Agent-based simulation of competing business models for a sustainable meat supply chain

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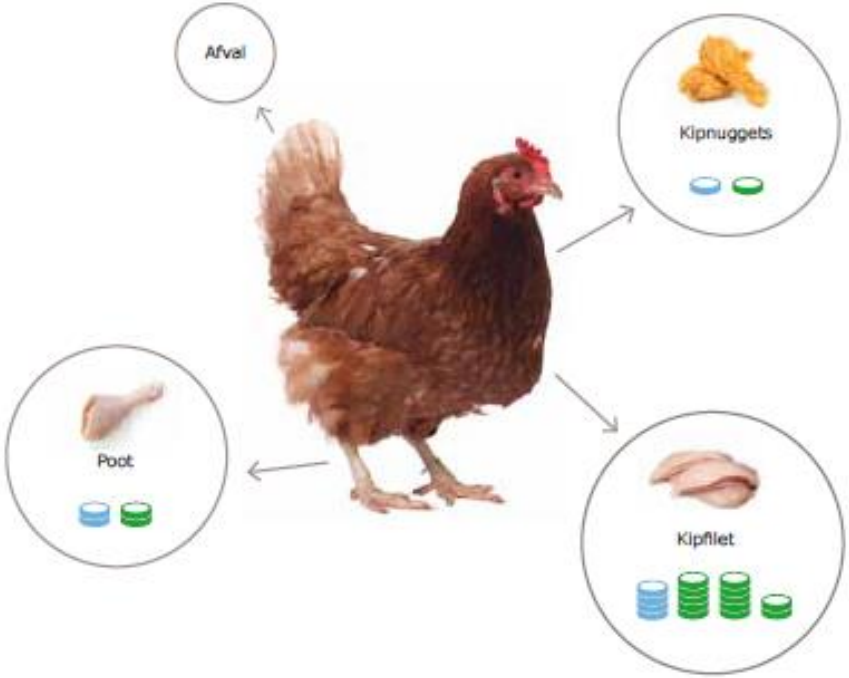
Introduction

Dutch pork supply chain

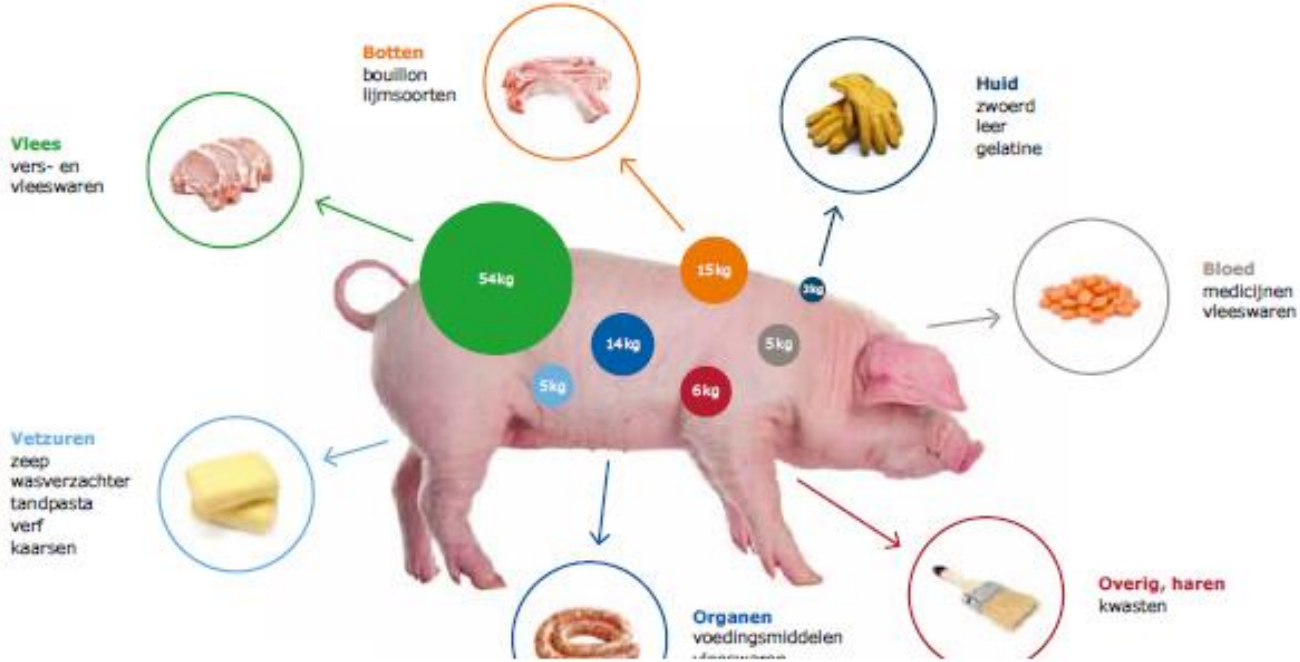
- Consumer demand for organic meat remains low
- Profits in primary sector are dwindling
  - Short term markets
  - Sustainability investments only pay off later
  - Fierce price competition (no brands)

