Supporting case studies from Finland

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Post ISVEE Workshop "Using Economics for Animal Health Decision Making"

Impact assessment:
Case study of simulated FDM outbreak in Finland

Based on:

Lyytikäinen, T., Niemi, J.K., Sahlström, L., Virtanen, T., Rintakoski, S., Kyyrö, J., Sinisalo, A., Lehtonen, H.2015. The effects of structural change in agriculture on the spread of animal disease in Finland.
Evira Research Reports 3/2015.

Lyytikäinen T., Niemi J., Sahlström L., Virtanen T., Lehtonen H. 2011.
The spread of Foot-and-mouth disease (FMD) within Finland
and emergency vaccination in case of an epidemic outbreak.
Evira Research Reports 1/2011.

FMD case study

- Based on simulation studies carried out in Finland during 2008-2015
- Impacts assessed
- Methods employed
- Results
- Comparison to two other studies (DK, UK)

Introduction

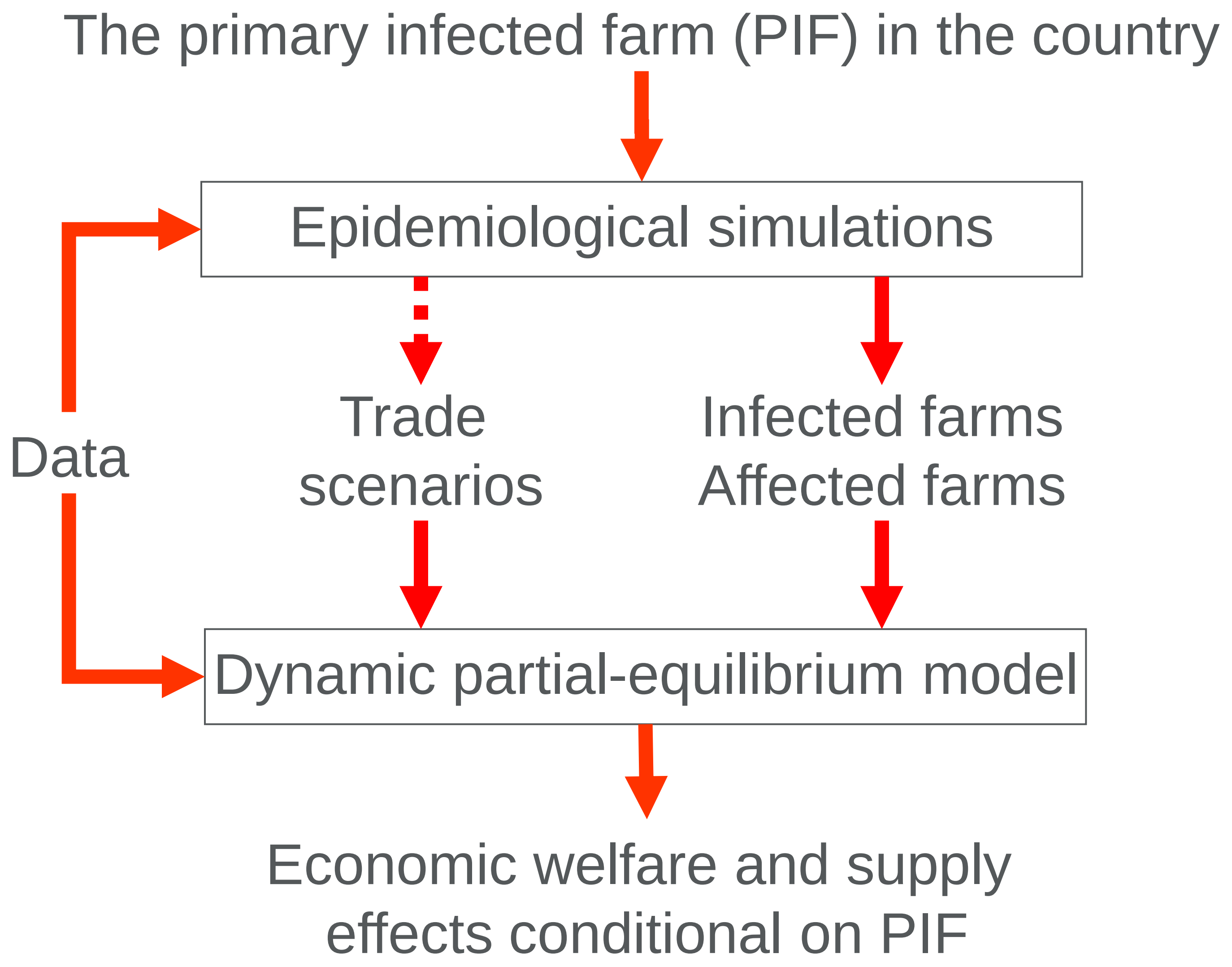
- Animal diseases can cause substantial losses
  - Productivity losses
  - Eradication and preventive measures
  - Market distortions
- Sanitary and Phytosanitary agreement of the WTO
  - It allows countries to protect themselves from the risks of entry, establishment or spread of pests and diseases
  - Over 1000 measures were taken in 2010
  - SPS trade concerns mainly affect the agricultural sector
  - About 28 % of WTO trade disputes in the ag sector cite SPS

Objective

- To assess what could be economic impacts of a foot and mouth disease outbreak in the Finnish livestock sector and consumers?

