments per farm type in the Netherlands range from 90 euro per ha on horticultural farms to 610 euro per ha on starch potato farms. Also between dairy farms farm payments per ha can differ substantially, largely depending on the historic level of milk production per ha.

Depending on the behaviour of the farmers, a policy switch towards more equity in farm payments per ha at EU level could potentially have a large impact on production and income and its distribution in the Dutch agricultural sector. Moreover, it could also affect the impact of the agricultural sector on the environment. In this paper equity in the level of farm payments per ha is assumed to take the form of a flat rate per ha at EU level. The objective of this paper is:

To determine production, income and environmental effects of an EU flat rate in combination with increased income uncertainty on different farm types in the Netherlands.

Many agricultural sector models incorporate farm payments and their effect on agricultural output (Balkhausen et al., 2008; Britz et al., 2006). However, these models do not incorporate differences in farm structure, related differences in farm payments and possible differences in behaviour of individual farmers. Other studies apply farm level or micro models (Baptiste et al., 2010; Marchand et al., 2008; Shrestha et al., 2007) that include individual farm behaviour and differences in farm structure and farm payments. A disadvantage of these models is that interactions between farms are not or only partly included. Moreover, as not all farms are represented, conclusions at agricultural sector level are lacking.

Gocht et al. (2011) apply the CAPRI model to analyse the effects of an EU wide flat rate scenario. The CAPRI model represents the major farm types in the EU. Moreover, prices of outputs and a selected number of inputs are endogenously modelled through an iterative link between a supply and a partial equilibrium market module.

In this research a detailed agricultural model of the Dutch agricultural sector (the Dutch Regionalised Agricultural Model (DRAM)) is combined with the CAPRI model. DRAM features a large number of agricultural activities, farm types, interactions between activities and farm types through land and animal manure markets, regions and environmental indicators especially focusing on the emissions of nutrients from mineral fertilizer and animal manure to the environment. Manure markets in DRAM also include transportation of animal manure between regions in the Netherlands and exports. Prices of agricultural outputs and purchased inputs, yields and fertilization requirement per farm type, activity and region are assumed constant. This means that at commodity and NUTS2 level the IO coefficients can only change through changes in the share of the different activities and farm types in total production. Availability of agricultural land is fixed at NUTS2 level in DRAM. If policy scenarios imply changing prices of agricultural outputs and inputs, yields and fertilization requirements these are taken from CAPRI and then included in DRAM.

For the purpose of this paper DRAM is extended with a risk module that enables to analyse what the consequences on income and environmental performance are of income volatility in combination with farmers' risk aversion due to the reform of the CAP.

The remaining part of this paper is organized as follows. Section 2 of this paper describes the scenarios. Section 3 describes DRAM and the modeling of income volatility and risk aversion of farmers in more detail. Section 4 discusses the data. Section 5 presents the results and we conclude with a general discussion and conclusions in section 6.

2. SCENARIOS

As it is likely that income effects of an EU flat rate will be large for Member States and farms, it is not realistic to assume that an EU flat rate per ha will be implemented in the short term. Transition towards an EU flat rate per ha at national or EU level can only be reached gradually, giving farmers time to adjust. In this study we assume that the policy transition is completed and the EU flat rate is fully effective in 2020.

2020 reference scenario

The reference scenario takes into account the effects of changes in exogenous variables, e.g. technological change, until 2020. Data used come from other studies such as Scenar 2020 and Scenar 2020-II or from projections of international institutes like OECD and FAO. The reference scenario further incorporates the 2003 CAP reform, the dairy policy reform and the abolition of the milk quota system in 2015. We also include the implementation of the Health Check, which among other things foresees a 10% reduction in farm payments. With respect to the budget for the CAP, we assume that this remains constant in nominal terms. All farm payments are decoupled. A possible WTO agreement on trade liberalisation is not included given the lack of information how this agreement would look.

EU flat rate scenario

The EU flat rate scenario assumes a switch from the current farm payments to one flat rate per ha for all utilized agricultural area (except fallow land) in the EU in 2020. All other variables are kept constant compared to the reference scenario. To be consistent with the CAPRI model, the EU flat rate equals €240 per ha in nominal terms.

