



# **An empirical economic model to reveal behaviour characteristics driving the evolution of agriculture in Belgium**

**ISEE 2016 Session Room III “Sustaining Sources and Sinks”  
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# Vision of future agriculture (1961)

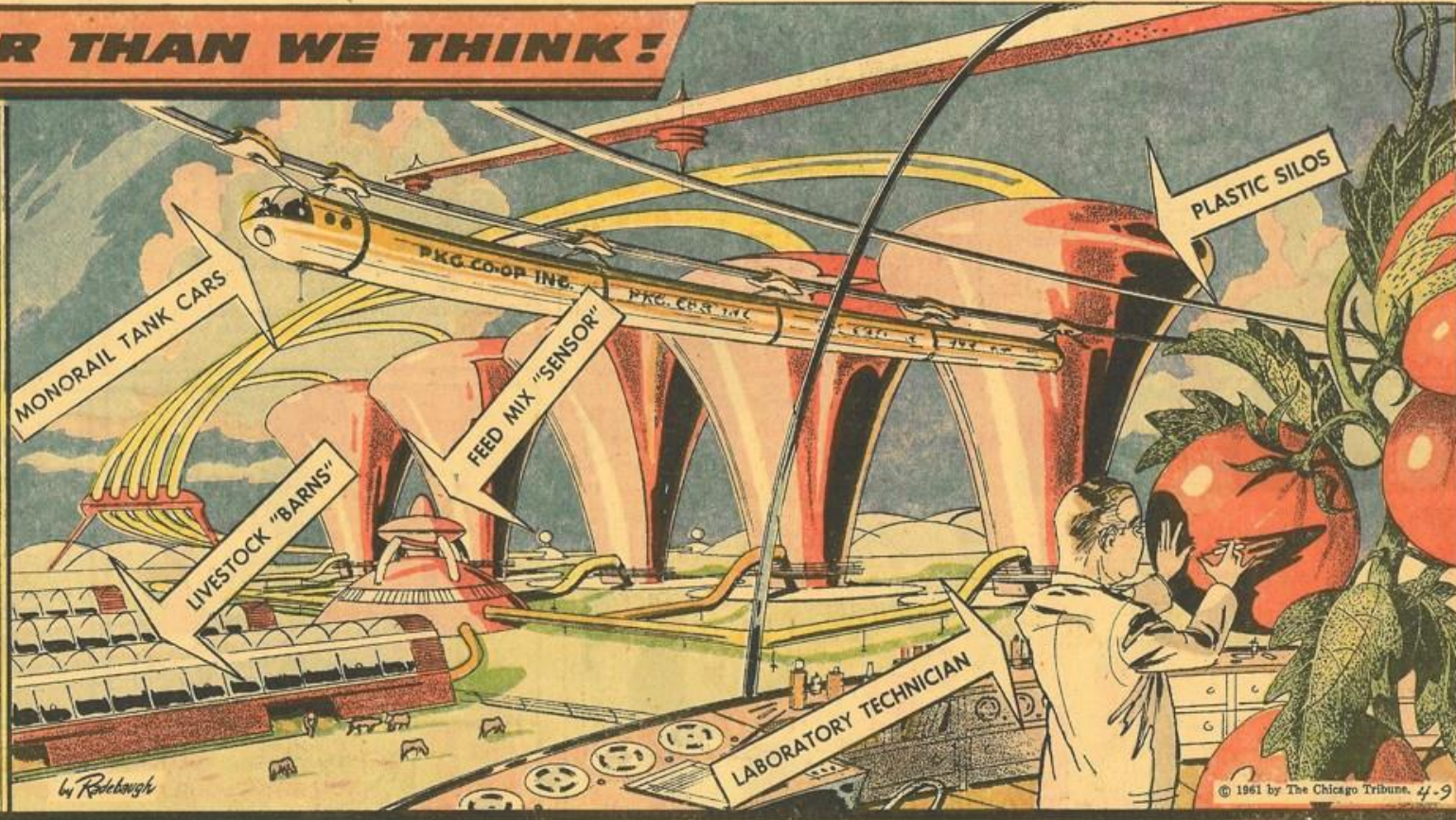
**... CLOSER THAN WE THINK!**

## "FACTORY" FARMS

Agriculture in the world of tomorrow will be so mechanized that farms will actually resemble factories. Crops and livestock will be raised on regular schedules under uniform and carefully controlled conditions.

