KU LEUVEN

EAAP 2018

69th Annual Meeting of the European Federation of Animal Science

Dubrovnik, Croatia, 27th to 31st August 2018

M3-BIORES KU Leuven

Advantages of individual feed consumption and weight monitoring of growing finishing pigs

A. Peña Fernández[1], T. Norton[1], A. Youssef[1], C. Bahr[3], E. Vranken[1,2], D. Berckmans[1]

[1]Department of Biosystems, Division M3-BIORES: Measure, Model & Manage of Bioresponses, KU Leuven, Kasteelpark Arenberg 30, 3001 Heverlee, Belgium.

[2]FANCOM B.V., Research Department, P.O. Box 7131, 5980 AC Panningen, The Netherlands

[3] Agrifirm Innovation Center B.V. Landgoedlaan 20, 7302 HA Apeldoorn

Fancom® agrifirm

Introduction

Large farms of more than 400 fattening pigs represent more than 90% of the industry in Europe (Marquer et al., 2014).

Feeding represents up to 70 % of production costs in pig farming (Woyengo et al., 2014) and it is a fundamental way of influencing the feed efficiency of pigs and thus the overall efficiency of pig production (Gaines et al., 2012; Douglas et al., 2015).

Today's commercial feeding strategies are set at group level and the growth-stage related nutrient demand is managed using feeding curves that adjust feed ration during either 2- or 3- phase feeding programs (Cloutier et al., 2015).

Conventional feeding strategies do not account for the variation of nutritional requirements among individual pigs, maximizing the performance of individual pigs and thus the efficient use of feed on the farm is not possible with these strategies (Andretta et al., 2014; Mayer et al., 2013).

Introduction

However, pigs are living organisms, the efficiency to convert nutrients into lean meat can vary between individual pigs during their growing and fattening periods (Brossard et al. 2009, Brown-Brandl, T.M. et al. 2013). Thus, pigs should be considered as Complex, Individually different, Time-varying and Dynamic (CITD) systems (Berckmans, 2004).

Complex | Individual | Time-Varying | Dynamic

Living organism = CITD - system

1. Measure

2. Model

3. Manage = Monitoring

- Continosly
- Fully Automated
- In Real-Time

M3-BIORES

Mechanistic models: Schinkel and De Lange, 1996; Green and Whittemore, 2005; Strathe et al., 2009; Wetten et al., 2011; Nitikanchana et al. 2015)

Grey-box models are used to estimate daily nutrient requirements for each individual pig according to their actual growth and feed intake patterns (Hauschild *et al*., 2012)

KU LEUVEN

Precision Feeding project

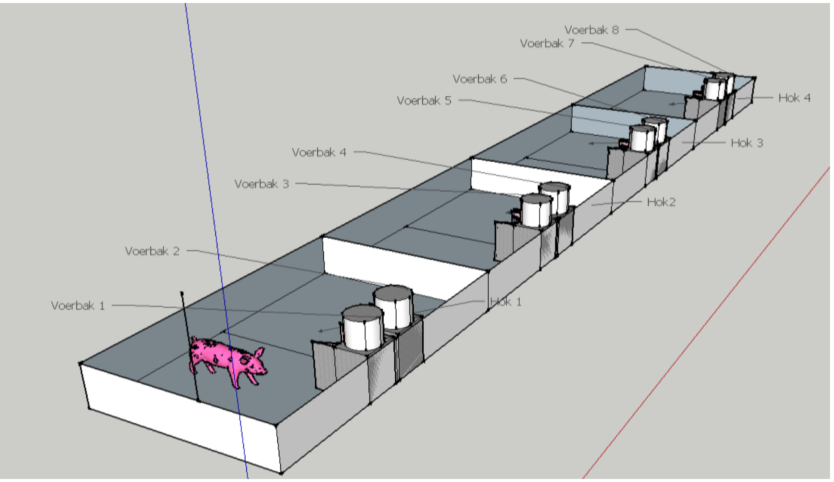
Hypothesis:

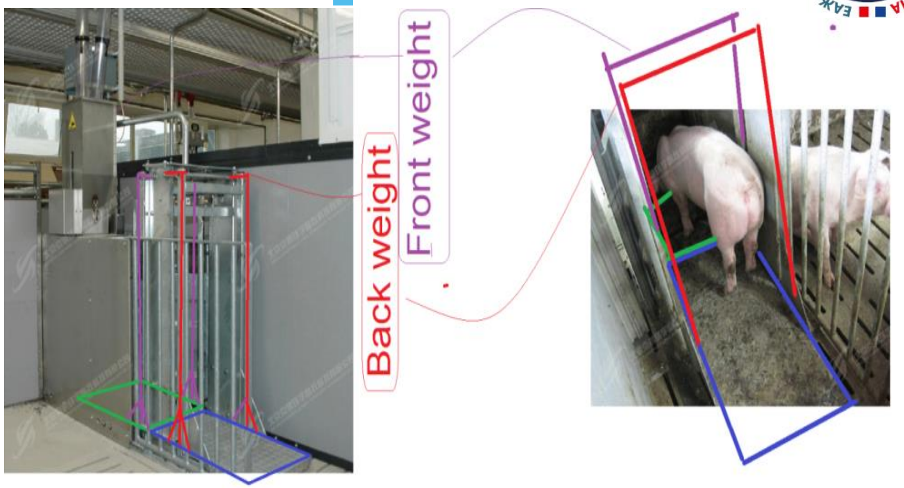
Optimal feed amount and composition can be determined for each individual pig in the batch to optimize their growth

Objective:

Develop a real-time model to forecast the right amount and composition of the feed for an individual pig according to its growing pattern.

