Dynamic monitoring of mortality rate for sows and piglets

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Background

Problem

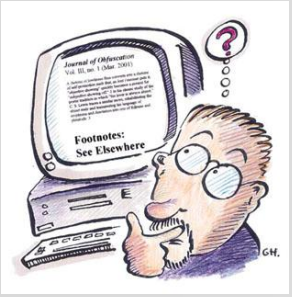
- Existing Management Information Systems (MIS) are *static* and typically computed every quarter or year

Solution

- Dynamic approach

  - Save time

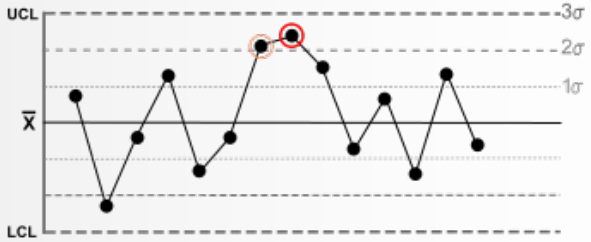
  - Save money



Objective

Develop new and more reliable methods for dynamic production monitoring

- Implementation of automatic methods for detection of systematic deviations from the expected results



Mortality rate model

The third phase of the project:

- Mortality rate being a binary trait, is modeled by using a Dynamic Generalized Linear Model (**DGLM**)
- Mortality rate of sows and piglets is treated at the same time

Model and dateset components:

- 15 parameters → μ_t, α_{2t} to α_{8t}, β_{2t}, γ_{1t} to γ_{4t}, ζ_t, δ_t
- 15 herds
- 3-9 years

Model parameters

$\mu_t \rightarrow$ general level for sow mortality

α_{2t} to $\alpha_{8t} \rightarrow$ coeff. referring to parity effects on sow mortality

$\beta_{2t} \rightarrow$ effect of the stage in the reproductive cycle
(insemination + gestation and nursing + dry)

γ_{1t} to $\gamma_{4t} \rightarrow$ coeff. for the parity specific stillbirth rate

$\zeta_t \rightarrow$ coeff. for pre-weaning mortality

$\delta_t \rightarrow$ coeff. for the slope of stillbirth rate after parity 4

The parameter vector will be:

$$\theta_t = (\mu_t, \alpha_{2t}, \ldots, \alpha_{Nt}, \beta_{2t}, \gamma_{1t}, \ldots, \gamma_{4t}, \zeta_t, \delta_t)'$$

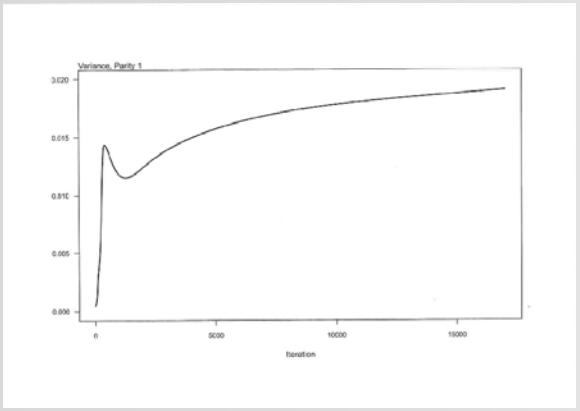
Material and methods

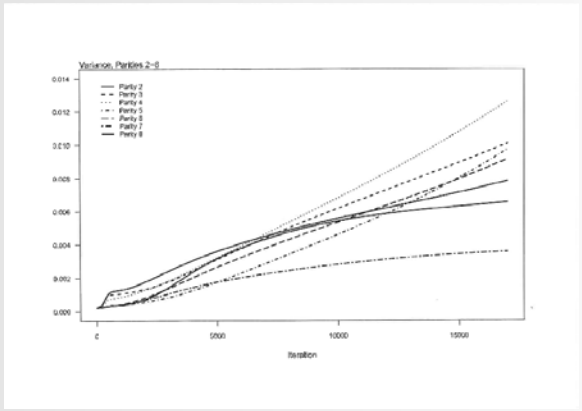
- Once that the parameters (μ_t, α_{2t} to α_{8t}, β_{2t}, γ_{1t} to γ_{4t}, ζ_t, δ_t) were calculated, at any week the last week's estimate is available as a result of the **Kalman filter** application