Data

- Set of epidemiological scenarios
  - Spatial farm data (n=23 439)
  - Explicit event-based data about animal movements between farms
- Economic data
  - Statistical data on prices, import, export and consumption for elasticity estimates
  - Production costs
  - Direct costs of disease eradication based on domestic prices and the 2001 UK outbreak


The primary infected farm (PIF) in the country
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Estimated direct costs

Unit of measure	€ per unit*
Infected farm, maximum fixed cost which depends on farm type	119 576
Per fattening pig in an infected farm	175
Per sow in an infected farm	572
Per dairy cow in an infected farm	1550
Per heifer in an infected farm	1211
Per suckler cow in an infected farm	1296
Per growing cattle in an infected farm	1726
Per farm in a protection zone	638+6028*duration in months
Per farm in a surveillance zone	425+468*duration in months
Per contacts farm	1130
Vaccination (excluding the cost of culling vaccinated animals)	892 per farm+8.53 per animal

* Including the value of culled animal, if applicable.

Lyytikäinen et al. 2011

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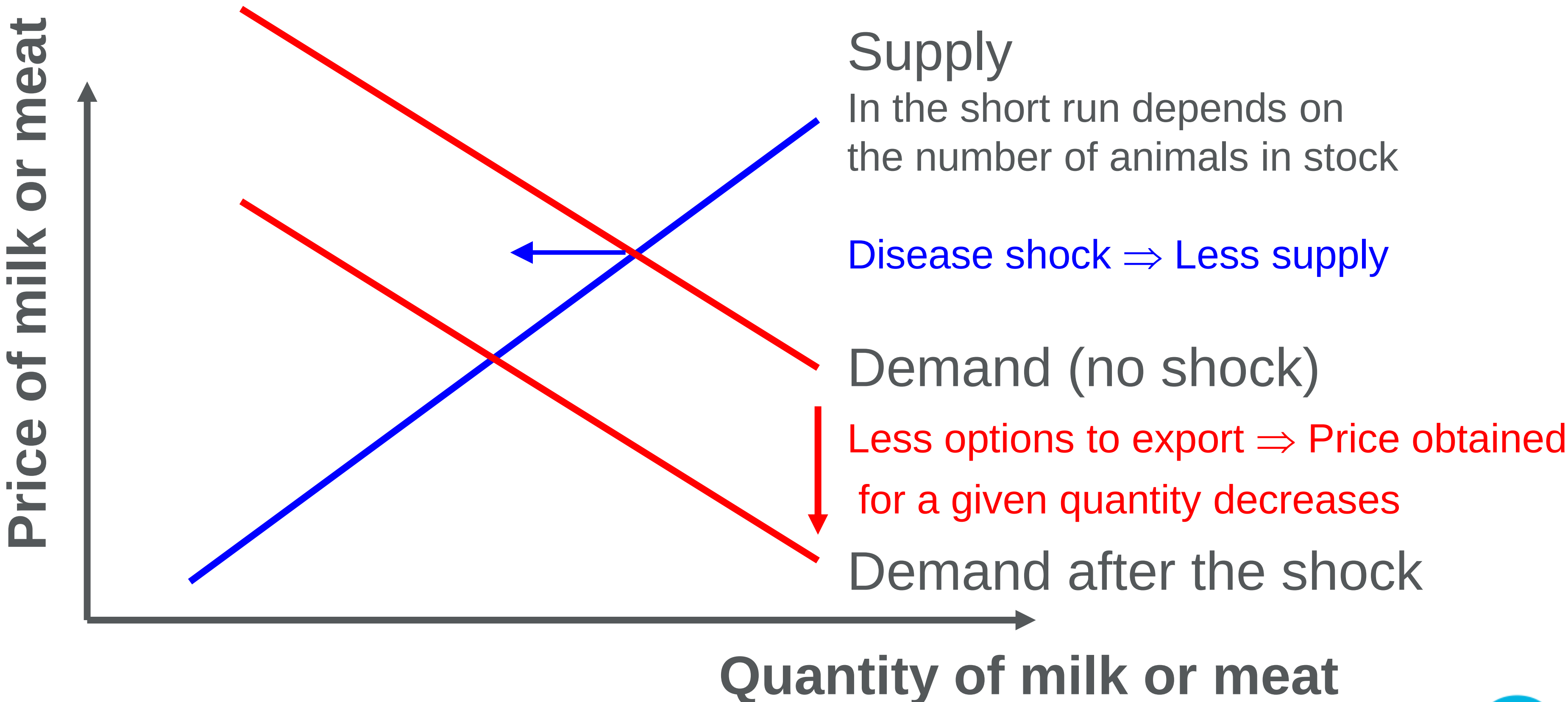
Partial-equilibrium model

