From Flat-Rate Payments to Whole Farm Insurance:

Modeling Impacts of the Evolution of the Common Agricultural Policy in the Netherlands

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Motivation

- European agricultural policy: more market orientation (incl. decoupling)
- The EU's recent CAP reform of June, 2013: further shift away from coupled support
- This affects level and variance of farm incomes, leading to
    - Greater price and income uncertainty for producers
    - Changes in the shadow prices (value) of agricultural land
- This will impact producers' land allocation decisions.

CAP-Reform

Distinguishes four pillars:

1. **Direct payments:** *Lump-sum payments to producers*
2. Market management mechanisms,
3. Rural development
4. **Horizontal regulation:** *Contains a risk management toolkit with insurance possibilities.*

Financial resources needed to pay for crop insurance will be made “through deductions from direct payments”

Wealth and insurance effect of subsidies

Wealth effect: *Increases farmer's wealth → thereby reduces level of risk aversion*

Insurance effect: *Lower bound on farmer's income*

SFP and insurance are likely to have these effects.

- **SFP** may have both an insurance & a wealth effect.
- **Income insurance** may incentivize greater production.

Objective of this study:

To determine the potential effects on land use (crop allocation) of crop-specific, per ha payments, single farm payments (SFP) and whole farm income insurance (WFI), as described in the June, 2013 agreement on CAP reform.

Following Turvey (2012), we simulate the effect of income insurance on farmers' enterprise choices under alternative per ha payment schemes and then a whole farm income approach. We calibrate the model using positive mathematical programming (PMP).

Base model and flat-rate payments

- Base model includes a crop-specific direct payment

- Assume a farmer who maximizes utility by maximizing income while accounting for risk
  - Allocates his land to various uses or activities

Base model with crop-specific payments

Maximize utility by allocating ha among K crops

Expected utility determined by:

Expected net revenues

$E[R_k] = \frac{1}{T}\sum_{t=1}^{T} R_{k,t}, \forall$ k

minus risk associated with crop portfolio

$\sigma^2 = \sum_{k=1}^{K}\sum_{i=1}^{K}[x_k \times CV(R_k, R_i)x_i]$ *with*

$CV(R_k, R_i) = \frac{1}{T}\sum_{t=1}^{T}(R_{k,t} - E[R_k])(R_{i,t} - E[R_i]), \forall$k,i

multiplied by an Arrow-Pratt measure of risk-aversion (ϕ).

Subject to:

net revenues given the endogenously determined crop allocation

$R_{k,t} = [p_{k,t}\, y_{k,t} - c_k(w) + FRP_k]\, x_k, k$

cultivated area should not exceed available area

$$\sum_{k=1}^{K} x_k \le \bar{X}$$

Calibration via PMP (1)

Positive Mathematical Programming (PMP) to calibrate the model so that it precisely duplicates observed crop allocation:

- First, we re-specify the model to an LP whose objective is to maximize current revenue:

$$\sum_{k=1}^{K} R_k = \sum_{k=1}^{K} \left(p_k y_k - c_k + FRP_k \right) x_k$$

Calibration via PMP (5)

Elasticity of land supply with respect to output price

$\eta_s = (\partial q/\partial p)\ (p/q) = (\partial x_b/\partial MC_b)\ (p_b/x_b^o)$

where x_b^o = observed land in barley

p_b = output price of barley

Recall:

$MC_k = \alpha_k + \beta_k x_k$, so $\partial MC_b/\partial x_b = \beta_b = p_b/(\eta_s \times x_b^o)$

Calibration via PMP (5) (cont)

Define adjustment at x_b^o that is added to the LP average cost to obtain a nonlinear cost function:

$$Adj = MC - AC = \tfrac{1}{2}\, \beta_b\, x_b^o = p_b/2\eta_s.$$

If adjustment applies to marginal activity – the activity whose calibration constraint is not binding – then PMP values for non-marginal activities must change as follows:

$$\hat{\lambda}_k = \lambda_k + Adj.$$

Final PMP Results

Crop	Observed and simulated area by crop (ha)	λ	α	β
Wheat	22.462	1,517.97	-1,021.97	135.16
Barley	3.042	912.42	-529.42	599.87
Seed potatoes	8.949	7,015.34	-3,743.34	1,567.86
Edible potatoes	11.612	7,489.25	-5,475.25	1,289.96
Starch potatoes	0.871	1,976.52	-986.52	4,539.19
Sugar beets	9.780	3,906.23	-3,287.23	798.84
Onions	4.334	5,009.49	-3,076.49	2,311.54
Total Land Use	61.05	164.45	–	–

Whole Farm Insurance

‘Risk Management Tool’

- producer restitution for up to 70% of lost income
- if total income from the entire crop enterprise falls below 30% of the reference level.