Experimental setup



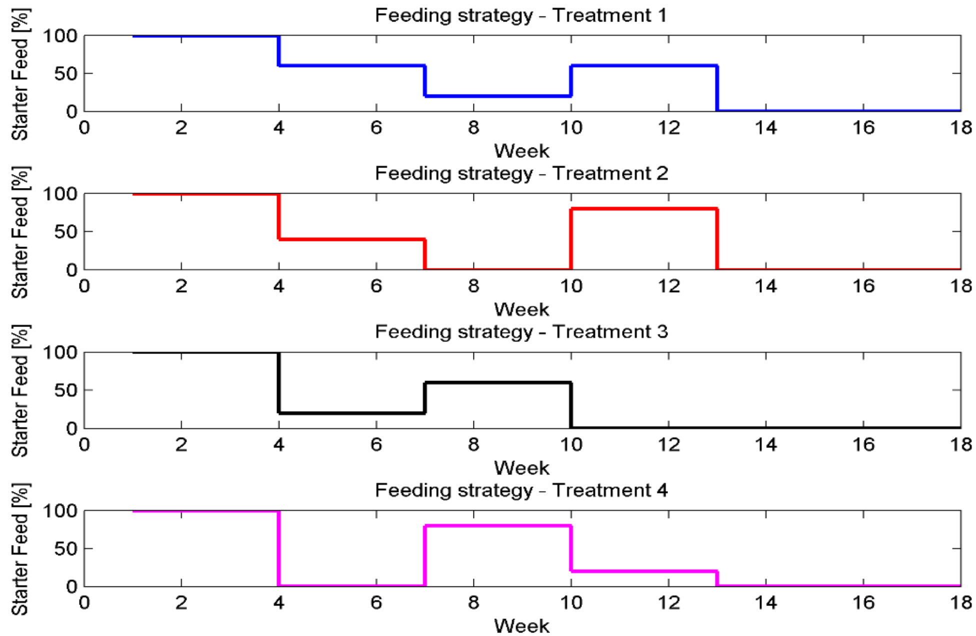


80 growing-finsihing boars (Pietrain x Topigs 20)

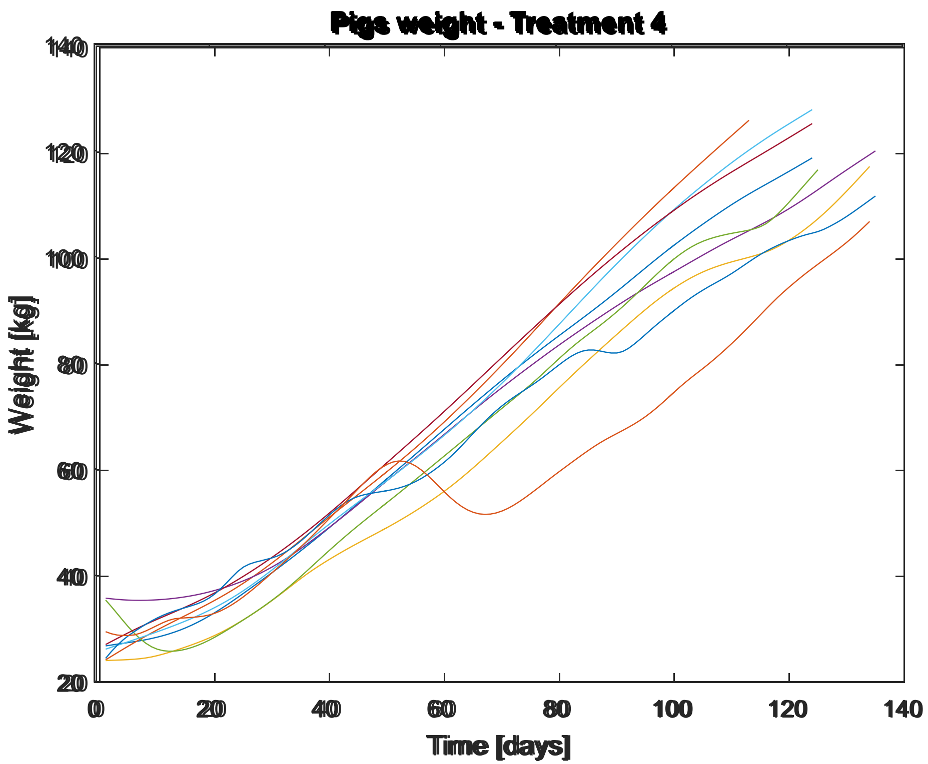
4 pens (67 m x 6.26 m; 16.71 m^{2}, effective 16.14 m^2 , 0.81 m^2 per animal), partially slatted floor and situated in a room with computer-controlled heating and mechanical ventilation systems.