- A dynamic programming model which maximises consumer surplus plus producer profit
- State variables
  - Reproduction animal stocks (sows and cows)
  - Slaughter animal stocks (relevant in the short run)
  - Binary variable defining the status of trade ban
- Control variables
  - The number of inseminated sows and cows
  - Harvest weight of growing pigs
  - Processing quantities of milk products

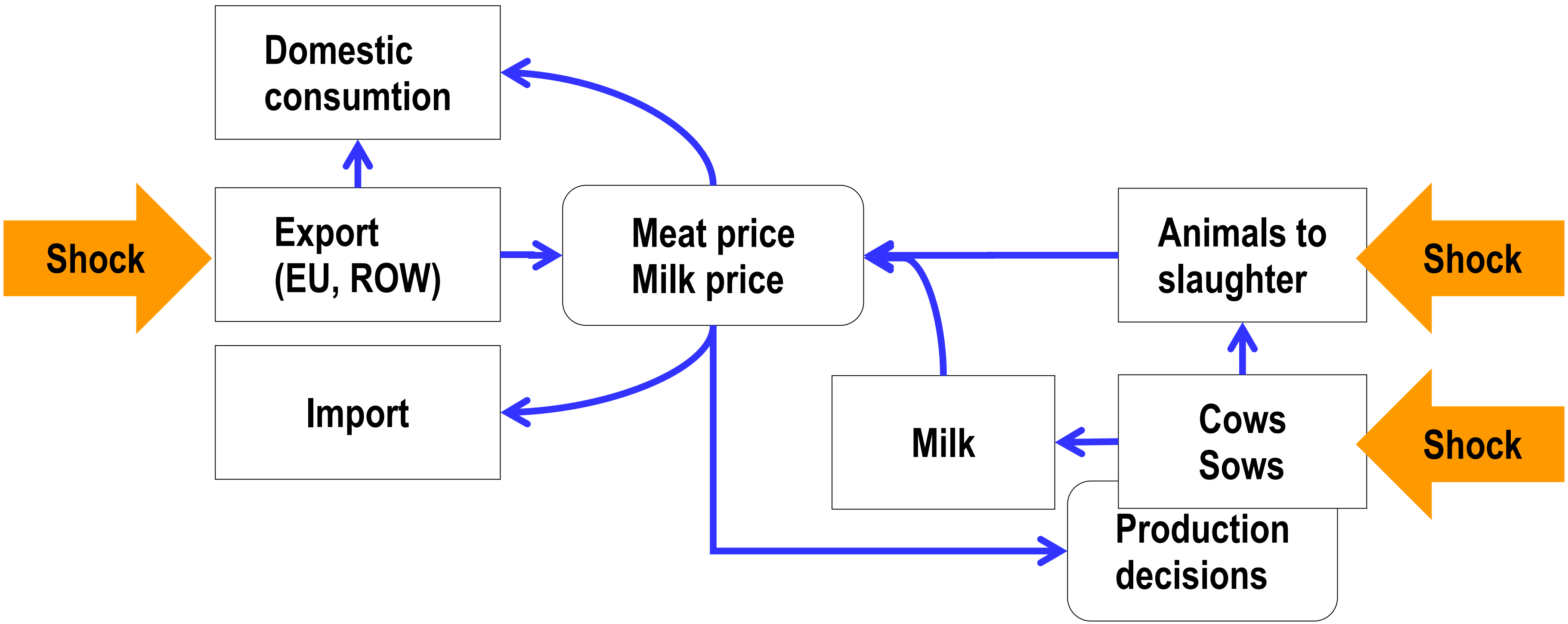
Principal impacts of FMD outbreak shock



Impact on domestic demand is assumed to be negligible

Disease shock is introduced into the dynamic production process

When information about the shock is obtained, primary production adjusts the number of replacement animals