- Therefore few investments in organic production

Vierkantsverwaarding van de gangbare en biologische kip



Vierkantsverwaarding van het varken



Research questions

Which business models could increase sustainable production of meat?

- Intrinsically dynamic dependencies between farmers / market / consumers
- Role of consumers and ngos

Compare plausible scenarios

- speed of sustainability uptake
- producer welfare (defaults / capital)

Method

- Agent based model
  - Based on stakeholder interviews/workshops in The Netherlands
  - Based on successful transitions in horticulture/ veal industry / coffee / soy markets

- Two pathways (Reinders et al., 2014):
  - increasing **brand differentiation** and transparency for consumers
  - **cost reduction** through chain internalization of external costs

Background literature

- Interaction between consumer demand, social norms and market dynamics
  - Supply chain ABM (see Mizgier ea 2012)
  - Pork cycle and bullwhip effects (Moyaux ea 2006; Lacagnina ea 2010)
  - Opinion dynamics (Deffuant ea 2010)

The model - actors

- Willingness-To-Pay (premium) is determined by sustainability preference, norm sensitivity, opinion dynamics and budget

- Optimize turnover given demand for sustainability; may form long term contracts

- Deliver either certified or noncertified batches; invest in certification depending on demand, capital and risk aversion

- NGO broadcasts sustainability information with a certain strength and tenor

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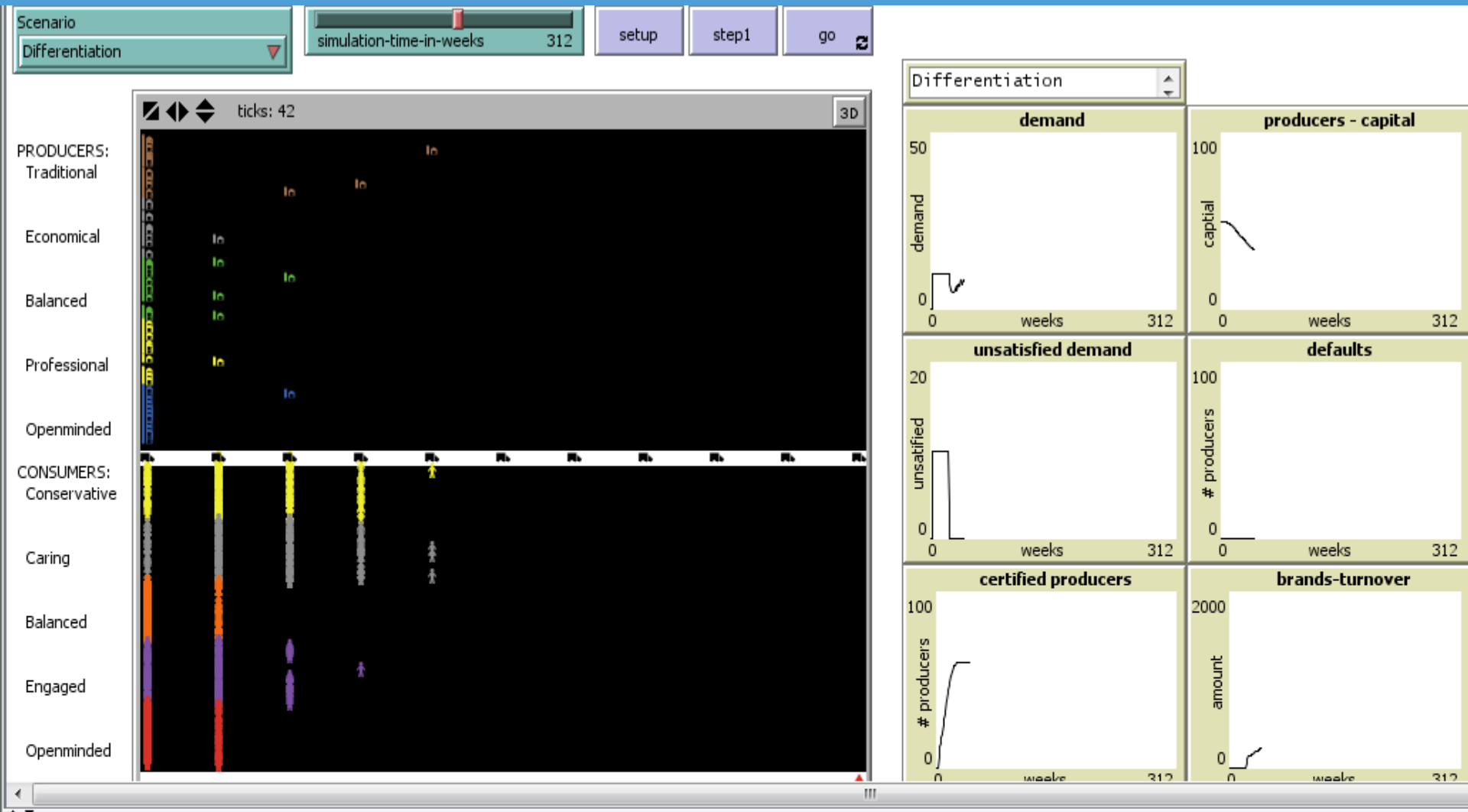
The model - actors

- Agents move along a sustainability spectrum

Interface in netlogo



The model - typology

Consumers

- Conservative
- Caring
- Balanced
- Engaged
- Openminded

(Hessing-Couvret ea 2002)

Producers

- Traditional
- Economical
- Balanced
- Professional
- Openminded

(De Lauwere 2002)