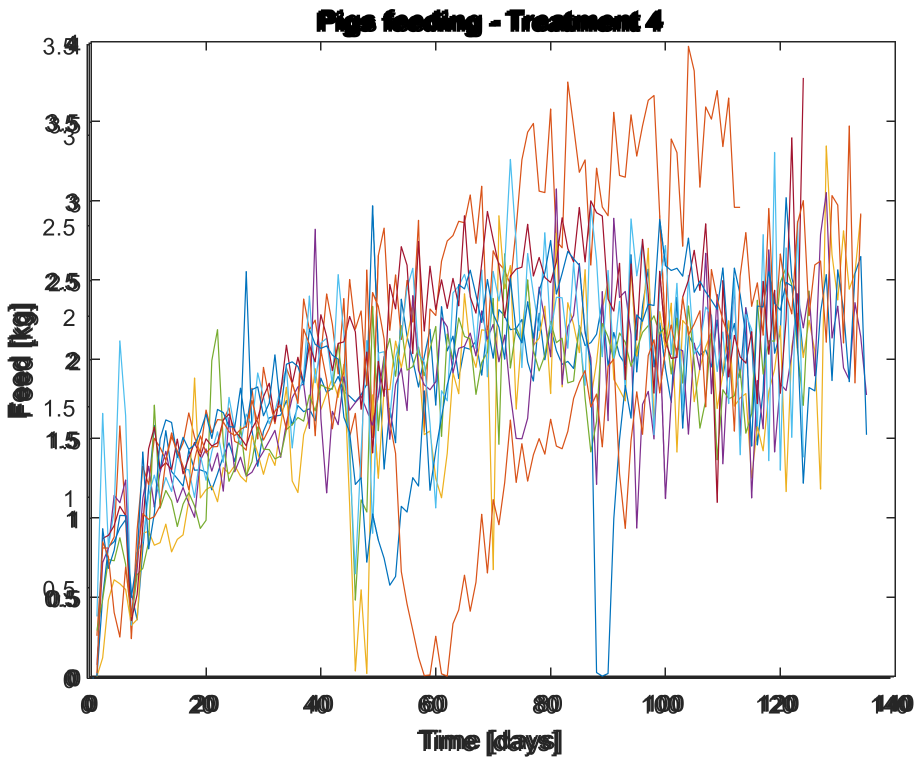
2 Schauer feeding stations per pen

Ad libitum feed and water



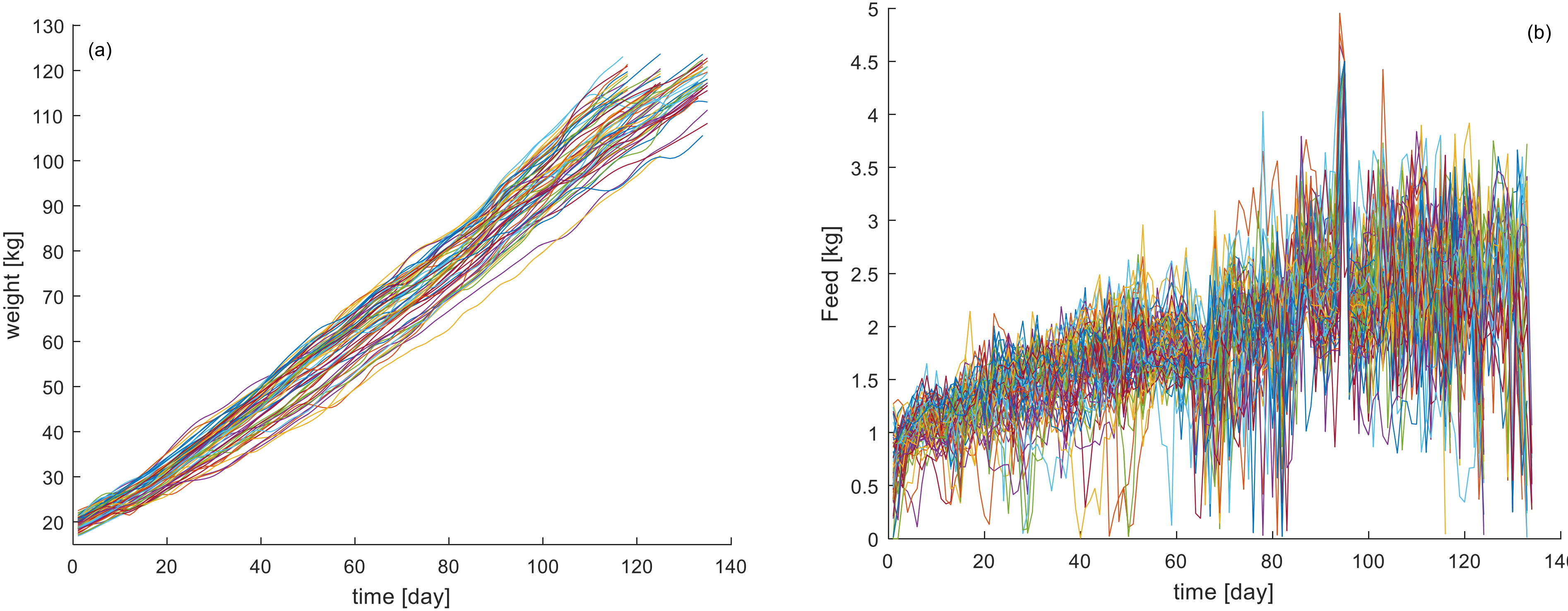
Experimental data





Each pig show an individual, time-variant, feed consumption and weight development when following the same feeding strategy