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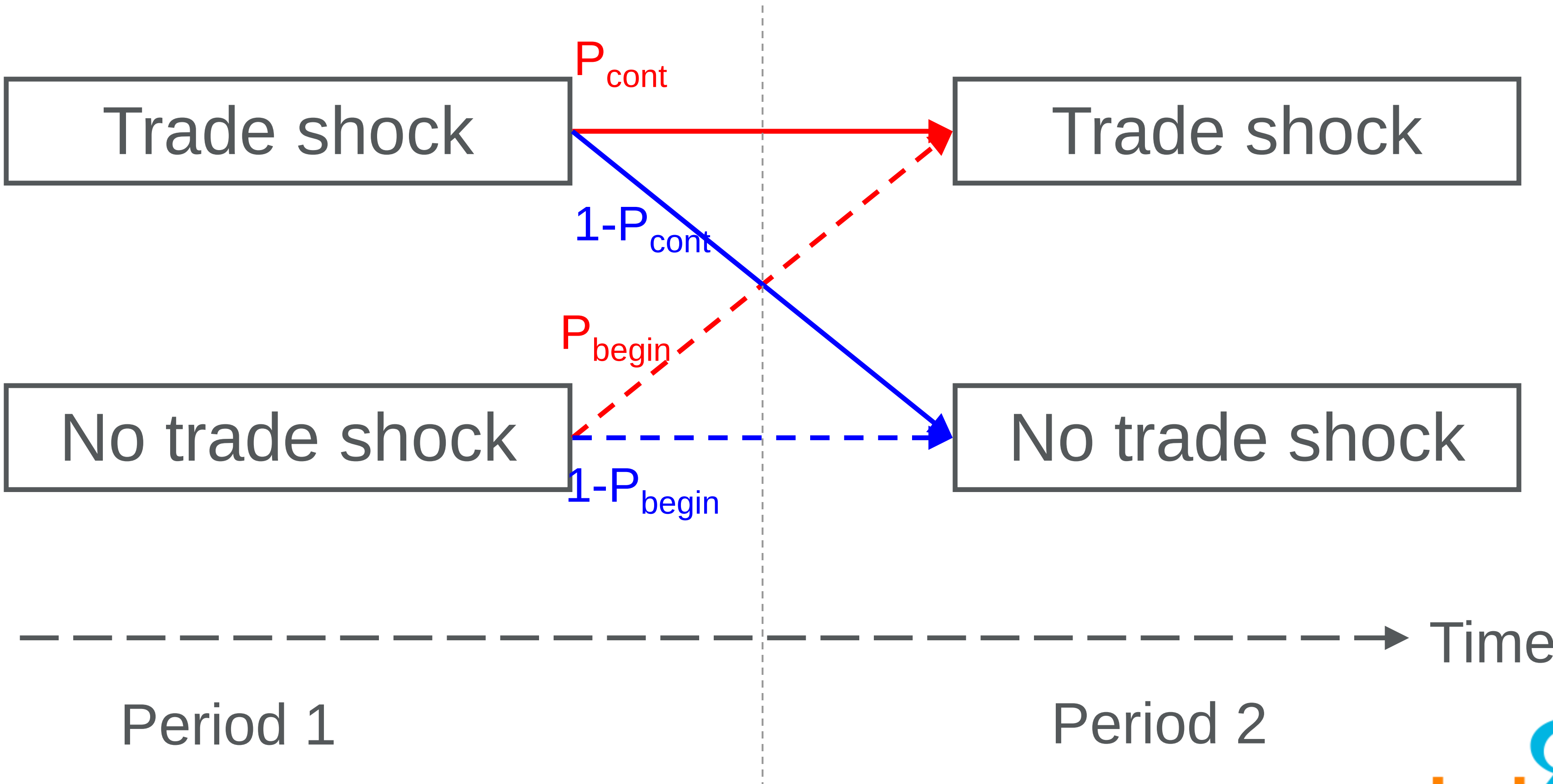
Trade shock and uncertainty