3. THE DUTCH REGIONALISED AGRICULTURAL MODEL

DRAM

In order to analyse the impact of the EU flat rate for different types of farms in the Netherlands, the Dutch Regionalised Agricultural Model (DRAM) is used. DRAM has been developed as an activity-based, comparative static, partial equilibrium, regionalized mathematical programming model of Dutch agriculture (Helming, 2005; Helming and van Berkum, 2008; Helming and Reinhard, 2009). In DRAM individual farms are grouped into different farm types (also called land use classes) producing the same type of agricultural outputs or commodities. DRAM is flexible to aggregate the activities and farm types to 12 provinces (NUTS 2 level) or 66 agricultural regions. DRAM distinguishes between 35 agricultural activities. These activities can be divided between 20 crop activities (soft wheat, rye, barley, oats, granule, other cereals, oil crops, legumes, sugar beets, other arable crops, fodder maize, grassland, other fodder crops, vegetables (arable), seed potatoes, consumption potatoes, starch potatoes, seeds, other arable crops and green manuring) and 15 livestock activities (female beef cattle, male beef cattle, meat calves, fattening pigs, sows, meat poultry, laying hens and eight types of dairy cow activities).

Table 1: Type of dairy farms represented by the dairy cow activities included in DRAM

Type of dairy farm	Type of dairy farm in DRAM	Milk production (kg per dairy cow)	Dairy cows (heads per ha)	Dairy cows (heads per farm)
Small and extensive dairy farm	dairy 1	< 7,450	< 1.6	< 60
	dairy 3	< 7,450	> 1.6	< 60
Small and intensive dairy farm	dairy 5	> 7,450	< 1.6	< 60
	dairy 7	> 7,450	> 1.6	< 60
Large and extensive dairy farm	dairy 2	< 7,450	< 1.6	> 60
	dairy 6	> 7,450	< 1.6	> 60
Large and intensive dairy farm	dairy 4	< 7,450	> 1.6	> 60
	dairy 8	> 7,450	> 1.6	> 60

DRAM can endogenous choose between 8 types of dairy cow activities to produce milk. ~~the binding milk quota.~~ It is assumed that they represent 8 types of specialized dairy farms in the Netherlands (Table 1). The amount of land per head per type of dairy cow is fixed in DRAM. So, the dairy cows are directly linked to land. Moreover, besides the 8 types of dairy cow activities, DRAM also includes two types of technologies to produce arable crops. The differentiation is based on the farm payment per ha per individual farm as found in the FADN. One technology in DRAM represents arable farms with a relatively high farm payment per ha and one technology represents arable farms with a relatively low farm payment per ha. The level of payments differ because of productivity differences and because of differences in cropping plan.

The introduction of an EU flat rate per ha will have a production effect in DRAM through:

- The linkage with CAPRI provides the changes in agricultural output and input prices, yields and fertilization requirements that can be used in DRAM;
- The farm payments in DRAM are linked to land. Hence, farm payments are at least partly capitalised into the shadow price of the land in DRAM and~~T~~ the redistribution and lowering of farm payments affects these shadow prices. ~~between farm types affects production and income, e.g. f~~Farm types (technologies) with initially low farm payments per ha might increase their production at the expense of farm types with initially high farm payments per ha because the lower shadow price of land compensates for the decrease in the farm payment. ~~is affected.~~

CAPRI

CAPRI is a partial equilibrium, mathematical programming, regionalised, activity based, agricultural sector model of EU agriculture. It includes a supply and demand module of the different agricultural commodities and is extensively described in the literature (e.g. Britz et al., 2006). Besides the endogenous prices of agricultural commodities and feeding stuffs, yield and fertilization requirements per activity are endogenous in CAPRI. The latter is reached through the definition of an extensive and intensive technology type per activity. Depending on relative price changes land allocation might switch from one technology to the other. Per NUTS2 region, activity and commodity, the following variables from CAPRI are incorporated in DRAM: a) prices of agricultural commodities b) feeding costs per activity c) yield and fertilization requirements per activity and d) availability of agricultural land.