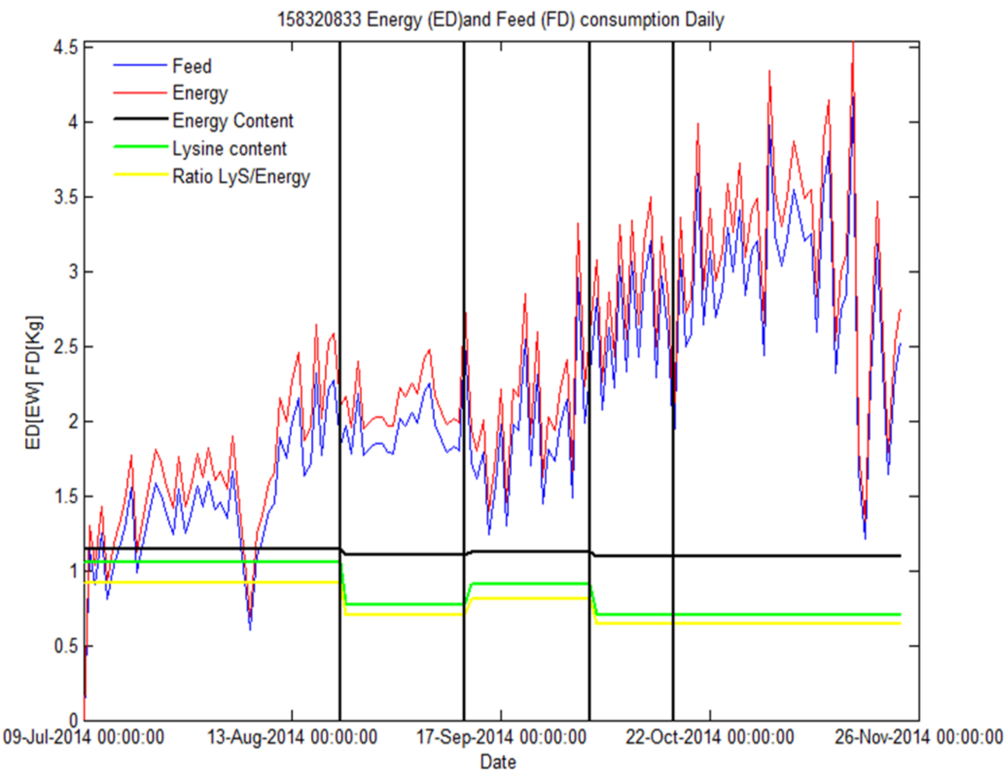
Experimental data

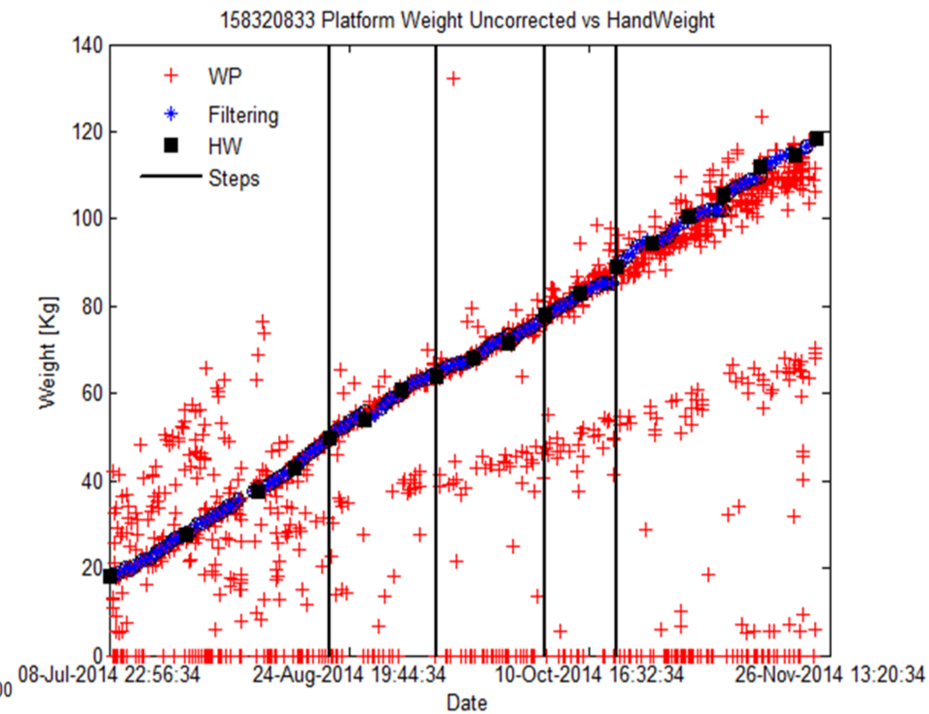


	Experiment 2							
	Treatment1		Treatment2		Treatment3		Treatment4	
	InitialWeight	FinalWeight	InitialWeight	FinalWeight	InitialWeight	FinalWeight	InitialWeight	FinalWeight
Average [kg]	21	118	21	121	25	120	26	119
SD [kg]	3	4	4	4	3	5	4	6

KU LEUVEN

Experimental data



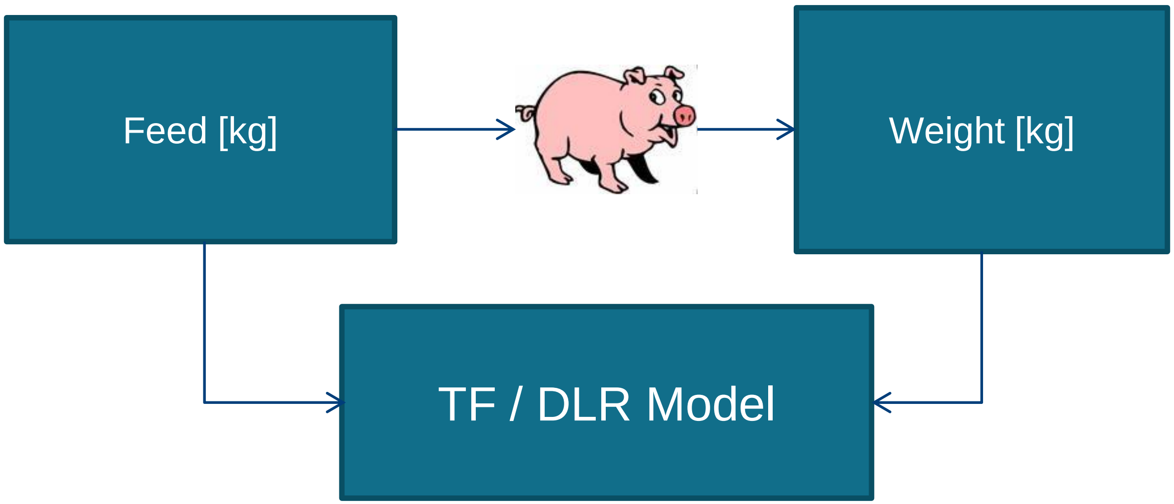


These graphs are an example of the input (left graph) and output (right graph) data which will be used in the system identification process to determine the model structure suitable for the process

KU LEUVEN

Time-invariant TF model

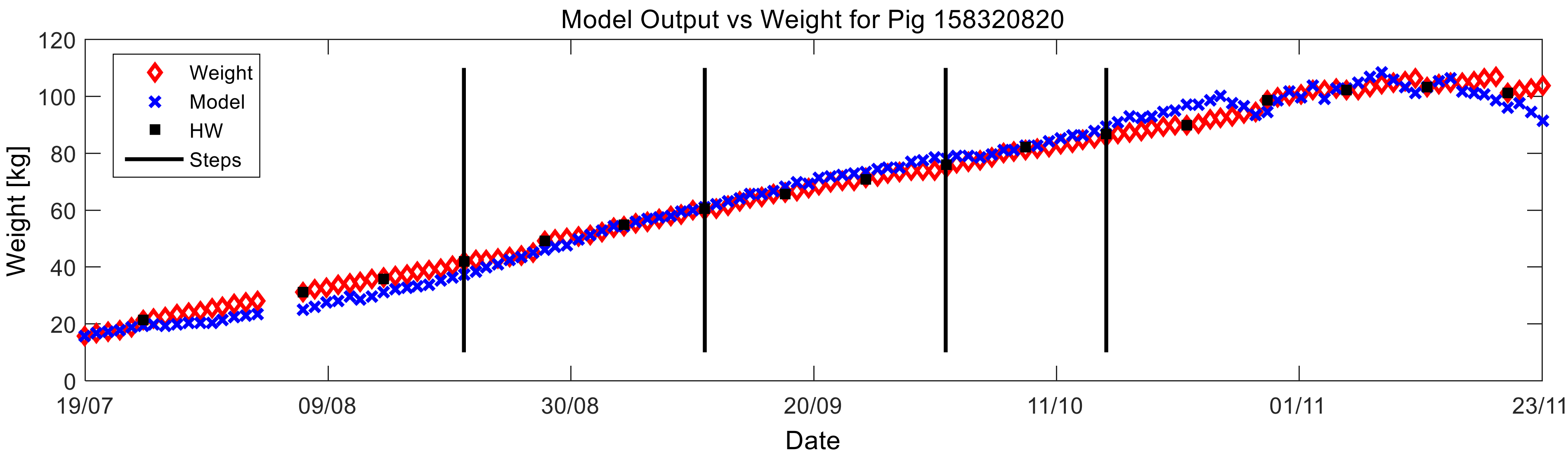
- Model the dynamics of the pig response to a change in the Feed supply