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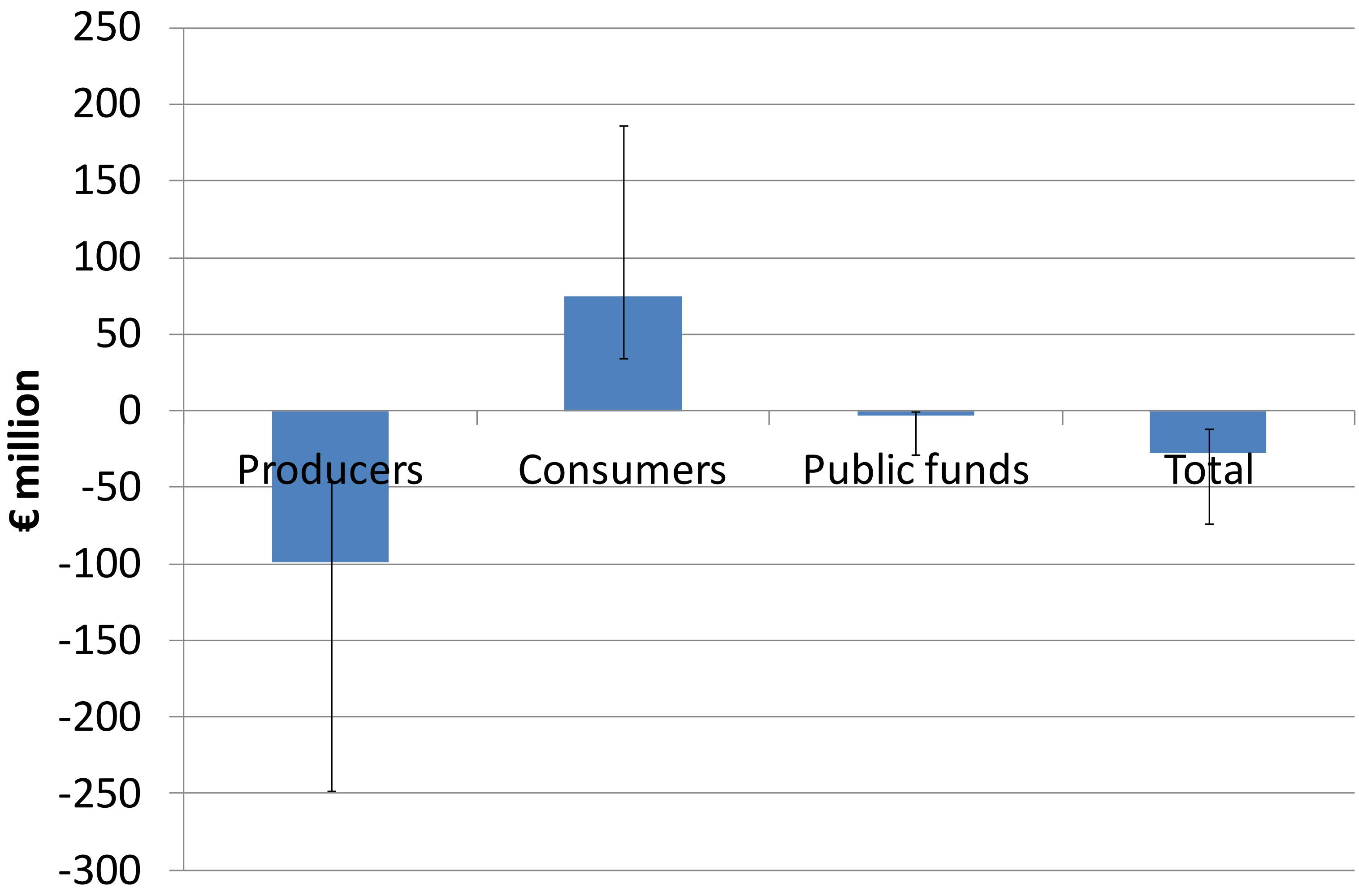
How much does FMD cost in total?