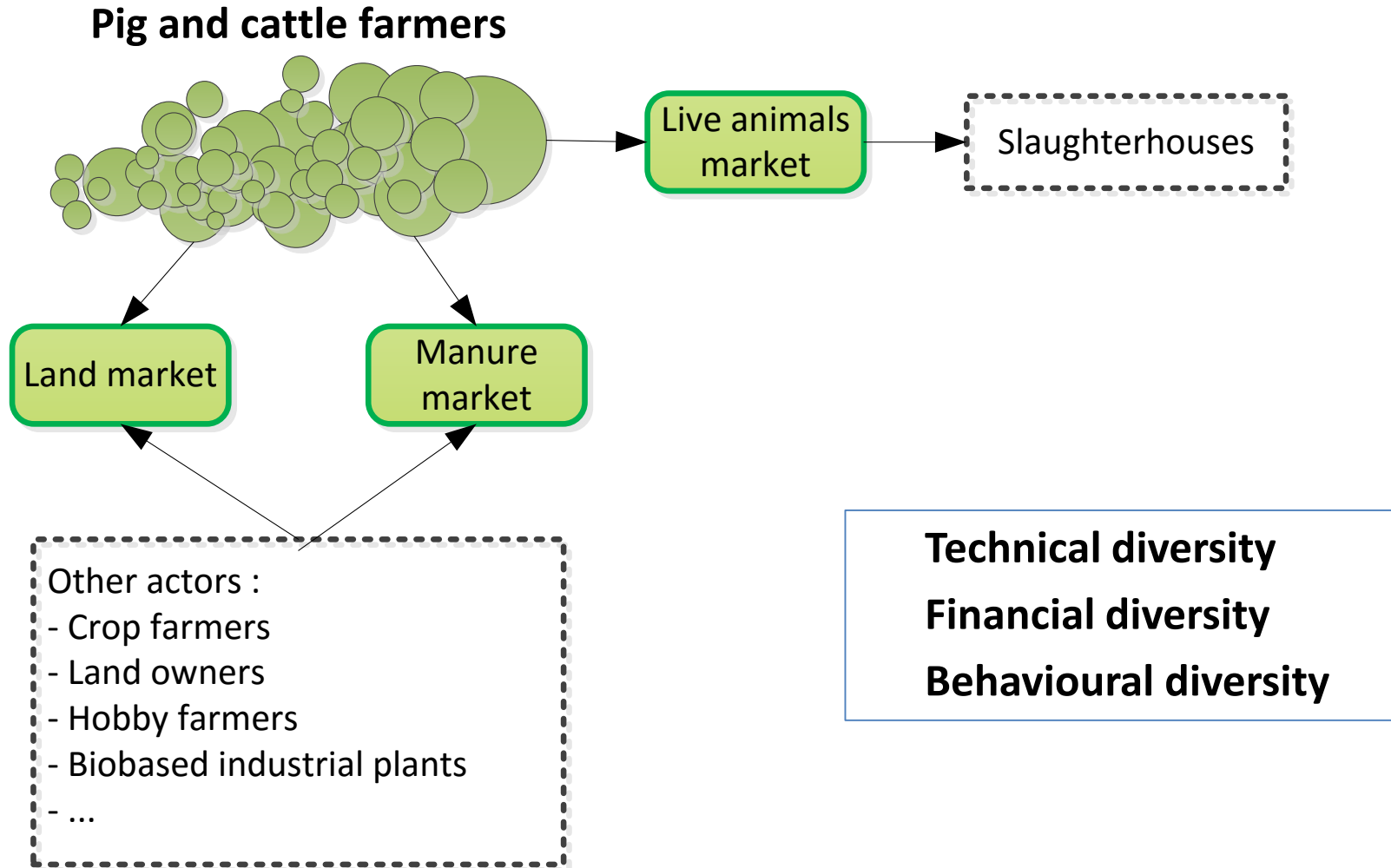
"Sensors," those automatic control devices for today's wonder machines, will be adapted to the requirements of precision agriculture. They will take the place of human judgment in deciding and reacting to soil conditions, crop maturity, moisture levels, weather forecasting, feeding needs, etc. Bendix researcher W. E. Kock has reported that instruments to do this already exist or will soon be developed.

The final part of the job for tomorrow's farms will involve the packaging of the grown foodstuffs and their shipment to market—accomplished just as automatically as the growing itself.