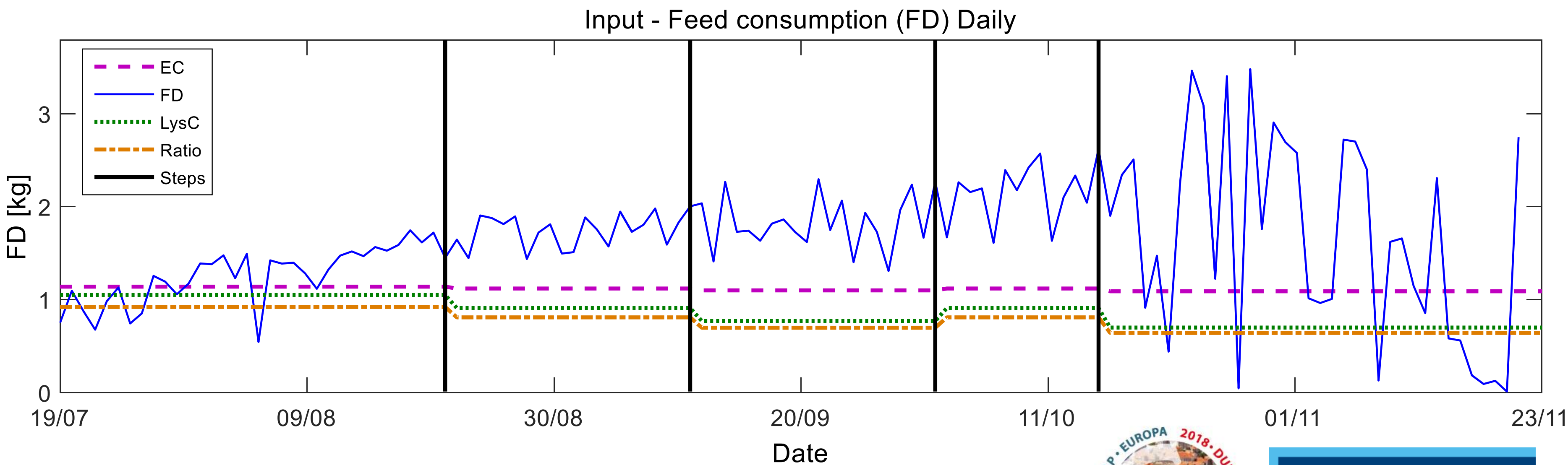


I/O Model → $y_t = \frac{b_0+b_1L+b_2L^2+\cdots+bnL^n}{1+a_1L+a_2L^2+\cdots+a_nL^n} u_{t-k}$ with $L^j y_t = y_{t-j}$

Model Order = [na nb nk 0]

Results Time-invariant TF





Results Time-invariant TF

- Discrete-time transfer function (TF) models

- Single-Input Single-Output (SISO)

$$y_t = \frac{B(L)}{A(L)} u_{t-k} = \frac{b_0 + b_1 L + b_2 L^2 + \cdots + bn L^n}{1 + a_1 L + a_2 L^2 + \cdots + a_n L^n} u_{t-k} \quad \text{with} \quad L^j y_t = y_{t-j}$$

Model: [1 1 0 0]

$$\boldsymbol{W_t = \frac{b_0}{1 + a_1 L} FD_t}$$

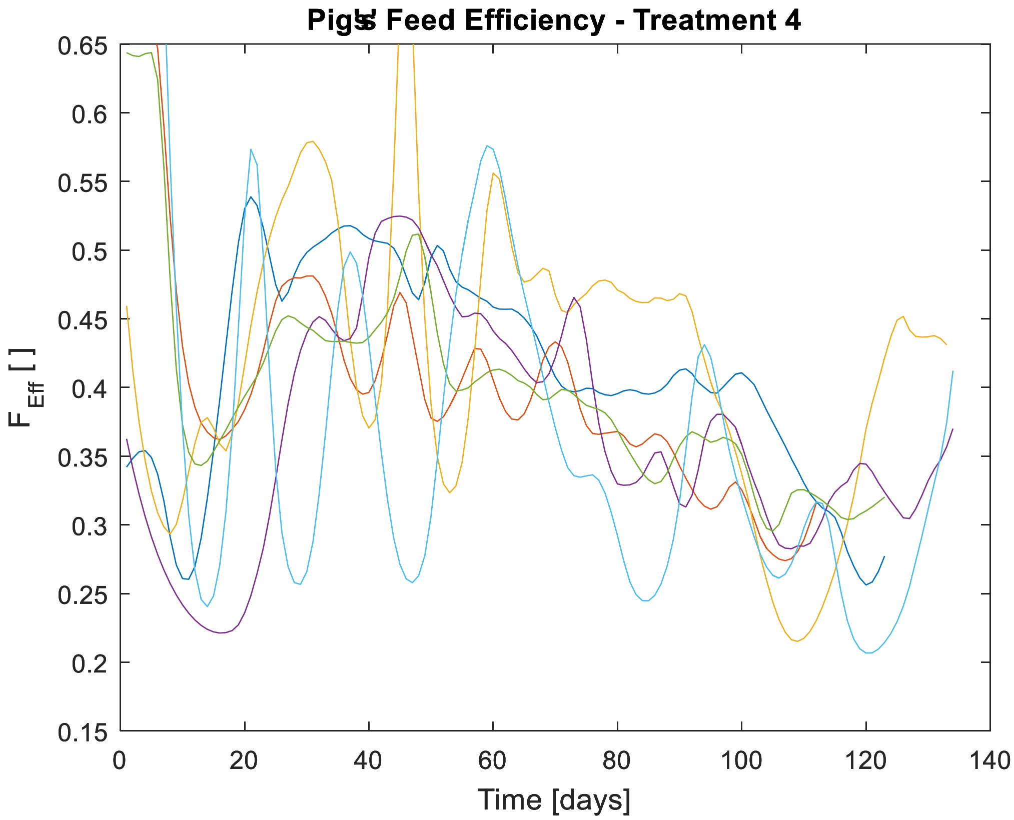
Group level: **Average value of a and b parameters from all pigs**

$$W_t = (0.990 \pm 0.006) W_{t-1} + (0.6 \pm 0.3) FD_t \qquad R_T^2 = (60 \pm 30)\%$$

Individual level: ***a* and *b* parameters are estimated individually for each pig** $\boldsymbol{R_T^2 = 94,3\%}$