Lyytikäinen et al. 2015

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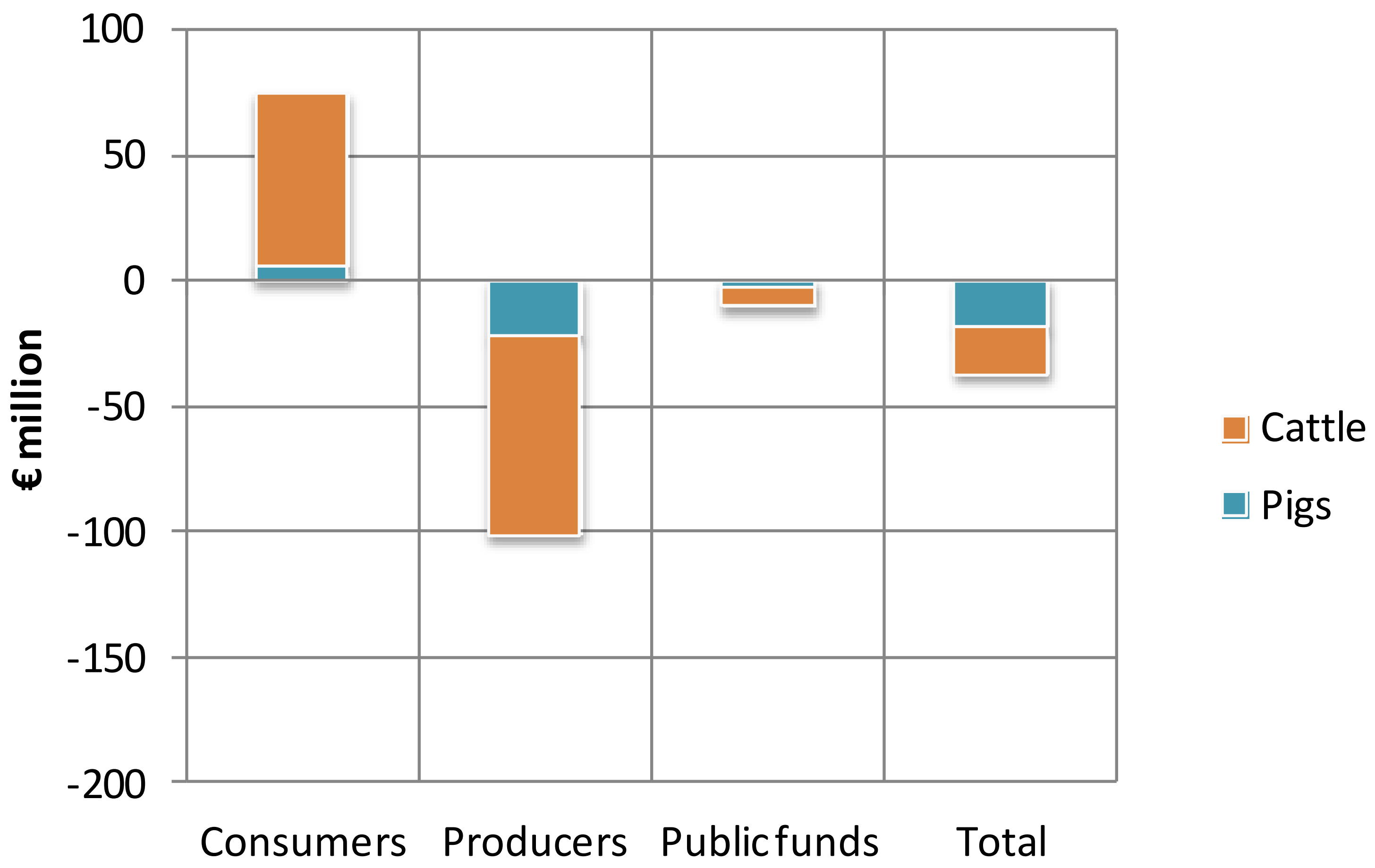
Impacts by sector