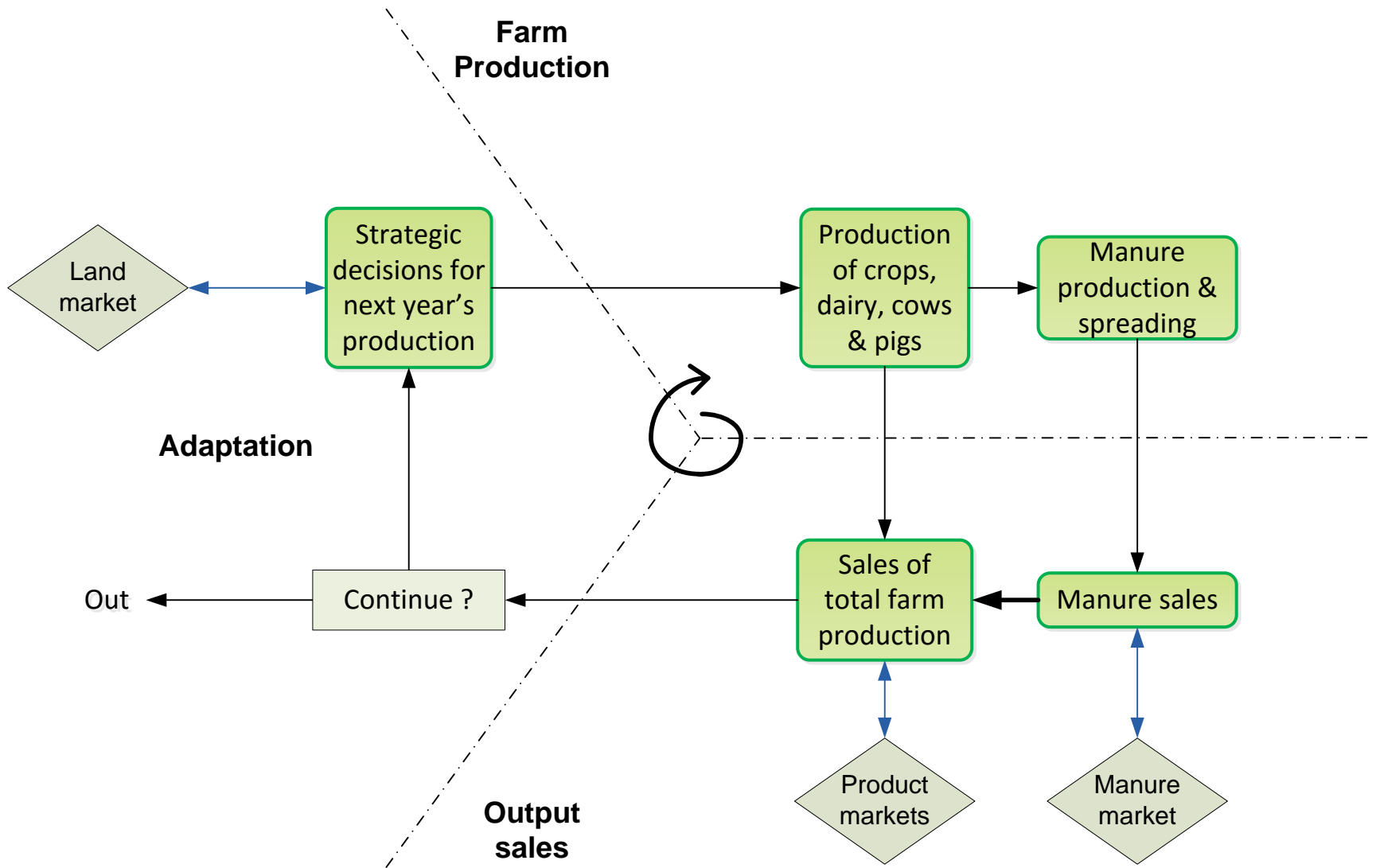


# Agent-based model

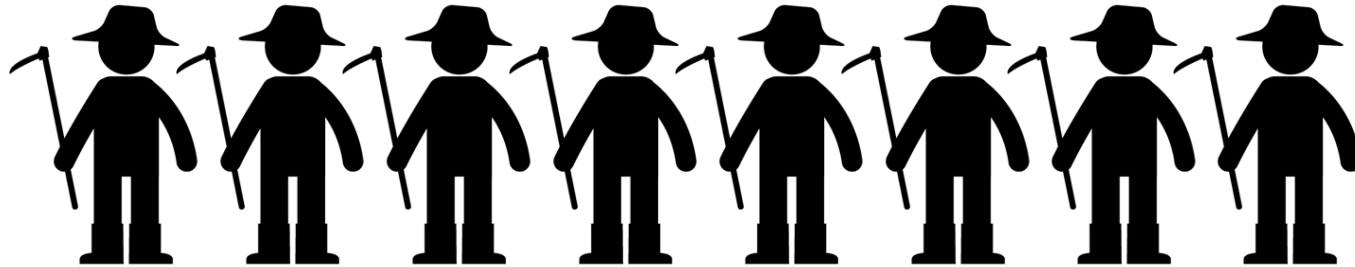
Determine the effect of new manure treatment technologies on the Flemish agriculture.