Biological insight

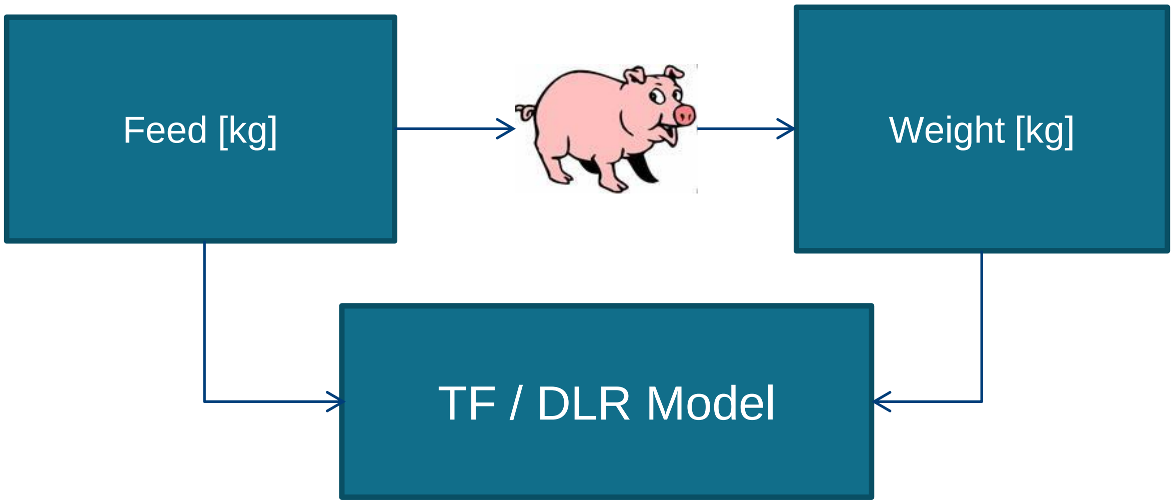
Time-invariant parameters: b_0 should be the average value of pig's feed efficiency



Solution: Time-variant parameters

Time-variant TF model

- Model the dynamics of the pig response to a change in the Feed supply

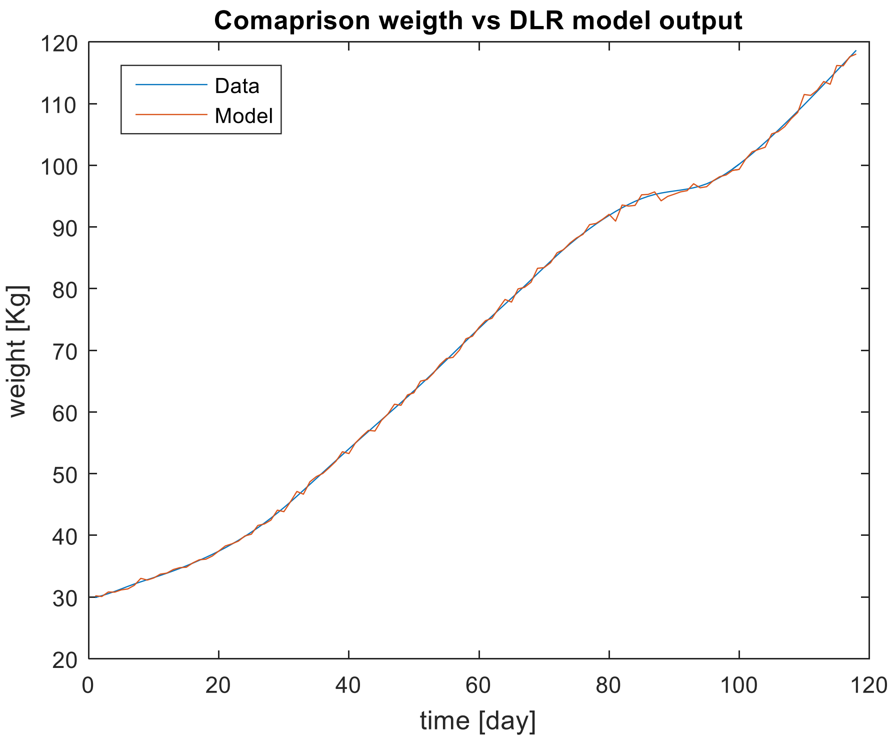


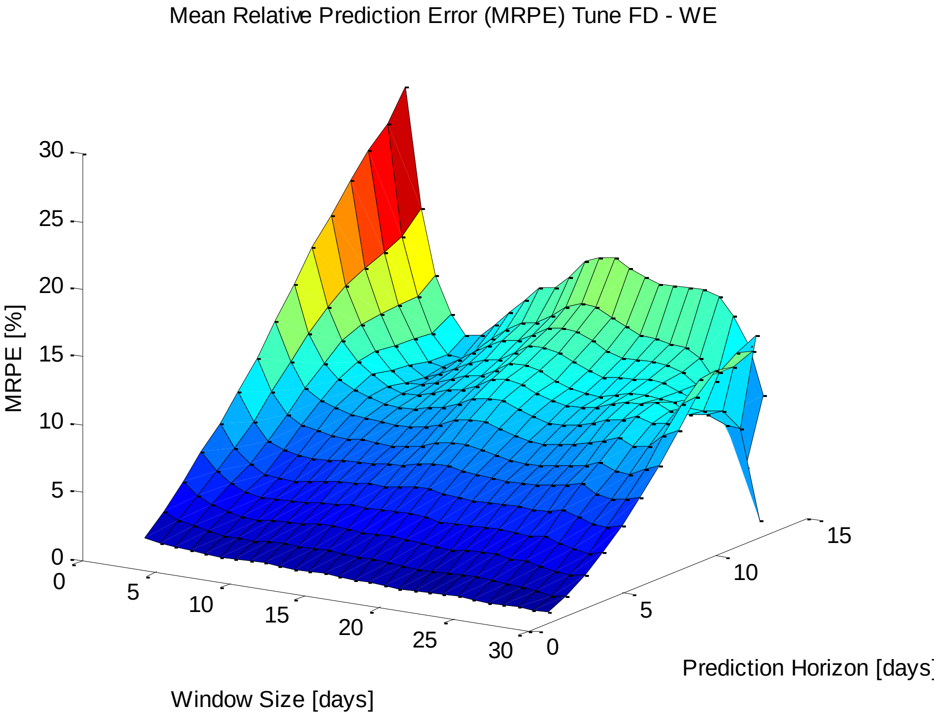
Dynamic Linear Regression (DLR):