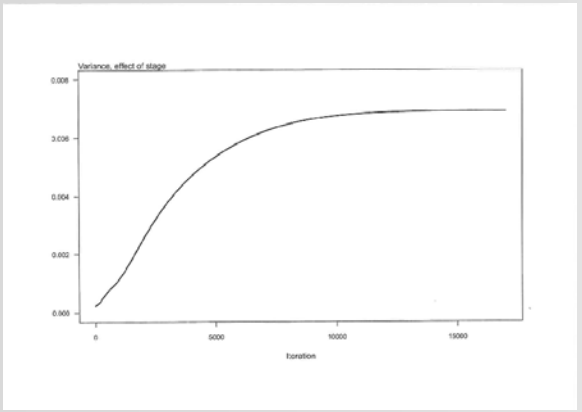
- Expectation-Maximization **(EM) algorithm** technique was used for estimation of the system variance

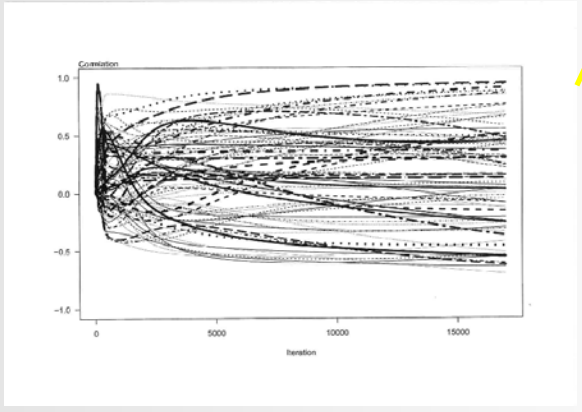
- Detection methods (**Control chart and V-mask**) were applied in order to monitor out-of-control situations

Results – Variance & Correlation sows - EM









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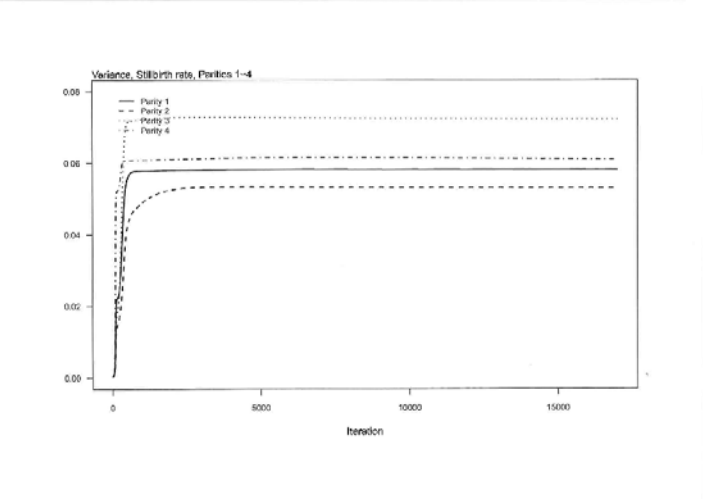
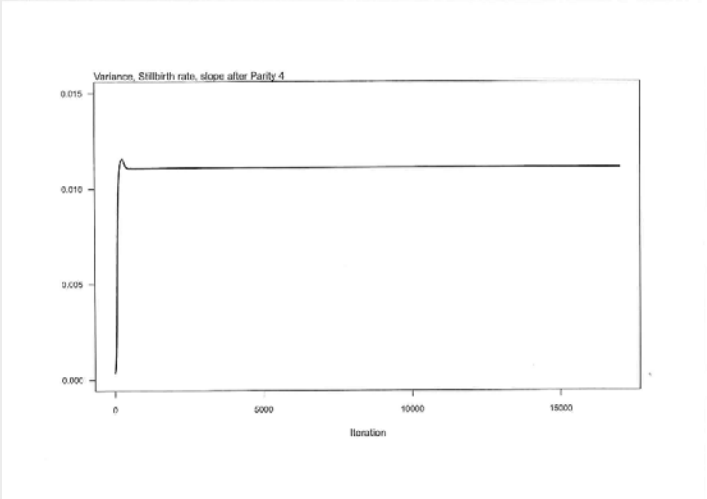
Correlation between all parameters

- Convergence: 17000 iterations
- Variance
- Correlation between parameters (…)