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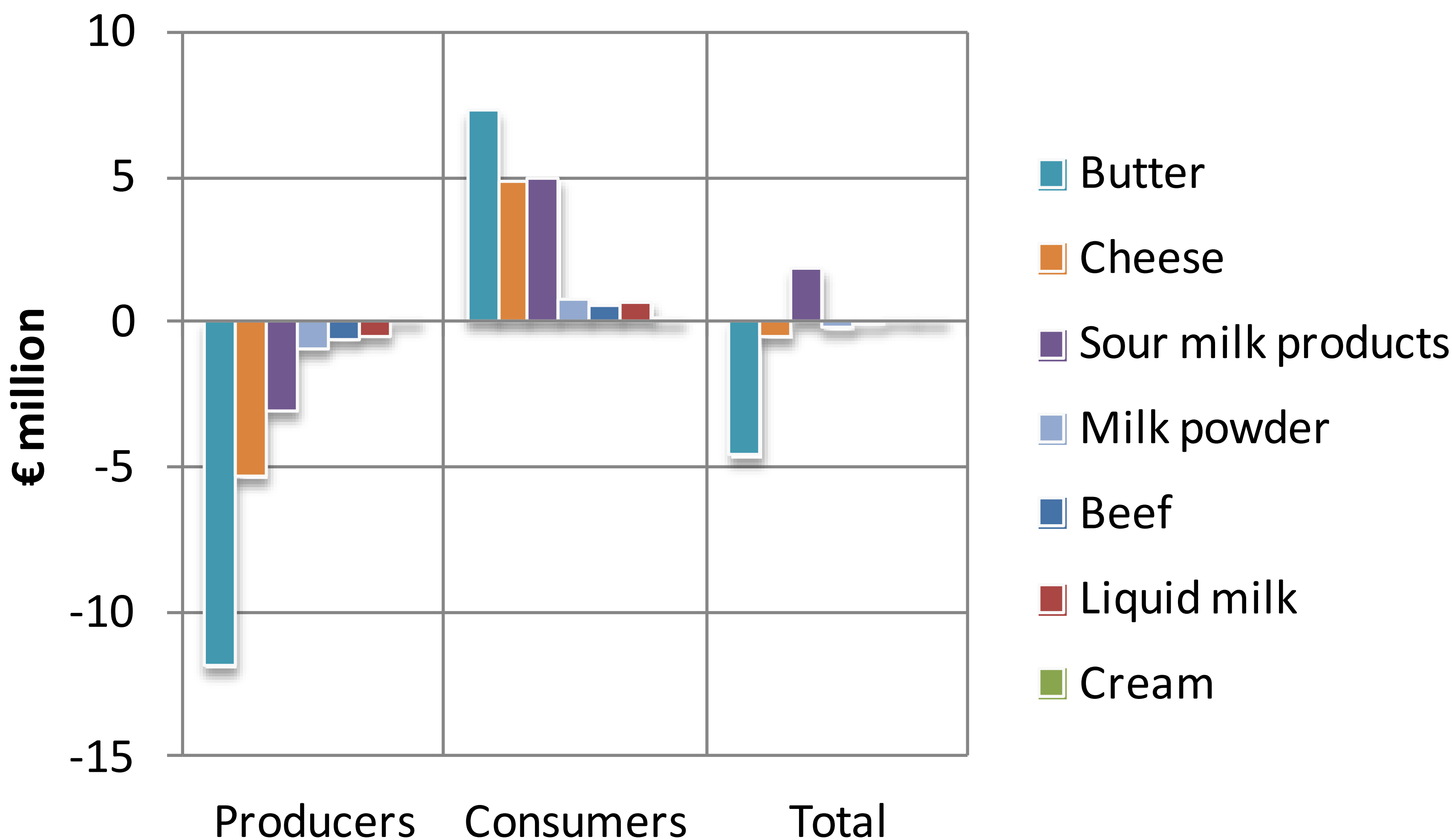
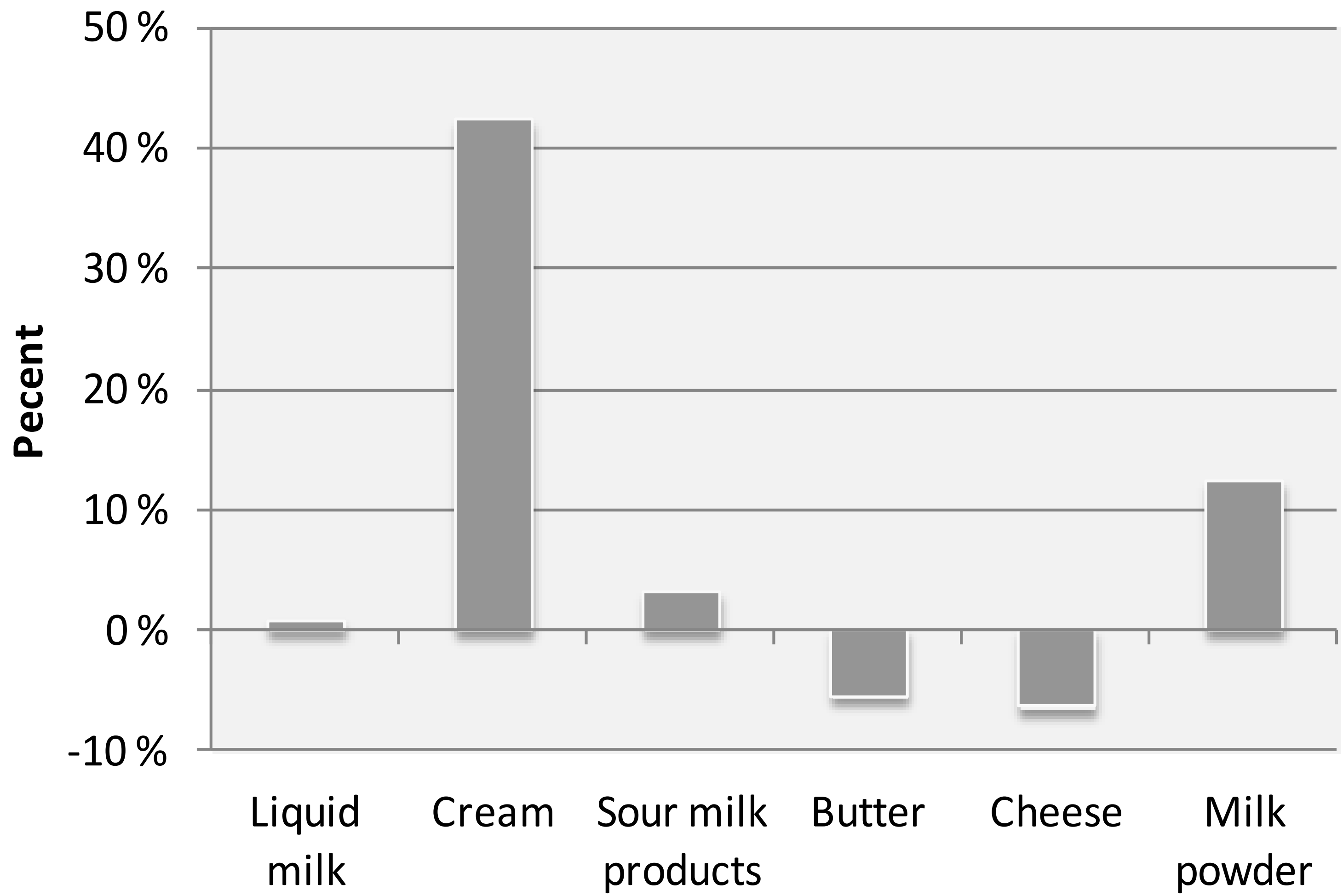
Impacts associated with dairy products (€/month)