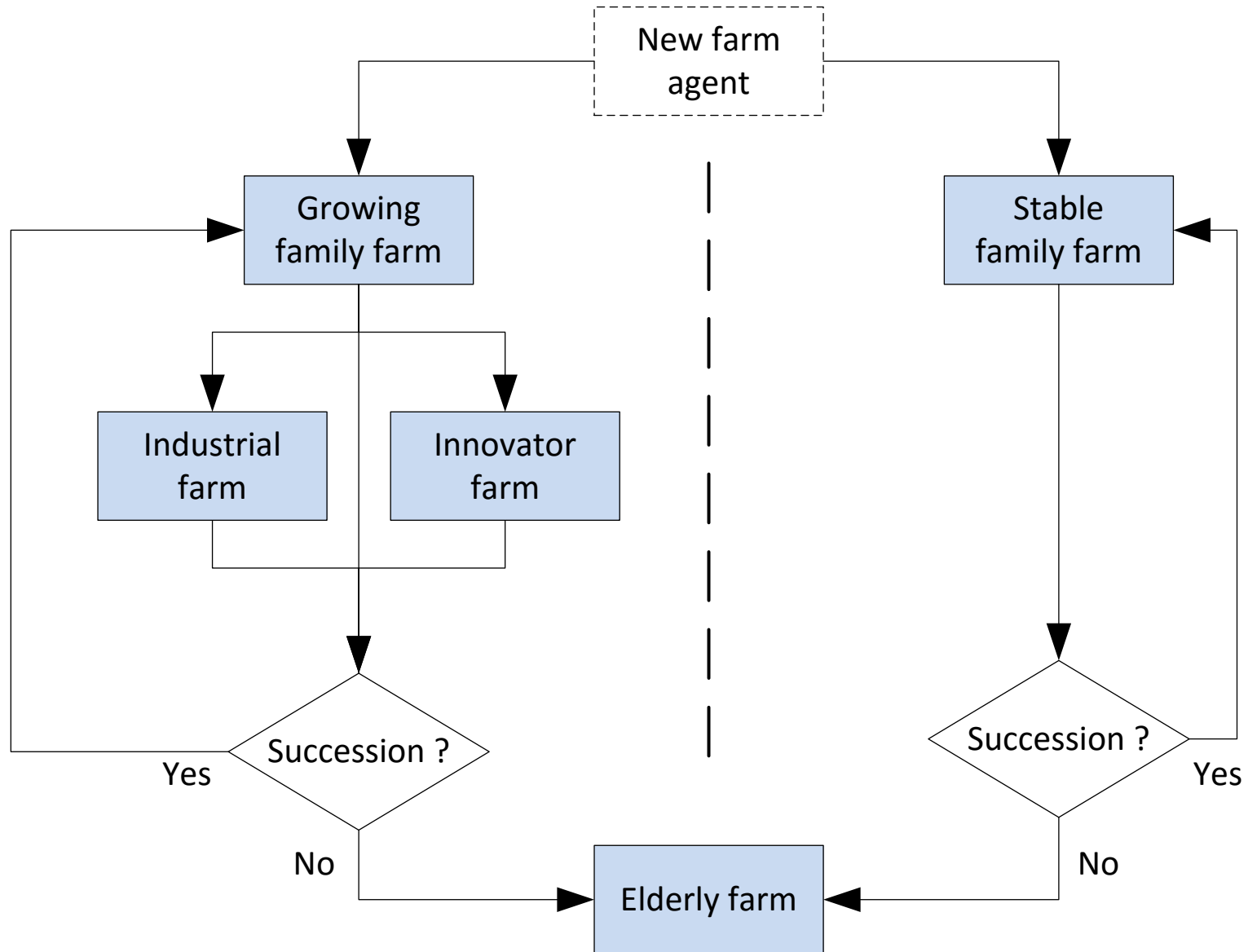
# Annual cycles for the Farm Agents



# Defining behaviour types



# Defining Behaviour types (Smajgl and Barreteau 2014)



# Calibration : Starting point (35 criteria)

<b>Calibration subjected to all criteria</b>										
# farms selected	27			<b>Weights</b>	Avg	SDv	Min	Max		
Total number of agents	32455				1 202	1 440	101	6 402		
<b>Calibration with macroeconomic criteria</b>										
Year	Cow meat production			Pig meat production			Raw milk production			
	2000	2001	2002	2000	2001	2002	2000	2001	2002	
Real production [M€]	379	369	361	1 353	1 264	1 498	595	559	433	
Approximation	100%	103%	102%	105%	104%	93%	99%	101%	103%	
<b>According to the Farmer's age</b>					<b>According to land surface</b>					
	Real	At initialisation				Real	At initialisation			
18-34	4597	85%			Less than 10 ha	73540	104%			
35-44	9991	92%			Between 10 & 30	236490	124%			
45-54	9129	84%			Between 30 & 50	187990	110%			
55-64	9063	71%			Over 50 ha	139040	126%			
> 65	8169	63%								
<b>Number of animals according to farm size in ha</b>					<b>Number of animals according to animal stock</b>					