Incorporating Risk and Uncertainty in DRAM

To include risky income and aversion of farmers to income variance the optimization problem becomes[1]:

$$\max = - \quad \Sigma \qquad (1)$$

Where: $^{-}$: vector of average gross margins per activity (€/ha or €/head), x: vector of activity levels (1,000 ha or 1,000 heads), parameter of risk aversion ~~–~~per activity (€/10,000€), Σ =variance covariance matrix of gross margins (10,000 €).

In case of risk neutrality is zero and we have the original profit maximisation problem.

Following Howitt (2002) the risk aversion parameter can be calculated for an individual activity assuming that a farmer minimizes the variance of the gross margin subject to ~~wants to receive with a certain probability~~ a minimum level of income. The risk aversion parameter can be calculated by solving the following problem:

$$\min = \quad \Sigma \qquad (2)$$

Subject to:

$$^{-} \geq \; ^{*}[\ ] \qquad (3)$$

Where: e*:the minimum expected gross margin, :the shadow price of the constraint.

It is shown by Howitt (2002) that the shadow price of the constraint (3) is equal to (1/). The parameter of risk aversion is low when a change in the activity level has a relative low contribution to income, i.e. leads to a low variance in income. This is for example the case for large dairy farms, while the opposite is true for small farms. For a farmer it is more easy to accept the risk in the first than in the last case.

The PMP model with risk aversion

Including the risk aversion parameter and the gross margin variance, “the cost of risk”, the quadratic cost function in DRAM changes to[2]:

$$= + \quad + 0.5 \quad + \quad \Sigma \qquad (4)$$

1. For reason of simplicity the index for farmtypes (f), activities (i) and regions (r) are not included.
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Assuming and $\sum$ known and using exogenous supply elasticities, the parameters α and β can be calculated such that the observed activity level, for every individual activity, is reproduced (Helming, 2005):

$$= \text{—} - 2 \ \sum \qquad (5)$$

$$= \quad (\ - 1)/ \qquad (6)$$

Where: mc: marginal cost including the opportunity cost of the calibration constraint in the first phase of PMP, n: supply elasticity.

This way the model with cost function k exactly calibrates towards the observed activity level. Note that by assuming in the calibration the cost component linked to risk constant the price elasticity used in the calibration is different from the price elasticity of the model in simulations because in the latter case the cost linked to risk is not constant.

4. DATA

Farm data

The average farm payments per ha per farm type in the Netherlands in the base period as included in DRAM is presented in table 2. For the different types of dairy farms the farm payments per ha in the base period is based on 2007 data from the Dutch FADN. The farm payments per ha for the two types of arable farms in DRAM is based on a) shares of individual crops in total cropping plan in 2007 as found in the Dutch FADN and b) coupled payments per crop per ha in the reference period. Coupled payments for the different types of arable farms includes the payment for starch potatoes. The coupled payments for all other farms include the coupled ha payment for fodder maize, different kind of beef premiums and slaughter premiums, excluding slaughter premiums for veal calves. Slaughter premiums for veal calves are linked to farms with veal calves. Total farm payments in the Netherlands equal € 853 million. It is assumed that in nominal terms in the 2020 reference scenario the direct payment per activity will be equal to the direct payment in the base period (2007).

Table 2: Farm payments per farm type in the Netherlands in 2007 (euro per ha)

Dairy farm type 1	408	Dairy farm type 6	533
Dairy farm type 2	470	Dairy farm type 7	715
Dairy farm type 3	589	Dairy farm type 8	779
Dairy farm type 4	636	Arable farm type 1	281
Dairy farm type 5	489	Arable farm type 2	420
		All other farms	258

Source: DRAM

Table 3 shows the cropping plan of both arable farm types in the base period. Shares are based on 2007 data as found in the Dutch FADN, total acreages are based on the 2008 agricultural census. The share of cereals (especially barley) and starch potatoes is relatively high on arable farm type 2 (relative high payment per ha) and relatively low on arable farm type 1 (relative low payment per ha).

Table 3: Land use per crop and average cropping plan of Arable farm type 1 and Arable farm type 2 in the Netherlands in 2007/2008.