Differ in

openness
budget/capital
norm sensitivity

risk aversion

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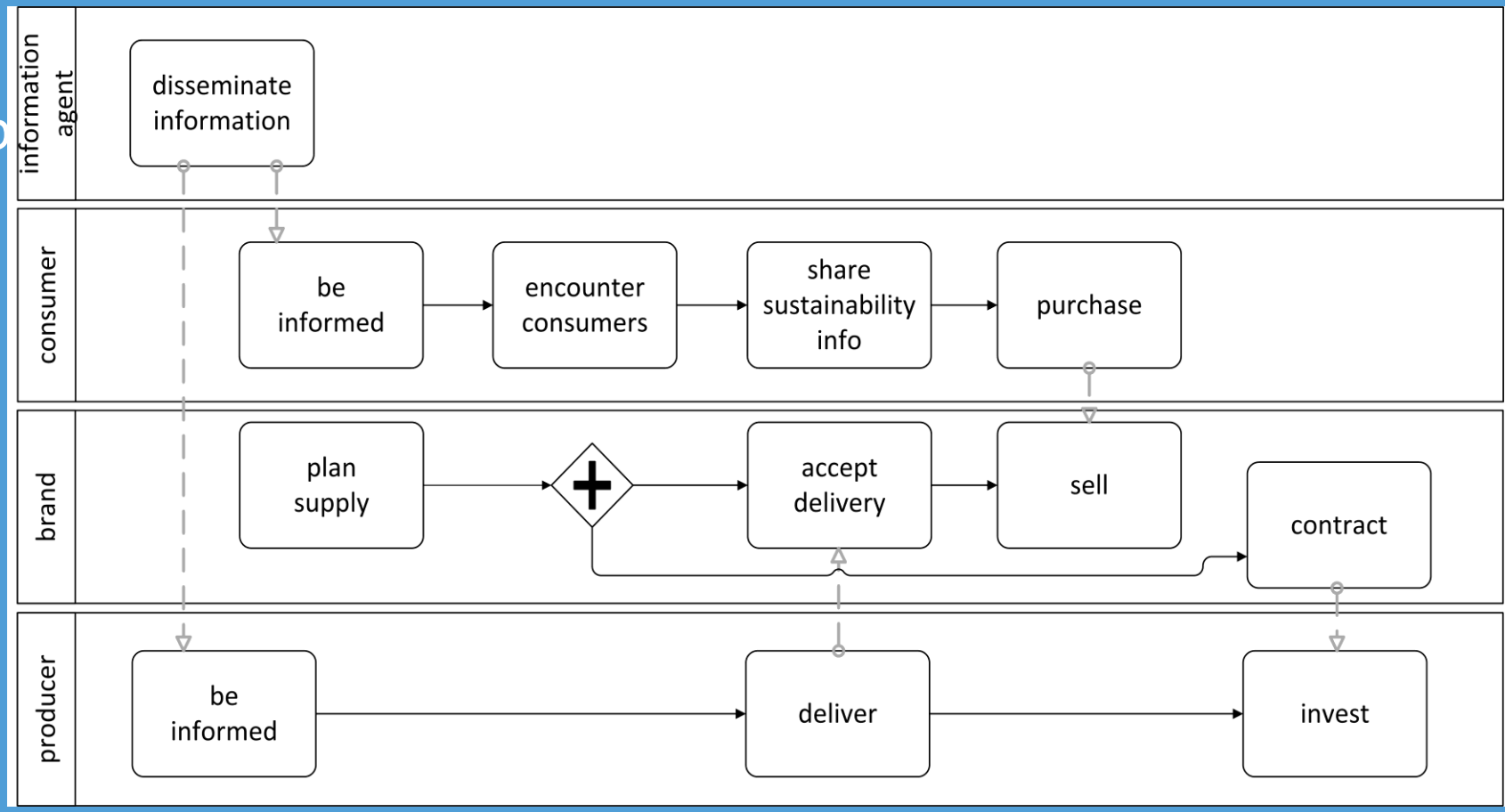
The model – time step



Business models

Baseline

No coordination; only regular and organic meat products

Differen-tiation

10 brands, differ in sustainability level

Example: the Netherlands)