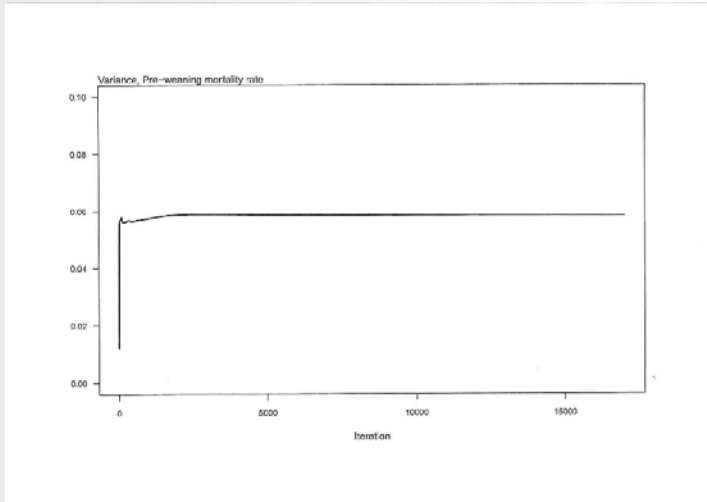
Results – Variance & convergence piglets - EM



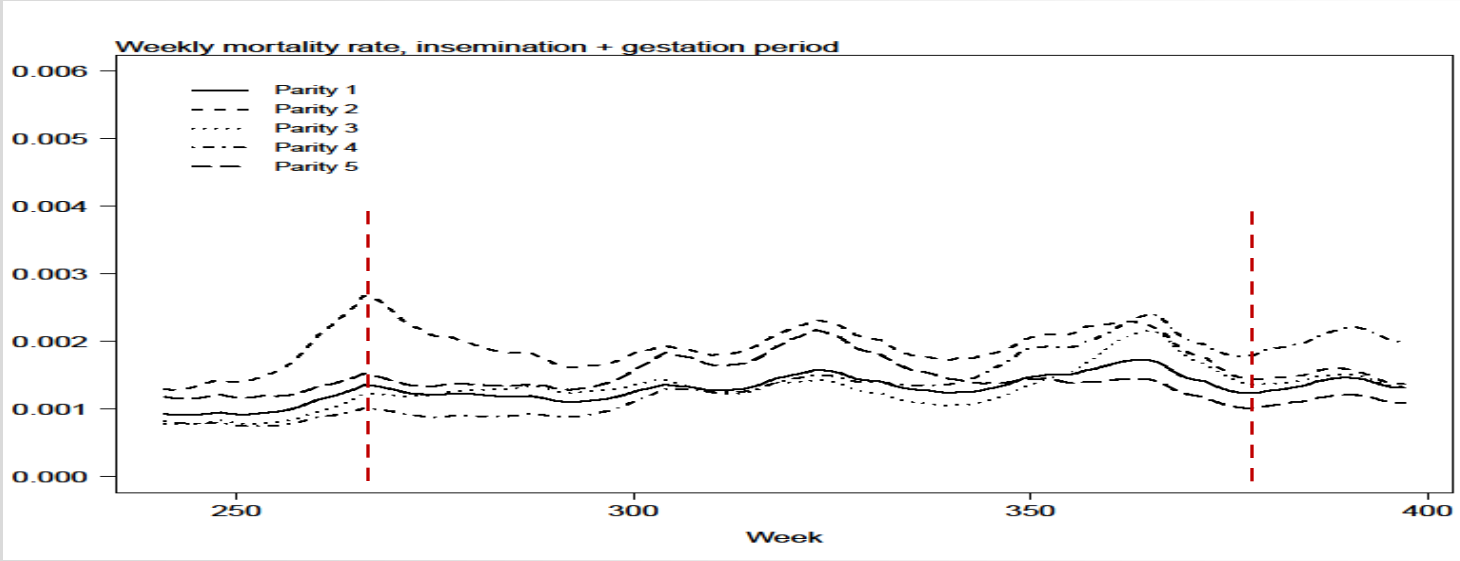


Convergence has been reached after less than 5000 iterations for:

- Stillbirth rate 1-4 parities
- Stillbirth slope after parity 4
- Pre-weaning mortality