	Arable farm type 1		Arable farm type 2	
	Ha (*1000)	Share (%)	Ha	Share (%)
Soft wheat	82	26	75	29
Barley	21	6	30	12
Other cereals	18	6	18	7
Total cereals	121	38	123	48
Oil seeds	2	1	2	1
seed potatoes	31	10	6	2
Consumption potatoes	50	16	19	8
Starch potatoes	12	4	35	14
Sugar beets	39	12	34	13
Vegetables	42	13	12	5
Other arable crops	22	7	25	10
Total arable crops	319	100	254	100

Source: DRAM

Agricultural prices and technical IO coefficients are as much as possible based on individual farm data from the Dutch FADN of 2007. The different types of arable farms in DRAM differ with respect to farm payments per ha, but IO coefficients are identical per crop per arable farm type per region. The supply elasticities used to calibrate DRAM (PMP) are assumed equal to 2.0 for arable crop activities, 1.0 for vegetables, 0.75 for all cattle activities (beef cattle, meat calves and dairy cows) and 1.75 for all intensive livestock activities (sows, fattening pigs, laying hens and meat poultry). These supply elasticities are relatively large, representing medium to long run agricultural production marginal costs. In the long term the farmers can react relatively easy to changes in their environment.

The acreages of arable crops and the number of animals in 2020 in the reference scenario are taken from Silvis et al. (2009). The share of the two types of arable farms in total acreage per crop is assumed equal to the observed shares in 2007.

Variance of gross margin and risk parameter in the reference scenario

By solving equations (2) and (3) for every activity per individual farm type and region, the farm type, region and activity specific risk parameter is calculated for the reference scenario. Activity levels are put equal to the assumed and calibrated levels in 2020. The variances of the gross margins of agricultural activities are derived from FADN data over the six year period 2005-2010 at national level. This outcome is applied to corresponding agricultural activities per region in DRAM, where the national average is corrected for the difference between gross margins per farmtype per activity per region in DRAM in 2020 in the reference scenario and the national average gross margin over the period 2005-2010 in FADN. This gives us the farm type, activity and region specific variance of the gross margin (Σ). Note that we assume covariances to be zero.

The average gross margin ($^{-}$) per activity is equal to the gross margin, excluding the decoupled farm payment, in DRAM in 2020 in the reference scenario. The minimum expected gross margin (e^*) is calculated as the expected average profit in the reference scenario:

$$^{*} = {}^{-} \qquad (7)$$

This guarantees that the activity level in the optimal solution is equal to the activity level in DRAM in 2020 in the reference scenario (x_{ref}).

Variance of gross margin and risk parameter in the EU flat rate scenario

The variances of the gross margins (Σ) in the EU flat rate scenario and the average gross margin ($^{-}$) per farm type, activity and region (excluding direct payments) are assumed equal to the reference scenario. However it is assumed that the minimum expected gross margin (e^*) can change leading to a change in the risk parameter. To what extent the e^* changes is unknown. Here we assume arbitrarily that the minimum expected gross margin is equal to the average gross margin in 2020 in the reference scenario minus 0.5 times the difference between the mean gross margin and (an arbitrarily) minimum gross margin ($maxdif^c$) plus 0.5 times the farm payment in the EU flat rate scenario ( ) times the activity level in the reference scenario. More precisely e^* is calculated as:

$$^{*} = ({}^{-} - 0.5(\quad - \quad)) \qquad (8)$$

This way it is taken into account that changes in the farm payment per farm type and the variation in margins alter the risk aversion of farmers. Compared to the reference scenario, the risk aversion parameter increases if the minimum expected gross margin and the activity level decrease; with lower minimum expected gross margin the farmer becomes more risk averse. The risk parameter per activity decreases if the minimum expected gross margin and the activity level increase; with higher minimum expected gross margin the farmer becomes less risk averse. ~~For example, farmers with very low farm payments per ha per activity in the initial situation are now less risk averse as the minimum expected income per ha per activity increases keeping the variance of the gross margin constant.~~ The factor 0.5 in equation (8) reflects the fact that the direct payment is decoupled from production. In this study we assume that maxdif^c per farm type per activity per region is equal to the corresponding farm payment in the reference scenario (dp_{ref}). Notice further that equation (8) equals equation (7) when maxdif^c would equal .

Table 4: National average standard deviation of the gross margin and the risk parameter (ρ) per selected activity in the reference and the EU flat rate scenario.