Green Track

1 brand with 10-99% of organic meat given WTP of consumers

Example: soy market

Market platform

Builds on Differentiation , with supply forecasts to producers

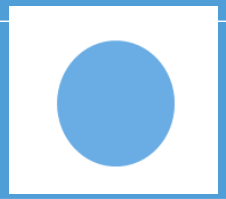
Example: horticulture

Producers' organisation

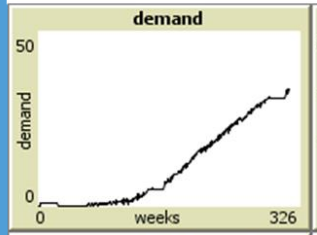
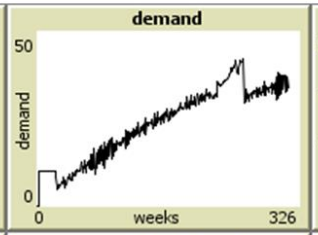
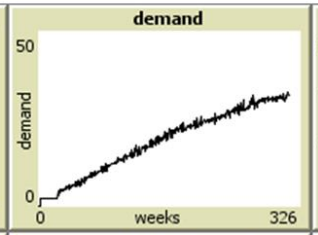
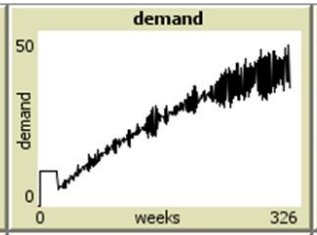
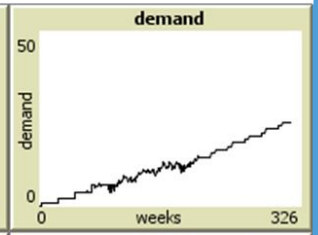
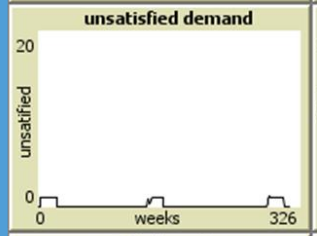
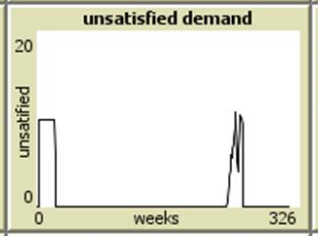
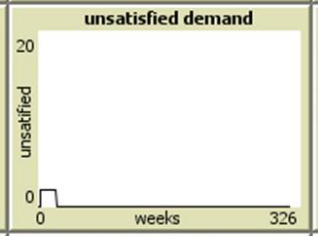
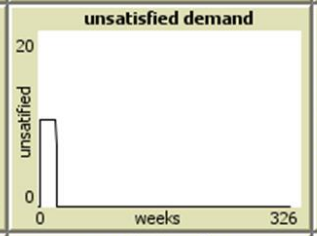
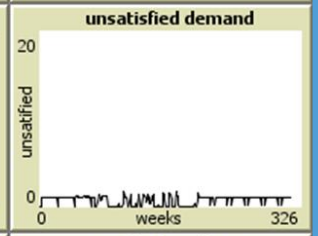