Whole Farm Insurance (1)

Net revenue is now specified as:

$$R_t = \sum_{k=1}^{K}\left[p_{k,t}\, y_{k,t} - c_k(x_k)\right]x_k + \mathrm{Max}\left(0,\ 0.7M - \sum_{k=1}^{K} R_{k,t}\, x_k\right) - \frac{\delta}{T}\sum_{t=1}^{T}\mathrm{Max}\left(0,\ 0.7M - \sum_{k=1}^{K} R_{k,t}\, x_k\right), \quad \text{if } \sum_{k=1}^{K} R_{k,t}\, x_k < 0.7M$$

$$R_t = \sum_{k=1}^{K}\left[p_{k,t}\, y_{k,t} - c_k(x_k)\right]x_k - \frac{\delta}{T}\sum_{t=1}^{T}\mathrm{Max}\left(0,\ 0.7M - \sum_{k=1}^{K} R_{k,t}\, x_k\right), \quad \text{if } \sum_{k=1}^{K} R_{k,t}\, x_k \geq 0.7M$$

where M is the reference level of income (Olympic average)

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Whole Farm Insurance (2)

$$\text{WFI Payout} = \text{Max}\left(0,\ 0.7M - \sum_{k=1}^{K}\left(p_{k,t}y_{k,t} - c_k\right)x_k\right)$$

$$\text{Premium paid} = -\frac{\delta}{T}\sum_{t=1}^{T}\text{Max}\left(0,\ 0.7\,M - \sum_{k=1}^{K}\left(p_{k,t}y_{k,t} - c_k\right)x_k\right)$$

Data

Base level: 2012 observed crop allocation for all arable farms in the Netherlands

Prices, yields and costs of production were obtained from the FADN

	Yield (10^3 kg/ha)	Price (€/10^3 kg)	Gross revenue (€/ha)	Variable cost (€/ha)	Observed allocation (ha)
wheat	9.13	238.6	2,178.42	552	22.29
barley	6.35	229.9	1,459.87	399	3.01
seed	37.91	275.7	10,451.79	3,522	9.17
edible	50.99	189.6	9,667.70	2,190	11.89
starch	42.89	73	3,130.97	1,102	0.77
sugar	75.64	62	4,689.68	694	9.43
onion	57.78	123	7,106.94	2,143	4.49

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Gross Revenue Scenarios

Monte Carlo simulation to generate random crop prices, yields and revenues for the representative farm using

$$R_{k,t} = (p_{k,t}y_{k,t} - c_k{}^o)\, x_k, \quad t = 1, \ldots, T, \forall k,$$

Yields distributed following:

$$y_{k,t} = \mathrm{E}[y_{k,t}] + \varepsilon_k, \ \varepsilon_k \sim \mathrm{N}(y_k, \sigma_k)$$

Prices follow a random walk with mean reversion:

$$P_{k,t+1} - P_{k,t} = \alpha\left(P^*_{k,t} - P_{k,t}\right) + \sigma_k \varepsilon_t$$