$$W_t = c_{1,t} + c_{2,t} \cdot FD_t$$

KU LEUVEN

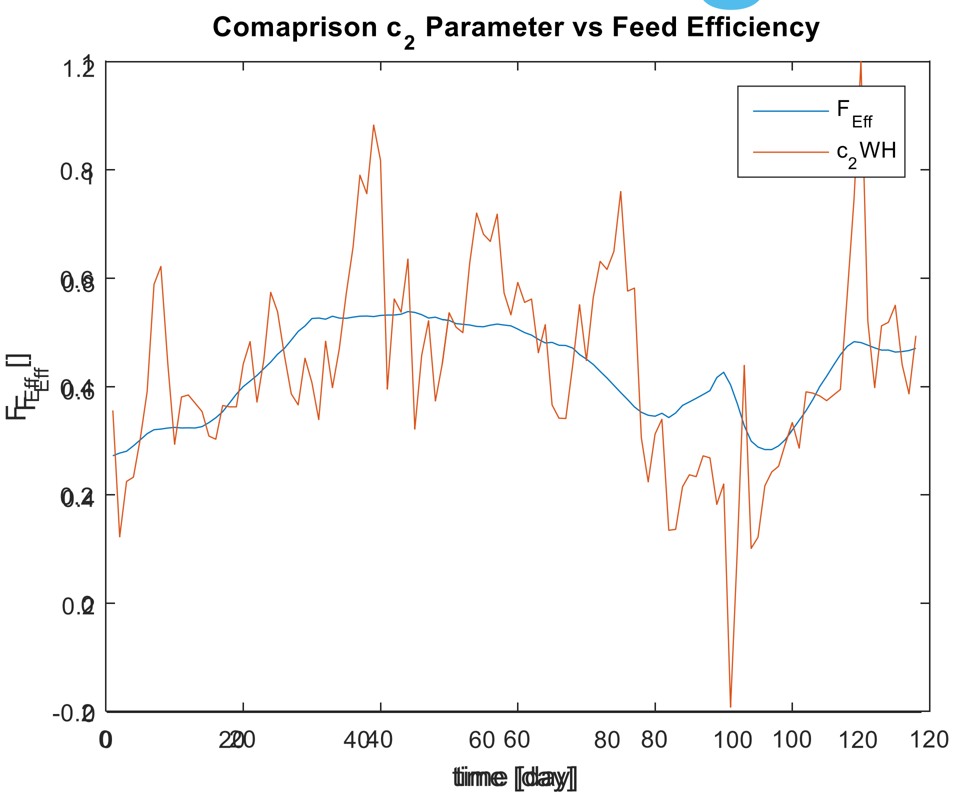
FORECASTING DLR



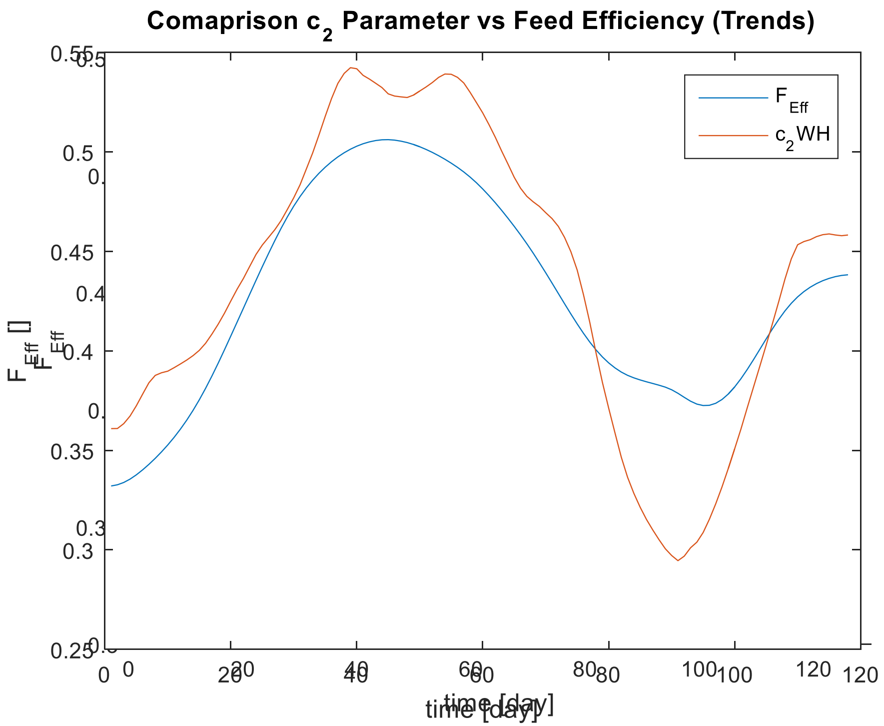


Time Window	Prediction Horizon	MRPE [%]
4 Days	1 day	1.0 ± 0.4
7 days	7 days	3.3 ± 1.3