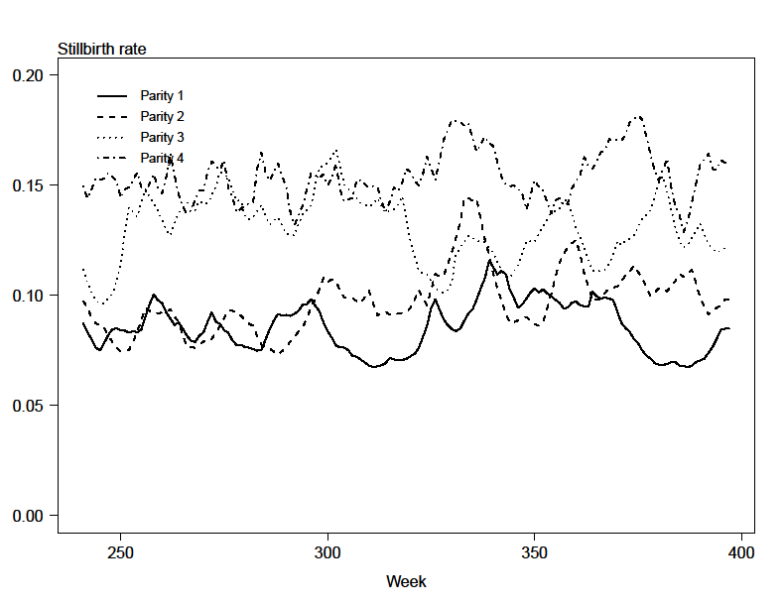
Results – Mortality rate per parity (3 years) – sows KF

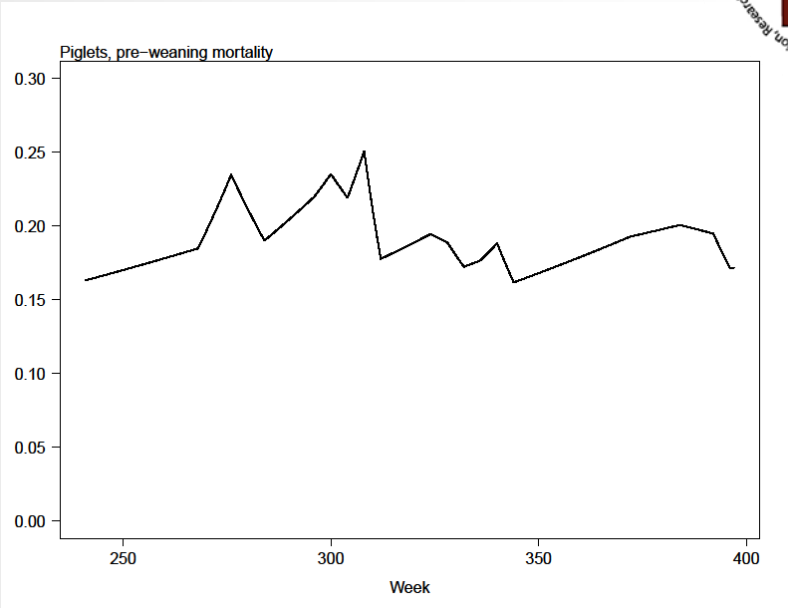


Sow mortality in 3 years for the first 5 parities – smoothed data

- The smoothing represents the best possible estimate
- It is possible to recognize a pattern (correlation)
- Red dotted lines → alarms in V-mask + Cusum [later commented]