Total LSU	< 20	20-49.9	50-99.9	> 100	Total LSU	< 10	10-19.9	20-49.9	50-99.9	> 100
Cows	29 610	56 000	245 330	664 370	Cows	14 393	27 221	119 254	322 947	804 049
	103%	105%	76%	81%		100%	102%	107%	96%	86%
	< 20	20-49.9	50-99.9	> 100		< 15	15-30	30-150	> 150	
Pigs	11 865	46 329	1 202 223	616 266	Pigs	11 118	43 412	1 126 540	577 471	
	105%	92%	97%	100%		100%	99%	95%	107%	

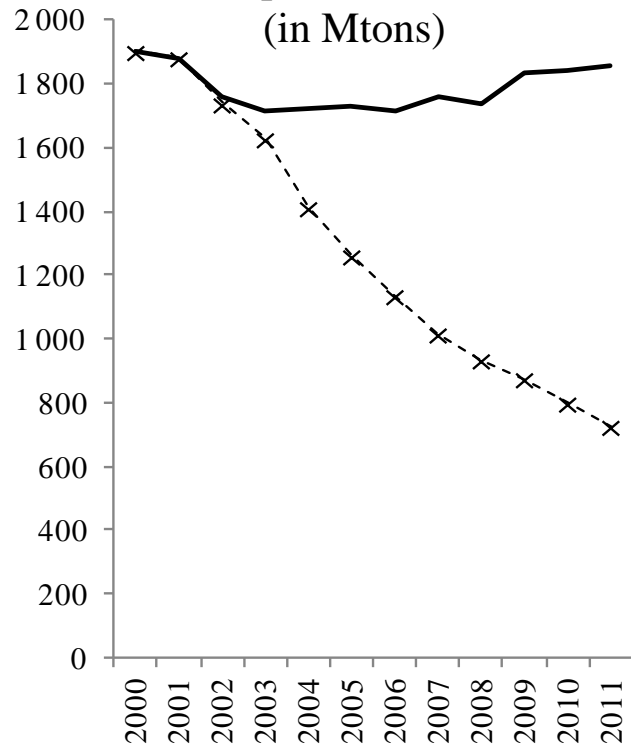
# Population calibration variables

- **The adaptation capacity** is the proportion of farm agents that execute the strategic decision process per year.
- **The Land availability** is the proportion of farm agents that has land available for purchase or for rent in his neighbourhood per year.
- **The transaction costs** are defined as an additional cost when change is undertaken, of  $x$  times the price of the livestock quantity change.
- **The proportion of Stable Family Farms** compared to the total population is a variable for the calibration with heterogeneous behaviour.
- The average difference with the real macroeconomic productions is used as a measure of approximation quality for the scenario.