		Reference	*EU flat rate*	*Difference*
	Standard dev (€/head or €/ha)	Risk parameter[1] (ρ)	Risk parameter (ρ)	Risk parameter (ρ)
Dairy cows				
Dairy farm type 1	184	13.6	14.4	5.8%
Dairy farm type 2	212	3.5	3.6	5.6%
Dairy farm type 3	204	24.3	26.0	7.0%
Dairy farm type 4	189	2.7	2.9	9.1%
Dairy farm type 5	229	4.8	5.1	4.8%
Dairy farm type 6	225	2.9	3.1	6.1%
Dairy farm type 7	185	12.1	13.7	13.8%
Dairy farm type 8	172	3.6	4.0	13.5%
Arable farm type 1				
- Soft wheat	289	4.4	4.6	2.7%
- Consumption potatoes	1,509	1.4	1.4	0.0%
- Seed potatoes	1,260	3.4	3.4	0.1%
- vegetables	2,286	0.1	0.1	-0.7%
Arable farm type 2				
- Soft wheat	302	4.9	5.4	9.6%
- Consumption potatoes	2,242	2.9	2.9	0.6%
- Seed potatoes	2,465	18.6	18.8	0.9%
- vegetables	3,737	0.8	0.8	0.7%

1.to be divided by factor 10.000
Source: DRAM

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Table 4 shows the average risk aversion parameters in the different scenarios for some selected activities. In dairy farming the risk aversion parameters are relatively high for small dairy farmers with low milk production per cow. The risk aversion parameter is relatively low for large dairy farmers. Risk aversion parameters per activity are relatively low on arable farm type 1, as compared to arable farm type 2. In dairy farming the risk aversion parameters going from the reference scenario to the EU flat rate scenario change more than on arable farms. The risk aversion parameter especially increases on farms with relatively high direct payments in the reference scenario (e.g. arable farm type 2 and dairy farm type 7 and dairy farm type 8).

5. RESULTS

The price effects of the EU flat rate scenario are in general very small. The largest price effect is found for cereals, namely +1%. The small price effects are due to the fact that in the reference scenario all farm payments are assumed decoupled from production. So the supply effect will also be relatively small. As explained, the yield and fertilization requirements of the different agricultural activities are endogenous in CAPRI, as well as the availability of agricultural land at NUTS2 level. The average yield change in the Netherlands as a whole is largest for grassland, namely +2% in the EU flat rate scenario as compared to the reference.

Table 5: Acreages per crop and number of animals in 2020 in the different scenario's (*1000 ha or head)

	Reference	EU flat rate scenario		Difference EU flat rate scenario and reference scenario	
	Activity level	Risk parameter equal to reference	Risk parameter adjusted	Risk parameter equal to reference	Risk parameter adjusted
Soft wheat (ha)	137	133	131	-2.9%	-4.0%
Barley (ha)	64	59	56	-6.7%	-11.9%
Other cereals (ha)	60	58	60	-2.7%	-0.1%
Total cereals (ha)	261	251	248	-3.8%	-5.0%
Oil seeds (ha)	2	2	2	-7.0%	-0.5%
Seed potatoes (ha)	31	31	31	0.2%	0.1%
Consumption potatoes (ha)	62	62	62	0.0%	0.3%
Starch potatoes (ha)	43	40	37	-8.0%	-14.1%
Vegetables (ha)	103	104	104	0.2%	0.6%
Total arable crops (ha)	606	591	586	-2.6%	-3.4%
Grassland (ha)	942	913	904	-3.0%	-4.0%
Fodder maize (ha)	234	220	217	-5.8%	-7.2%
Total roughage crops (ha)	1,175	1,133	1,121	-3.6%	-4.6%
Total agricultural land (ha)	1,782	1,724	1,707	-3.2%	-4.2%

Dairy cows (head)	1,589	1,524	1,496	-4.1%	-5.8%
Beef cattle (head)	279	280	280	0.5%	0.5%
Fattening pigs (head)	5,719	5,780	5,780	1.1%	1.1%
Sows (head)	1,197	1,211	1,211	1.1%	1.1%
Meat poultry (head)[1]	467	470	470	0.7%	0.7%
Laying hens (head)[1]	561	566	566	0.9%	0.9%

1.*100.000

Source: DRAM

This is explained by the shift from grassland with extensive technologies towards grassland with intensive technologies. The latter are characterized by higher yields and revenues and a relatively low share of farm payments in the reference. Productivity per ha of cereals increases with about 1%. Changes in fertilization requirements follow the yield changes. Yield changes and changes in fertilization requirements per activity can be different per region. This is also driven by regional changes in supply of agricultural land.