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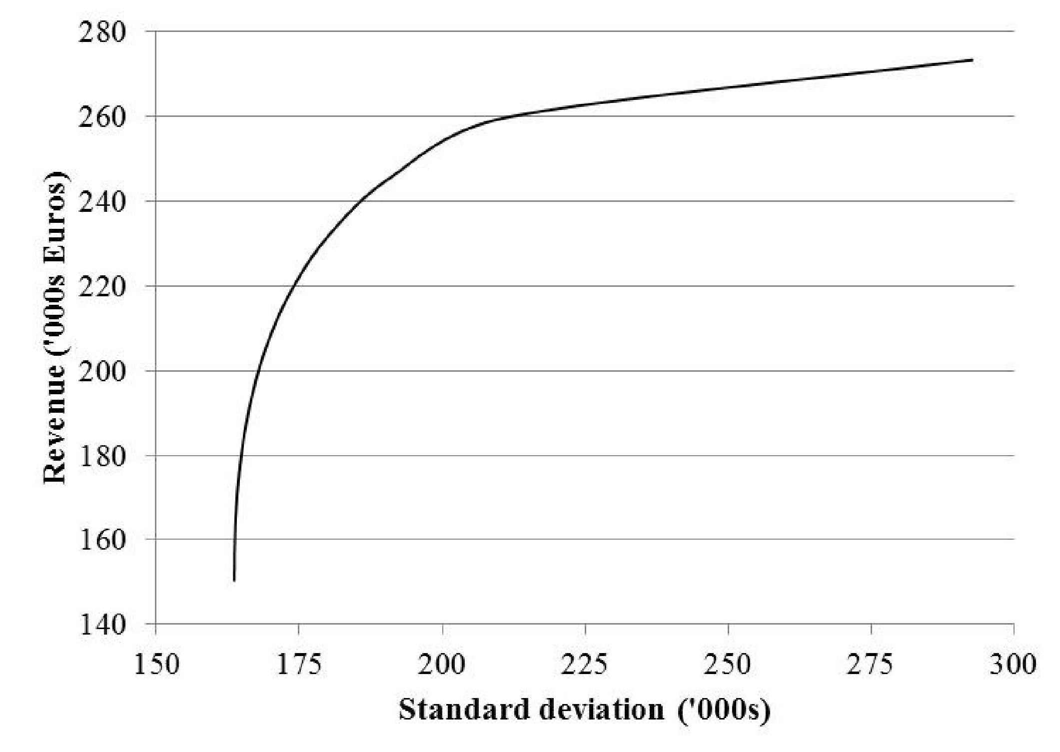
PMP-results

By varying the revenue target in each optimization of the base model we construct an EV frontier

When concerned with risk, a shift from wheat to barley, onions, and seed and starch potatoes, is observed



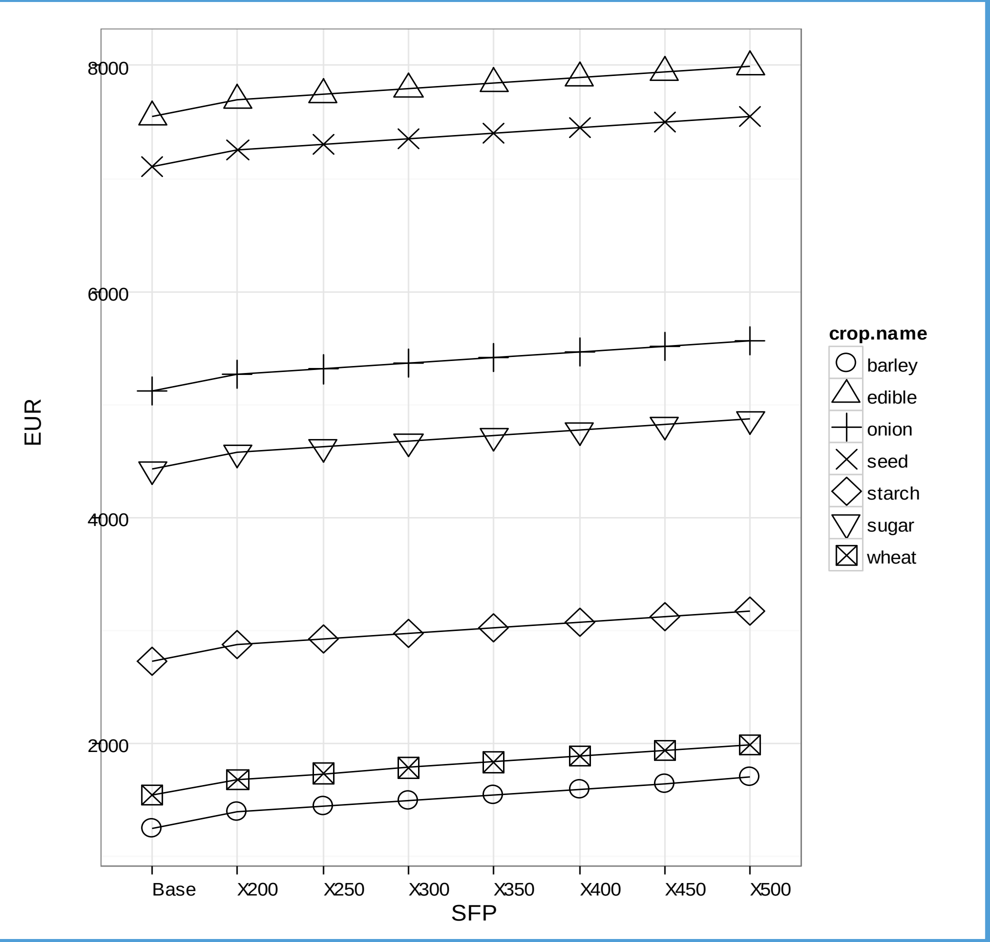
Tradeoff between Revenue and Standard Deviation, EV Frontier

SFP-results

Results show a very small wealth effect.