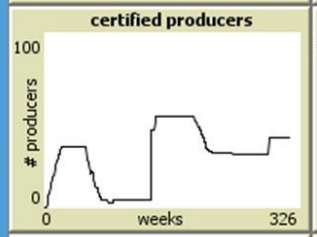
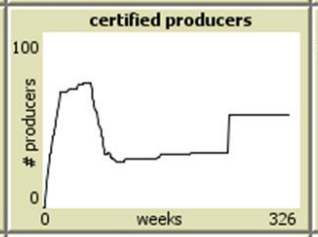
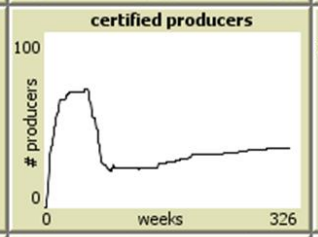
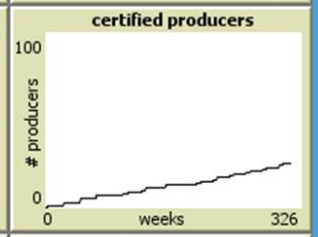
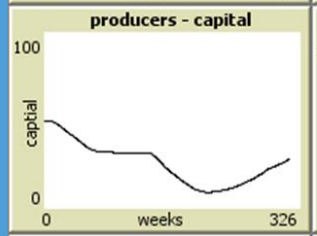
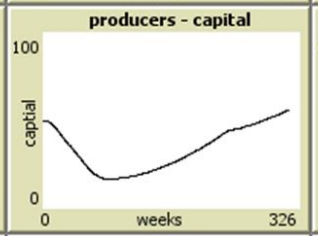
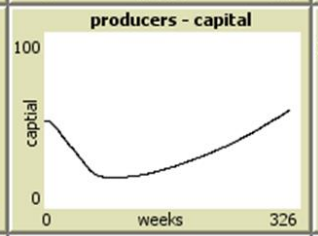
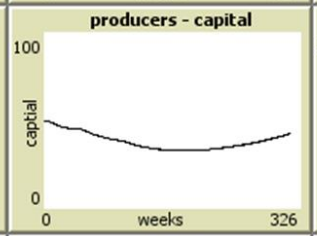
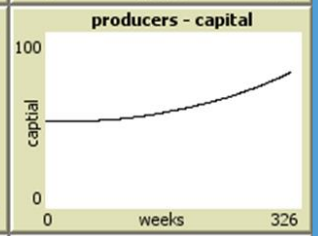
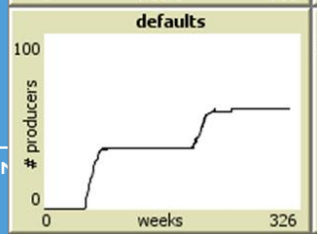
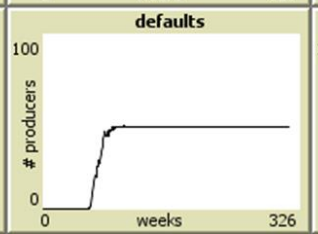
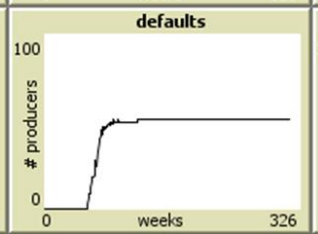
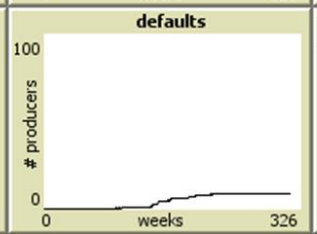
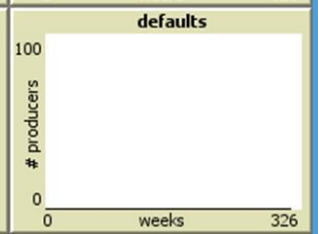
Long term contracts between brand and producer with fixed premium.