Results – Mortality rate per parity (3 years) – piglets KL





Piglets mortality in 3 years – smoothed data

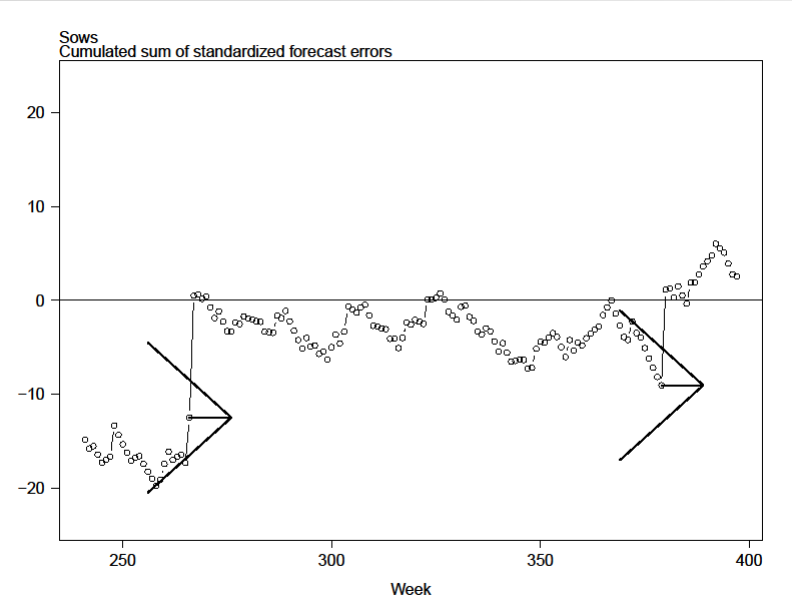
- No clear patterns have been found in stillbirth rate over the first four parities
- Pre-weaning mortality ranges between 16% and 25 %

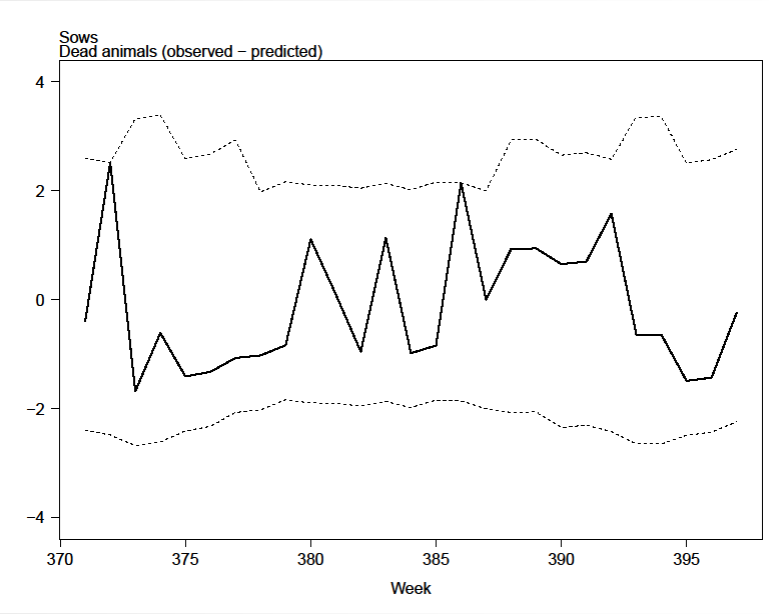
Results – Detection methods sows

Results were monitored both in a short and long time period

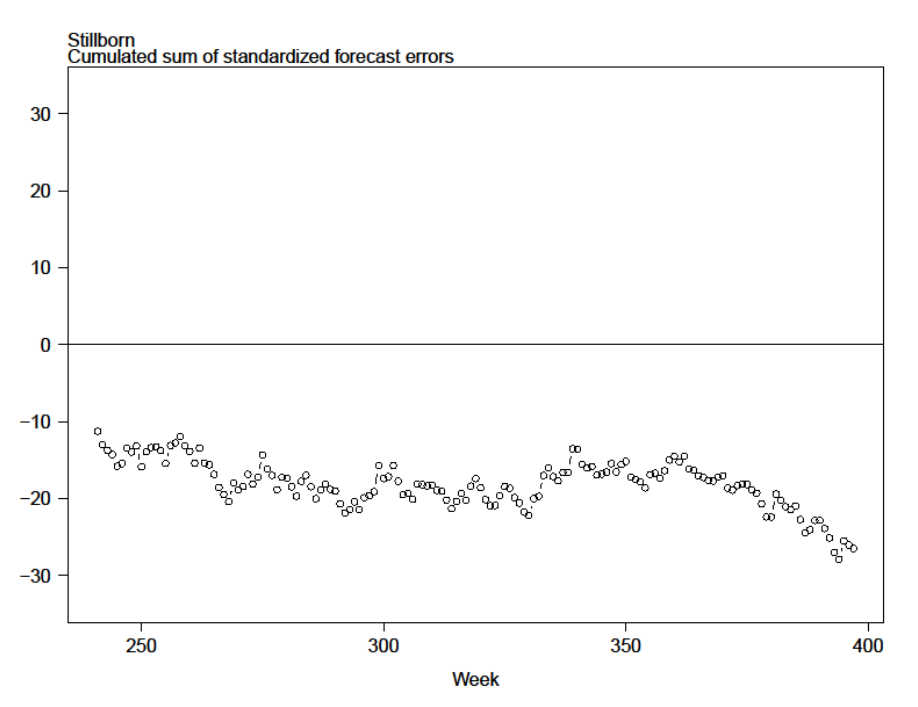
Monitoring methods:

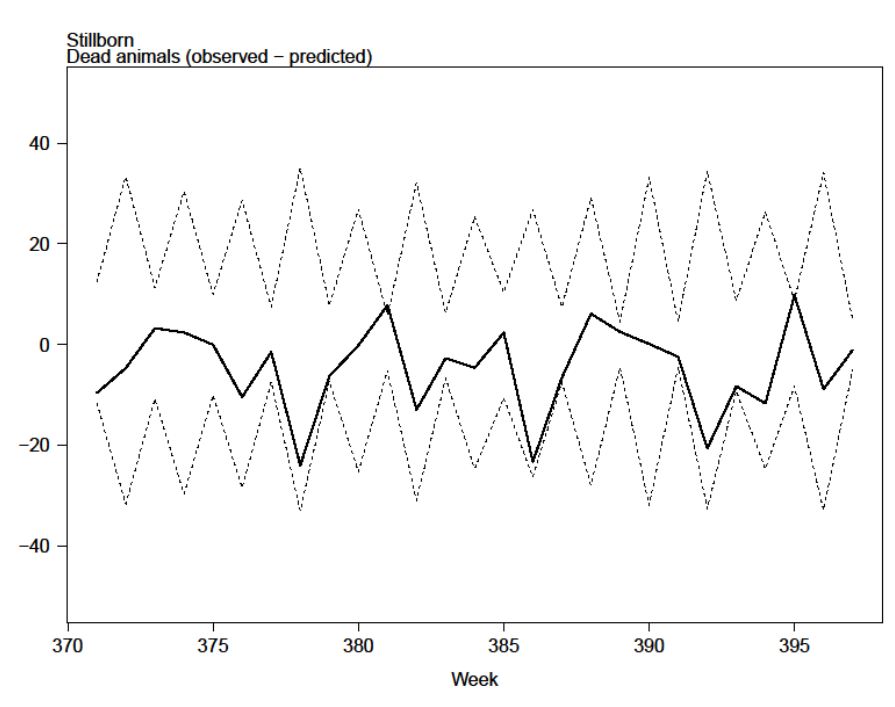
- V-mask applied on Cusum → Long time horizon (3 years)
- Control Chart → Short time horizon (26 weeks)





Results – Detection methods piglets





No alarms have been found

→ Warning limits suggested for control chart method

Conclusions

- The system for monitoring mortality rate of sows and piglets based on DGLM, V-mask and Control Chart can be a useful tool for modeling mortality rate week by week in short and long period
- V-mask settings (angle of the arms) need to be optimized
- Parity specific deviations can be monitored
- A suggestion for further developments can be to "***split***" the model into sow mortality and piglet mortality, and combine them at a later stage

Conclusions and Perspectives

The junction of the three models will represent an important step towards the construction of a management tool (i.e. software)

This tool may be used:

- To help in the decision support system
- To monitor changes
- To predict production in a dynamic way

Litter size — phase I + Farrowing rate — phase II + Mortality rate — phase III =

Thank you

First two phases

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Dynamic production monitoring in pig herds I: Modeling and monitoring litter size at herd and sow level

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Dynamic production monitoring in pig herds II. Modeling and monitoring farrowing rate at herd level

Material and methods

Dynamic Generalized Linear Model (DGLM)

DGLM consists of these equations:

Observation equations →

$$y_{Gt}|\theta_t \sim \mathcal{B}(N_{Gt}, p_{Gt})$$

$$\eta_t = F_t'\theta_t$$

System equation →

$$\theta_t = G_t\theta_{t-1} + w_t$$

B → denotes the binomial ditribution

The parameter vector for week t will be:

$$\theta_t = (\mu_t, \alpha_{2t}, \ldots, \alpha_{Nt}, \beta_{2t}, \gamma_{1t}, \ldots, \gamma_{4t}, \zeta_t, \delta_t)'$$