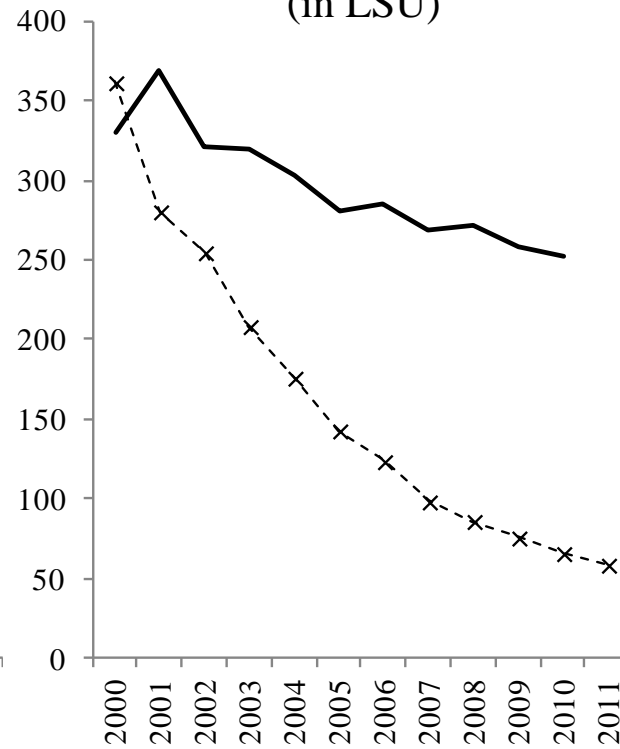


# Evolution without diversified behaviour (0% Stable farms)

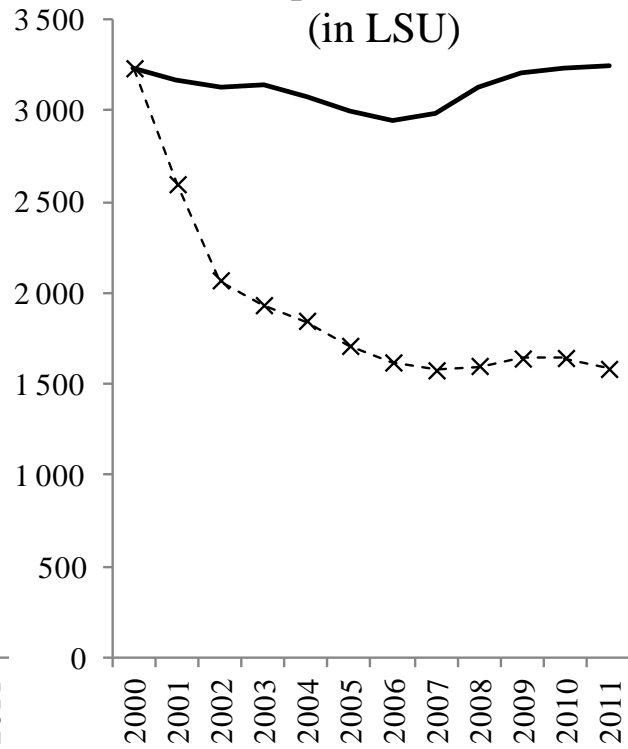
### Total Belgian Dairy production (in Mtons)