Example: German poultry

Results





	Baseline	Differentiation	Green Track	Market Platform	Producers' Organisation
Demand					
Unsatisfied demand					
Certified producers					
Producers' capital					
Producers' defaults					

Simulation results

1. The Producers' Organization scenario:
   - results in great wealth for the few members;
   - reduces competition opportunities for the others;
   - inferior sustainability compared to other scenarios
2. Only the Market Platform can prevent financial trouble
3. Product Differentiation results in
   - rapid and substantial sustainability uptake
   - financial trouble for many producers when not combined with the Market Platform
4. When applied in moderation, Green Track can further enhance both sustainability and producers' welfare

Conclusion

- With this model we show the potential of agent-based simulations for policy support

  - Explore scenarios for intervention in complex social or economic systems with heterogeneous actors
  - Experiment with different assumptions about the properties of the system and the agents
  - Discover unintended and unexpected effects

Discussion

- Simplified supply chain structure is used
  - in reality, supply chain partners (meat industry, slaughterhouses, retail) interact
- Future work: extensive sensitivity analysis
- Agent-based simulation requires detailed data
  - experts or stakeholders must make assumptions


Week 12: Do you want to invest in certification?
Yes
No
Attack
Defense
Magic
Life
Coins

Extensions

- Implement a serious game

- Participants could study effect of
  - Specific policy interventions
  - Individual decisions and strategies
  - The interplay between the above

- Questions?

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Results - Comparing scenarios

Scenario	Sustain-ability	Consumer uptake	Producer defaults	Average revenue
Baseline	3-4	Elite	Highest	Low
Differen-tiation	2	Broad	High	Moderate
Green Track	3-4	Elite	High	Moderate
Market platform	1	Broad	Low	High
Producers' organisation	5	Elite	none	Highest