Biological insight

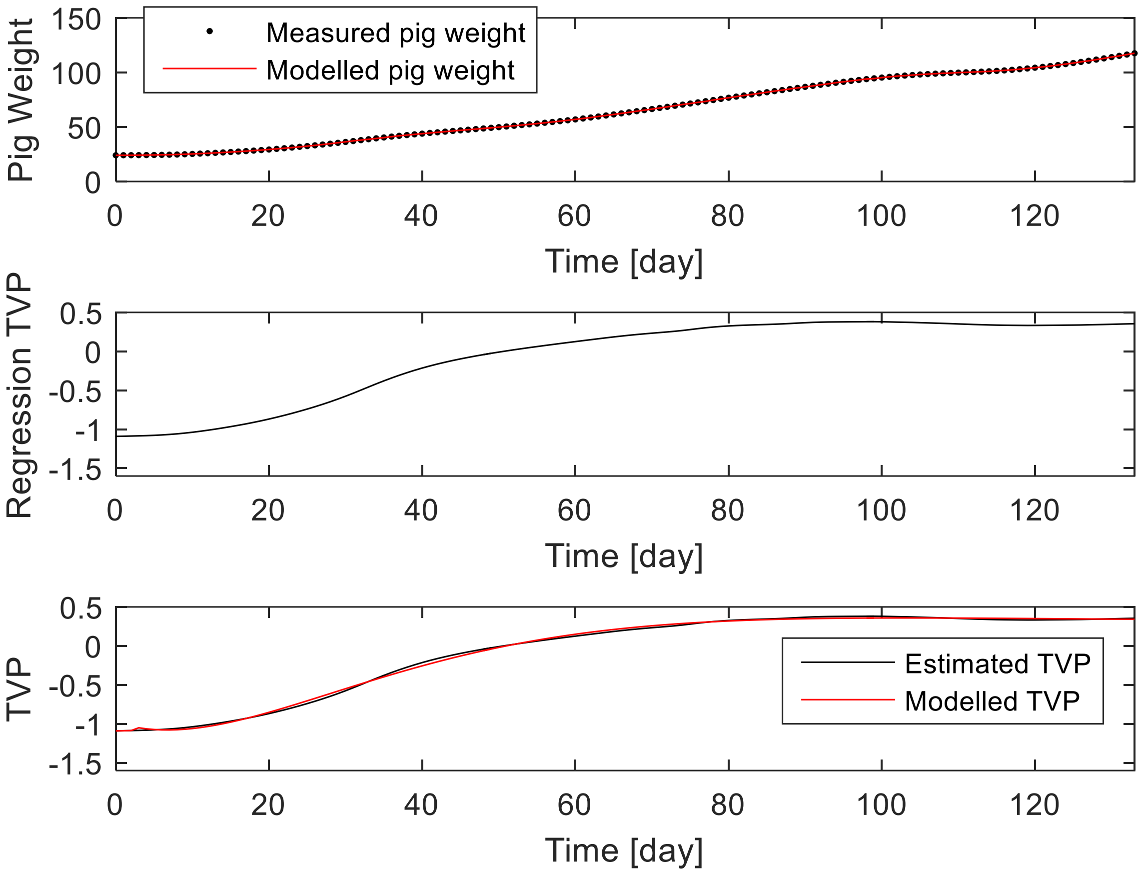


Relation between feed efficiency and $c_{2,t}$ DLR parameter



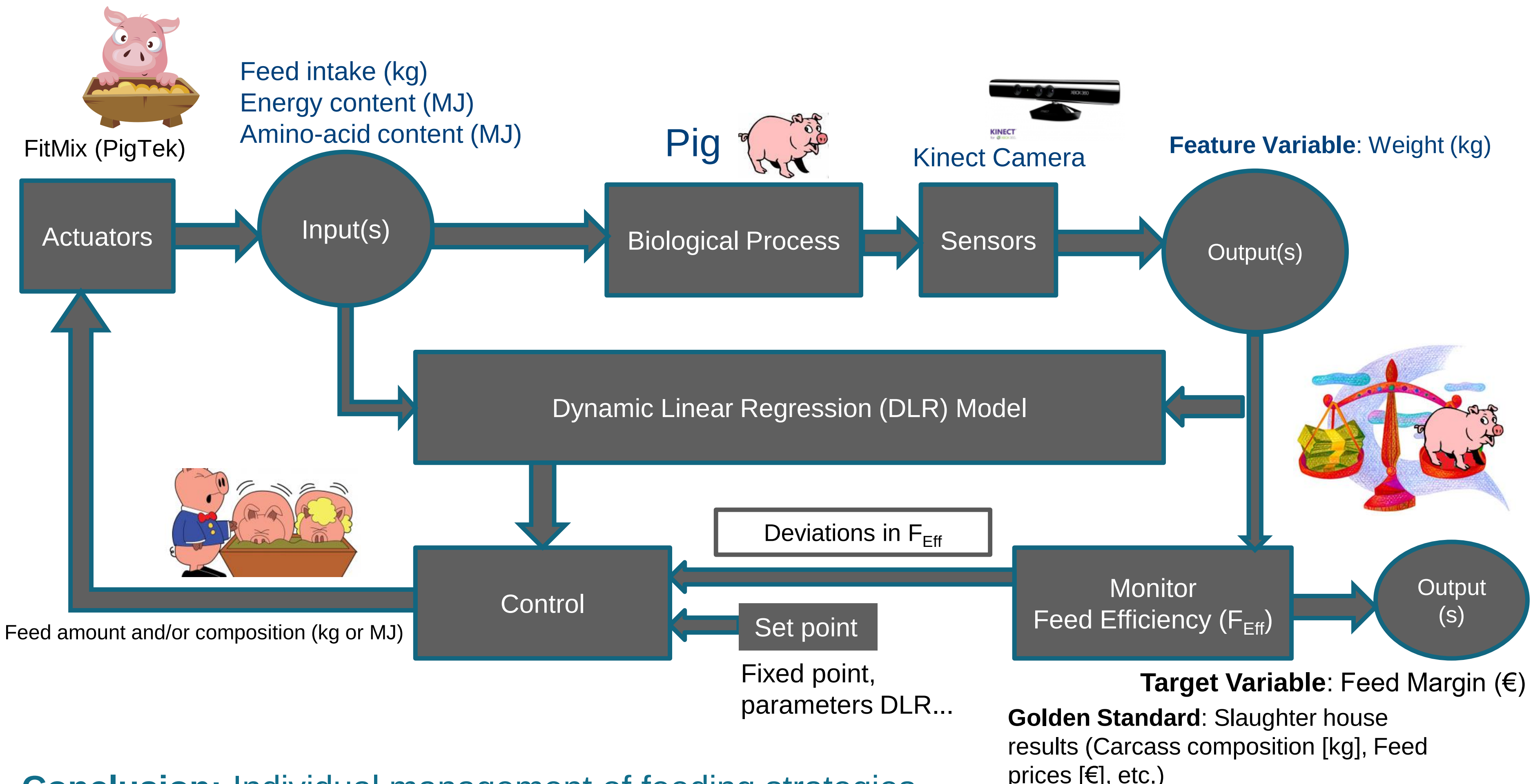
Coefficient of correlation → $r = (0.9 \pm 0.2)$

Biological insight



Nutrient or fat deposition??

Flowchart control system



Conclusion: Individual management of feeding strategies may enhance pig's performance and overall productivity

KU LEUVEN

EAAP 2018
69th Annual Meeting of the European Federation of Animal Science
Dubrovnik, Croatia, 27th to 31st August 2018

Thanks for your attention!!

Questions?

M3-BIORES
KU Leuven

Fancom®

agrifirm

KU LEUVEN