Table 5 shows the impact of the EU flat rate scenario on allocation of land to the different crops and the number of animals in the Dutch agricultural sector. To analyse the isolated effect of the changes in the risk aversion parameter, results are presented with and without changes in the risk aversion parameter.

The effect of the EU flat rate scenario on allocation of land to arable crops with risk parameter equal to the reference scenario (see table 5), is mostly explained by the cropping shares of the two arable farm types. The arable farm type with relatively high direct payments per ha (arable farm type 2) has a relatively large share of barley and starch potatoes in its cropping plan, while the share of seed and consumption potatoes and vegetable crops is relatively low. After the policy shock, the average cropping plan develops in the direction of the cropping plan of farm type 1. Farm type 1 has relatively a high share of seed and consumption potatoes and vegetables in its cropping plan.

Farm payments per ha are relatively high on the different types of dairy farms. As a result the EU flat rate scenario the number of dairy cows decreases compared to the reference scenario.

Including gross margin volatility in combination with changes in the risk aversion parameter amplifies the different effects. The total acreage of cereals and especially starch potatoes further decreases while the acreage of consumption potatoes and vegetables further increases. Taking into account the changes in the risk aversion coefficients, the decrease in the number of dairy cows equals almost 6%. Total acreage of arable crops in the Netherlands decreases with about -3.4%, while the acreage of fodder crops decreases with about -4.6%. Land allocated to silage maize decreases with more than 7%.

The number of animals in the intensive livestock industry in the Netherlands increases in the EU flat rate scenario. This is explained by the small increase in the price of intensive livestock products, while the price of feed stuffs is hardly affected.

The effect per province (NUTS 2 region) can be very different from the national average in the Netherlands. In the EU flat rate scenario, production and acreages of arable crops especially decreases in provinces with a high share of starch potatoes and barley in their arable cropping plan. As a result total acreages of arable crops especially decreases in Groningen (-14%), Drenthe (-15%) and Overijssel (-12%). In other provinces acreages of arable crops increases at the expense of fodder crops originally grown on dairy farms and the remaining farm types. This is especially the case in Friesland (+3%), Utrecht (+5%) and Noord-Brabant (+6%).

The changes in the number of dairy cows can also be very different per province, ranging from -2% in Drenthe to about -7% in other provinces in the Netherlands.

Table 6 shows the impact of the EU flat rate scenario with and without changes in the risk aversion coefficient on the land use in ha per farm type. The decrease in the total acreage of land allocated to dairy farms is especially explained by the decrease in the acreage of land allocated to dairy farm type3, dairy farm type 4, dairy farm type 7 and dairy farm type 8. These are dairy farm types with relatively high number of dairy cows, milk production and direct payments per ha in the reference scenario. Again, including gross margin volatility in combination with changes in the risk aversion parameter amplifies the different effects in Dutch dairy farming. The production technology on the average dairy farm in the Netherlands will be less intensive in the EU flat rate scenario as compared to the reference scenario.

Including the changes in the risk aversion parameter, the acreage of land allocated to arable farm type 1 (average farm payments per ha relatively low, see table 2) increases with 1.2% while the acreage of land allocated to arable farm type 2 (average farm payment per ha relatively high) decreases with -9.5%. Land allocated to the remaining farm type is about stable in the EU flat rate scenario as compared to the reference scenario.

Table 6: Total acreage per farm type in the Netherlands in 2020 in the reference scenario and the different EU flat rate scenario's.