### Total Belgian Cattle (in LSU)



### Total Belgian Pig production (in LSU)



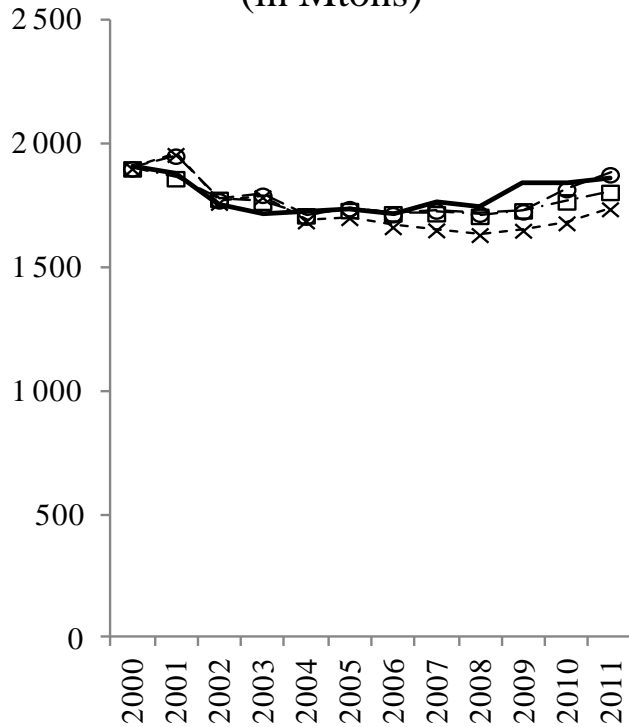
**Legend :**

— Historical data

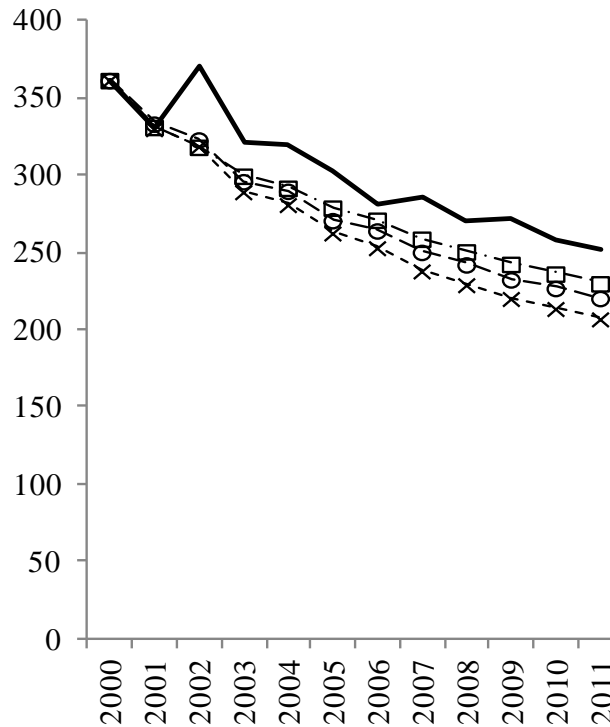
--x-- Common heuristics

# Evolution with diversified behaviour

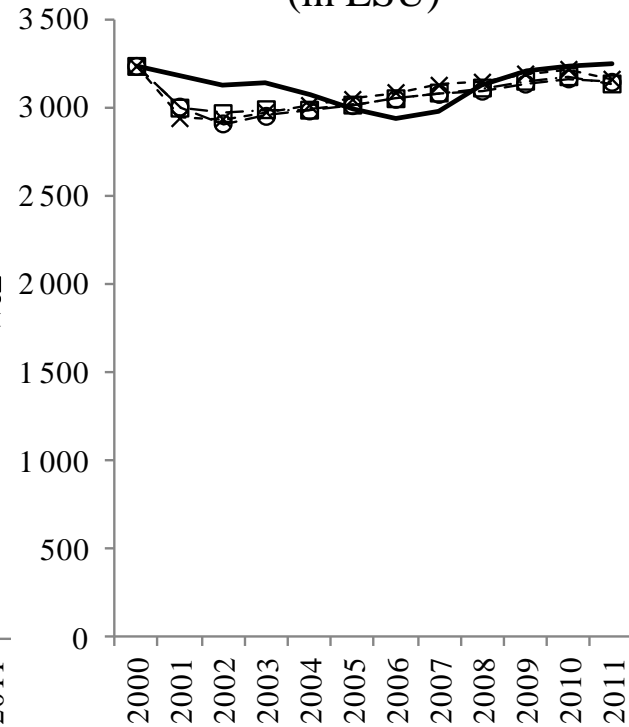
Total Belgian Dairy production (in Mtons)



Total Belgian Cattle (in LSU)



Total Belgian Pig production (in LSU)



**Legend :** — Historical data    --x-- 50% Stable    -○- 55% Stable    -□- 60% Stable

# Interpretation of the calibration parameters

Proportion of stable family farms	0%	15%	30%	45%	50%	55%	60%	75%	90%
Adaptation capacity	3%	5%	10%	55%	55%	60%	<b>60%</b>	60%	40%
Land availability	2%	2%	10%	20%	30%	35%	<b>30%</b>	30%	10%
Transaction costs									
Dairy	20	20	-	-	-	-	<b>20</b>	-	-
Other cattle	20	20	-	-	-	40	<b>40</b>	30	30
Pigs	40	40	80	5	40	40	<b>40</b>	15	15
Average difference	23.7%	18.8%	11.6%	9.3%	6.5%	4.7%	<b>3.9%</b>	11.3%	20.3%

# Conclusions

- Capturing behaviour correctly is critical
- Historical production levels can only be replicated with high rigidities
  - Rigidity in markets
  - Rigidity of Farmers' behaviour
- Importance of heterogeneity