When SFP moves from a crop specific to a non-crop specific payment, crop allocation changes slightly.

Further increases in SFP do not show an effects on crop allocation.

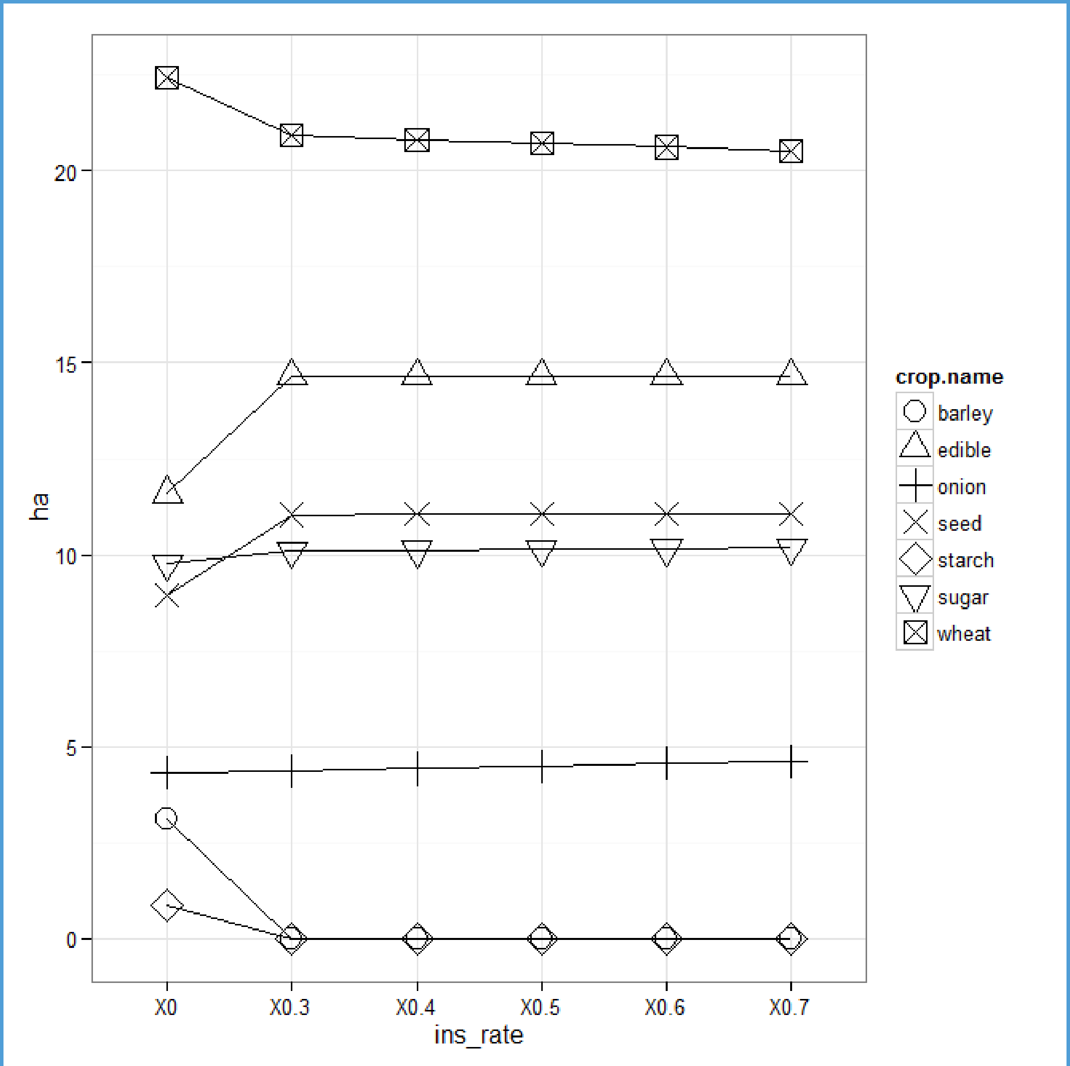


Average revenue under different levels of SFP

Insurance results

Finally, we consider how the crop allocation changes when whole farm insurance is implemented.

We examine the effects of changing δ – the share of the premium paid by the farmer.



Conclusions

A small wealth effect due to transition to SFP

The change from a crop-specific to a flat-rate payment affects the shadow price of land which in turn affects the producer’s crop allocation.

This effect is larger with insurance

Thank you for your attention

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