Farm type	Reference (1000 ha)	EU flat rate		Farm type	Reference (1000 ha)	EU flat rate	
		Risk parameter adjusted:				Risk parameter adjusted:	
		No	Yes			No	Yes
Total dairy farms	973	-3.9%	-5.6%	total arable farms	606	-2.6%	-3.4%
dairy farm:				arable farm:			
type 1	56	-2.7%	-3.5%	type 1	345	0.6%	1.2%
type 2	210	-3.1%	-4.4%	type 2	262	-6.8%	-9.5%
type 3	21	-4.6%	-6.4%	remaining farms	202	-1.9%	0.0%
type 4	179	-5.0%	-7.1%	total	1,782	-3.2%	-4.2%

				agriculture
type 5	114	-3.0%	-3.8%	
type 6	211	-3.3%	-4.9%	
type 7	49	-6.0%	-8.7%	
type 8	132	-4.9%	-7.4%	

Source: DRAM

Income is defined as revenues plus farm payments minus variable costs. Taking into account changes in the risk aversion parameter, land shifts and changes in number animals per farm type, total income effect of the EU flat rate scenario ranges from -10% for dairy farm type 1 and 5 to -22% for dairy farm type 7 and 8. Average income of arable farm type 1 increases with 0.6% while average income of arable farm type 2 decreases with -10%. Total income at remaining farm types increases with about 4%. Income in the Dutch agricultural sector, as included in DRAM, as a whole decreases with about -7%.

Table 7 shows that under the EU flat rate scenario the total N surplus at soil level and the total ammonia emissions to the environment in the Netherlands decrease compared to the reference. This can be largely explained by the decrease in the number of dairy cows. As a result of the decrease of the agricultural land supply, the emissions are produced on less agricultural land.

On average dairy farms become less intensive (see table 5). This average change towards less dairy cows per ha and less extensive production technologies, increases the opportunity for dairy farmers to further decrease their nutrients surplus at soil level and emissions of nitrogen to the environment (Daatselaar et al., 2010). Baptiste et al. (2010) also found that decoupling has a positive impact on the score of dairy farming environmental criteria. Moreover, the decreased land demand for agricultural production, opens extra opportunities for the government and nature organizations for the production of public goods.

Table 7: Nitrate balance of the Dutch agricultural sector (totals) in 2020 under the EU flat rate scenario (indices, reference is 100)

	EU flat rate scenario Risk parameter adjusted:	
	No	Yes
Mineral fertilizer	99.2	99.6
Animal manure	96.6	95.3
Uptake with harvested crops	98.0	96.9
Surplus at soil level	96.7	97.5
Ammonia emissions	97.7	96.8

Source: DRAM

6. DISCUSSION AND CONCLUSIONS

In this research the Dutch agricultural sector model DRAM is applied using values of exogenous variables, mainly prices, coming from CAPRI. Although the sectoral and regional results are straightforward and easy to explain, there are a number of effects that are not modelled and that could result into different effects in reality. From the literature a large number of potential effects of decoupled payments on production, also relevant for a policy switch from decoupled payments based on historical references are identified: liquidity effect (a change in cash with could affect to the buying of e.g. land), creditworthiness effect (cost of debt change), expectations effect (future payments can be affected by today's production decisions), wealth effect (increase of wealth) and the impact on the producer decisions to work on or off the farm. For example, in our case, the EU flat rate scenario potentially has a negative impact on agricultural production in the Netherlands, via the negative wealth effect. The lack of data on e.g. individual farms, and transaction costs could also potentially lead to different results in reality. Moreover, there is also the aggregation error as we implicitly assume that the cropping plan on an individual farm corresponds to the regional average cropping plan of the corresponding technology included in DRAM. For example, most of the vegetables production accounted for in DRAM is produced on specialised vegetable farms. The risk behaviour on these type of farms could be different from the regional average.

Notwithstanding the above mentioned shortcomings of the modelling approach, some conclusions can be drawn. The policy switch from farm payments based on historical entitlements towards an EU wide flat rate has a large effect on income in the Dutch agricultural sector. This especially accounts for intensive dairy farmers and arable farmers with relatively high farm payments per ha in the initial situation. Production effects are less pronounced although some re-allocation of agricultural land between farm types and crops is to be expected. The policy switch towards an EU flat rate decreases the total emissions of nutrients to the environment from agricultural production. Moreover, the average dairy farm will be based on more extensive production technologies. This gives room for further improvement of environmental indicators at the farm level. These effects are strengthened if risk is included in the model.

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