Simulated changes in the volumes of dairy processing



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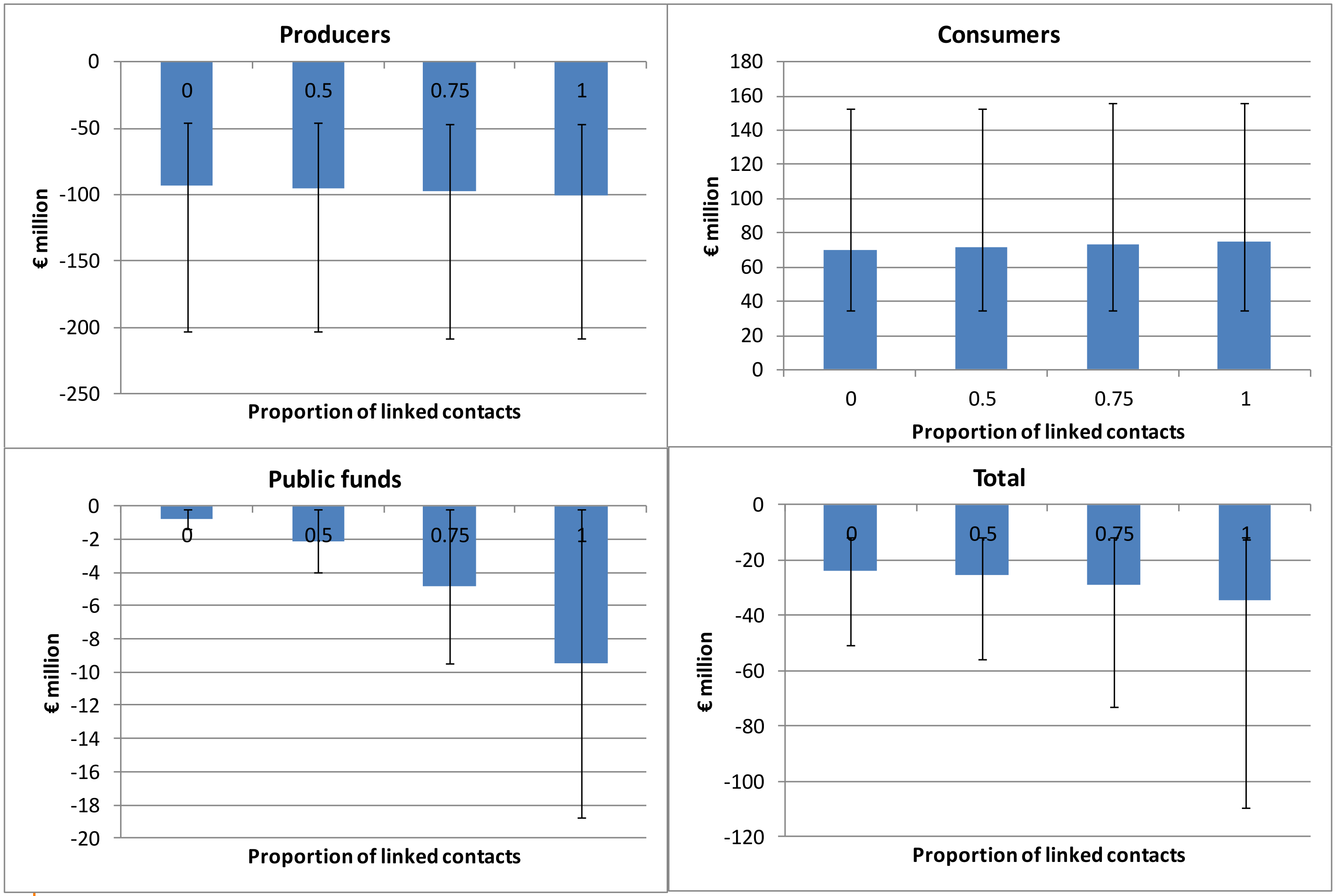
Simulated economic impacts of FMD outbreak under 2033 farm structure scenario



Source: Lyytikäinen et al 2015

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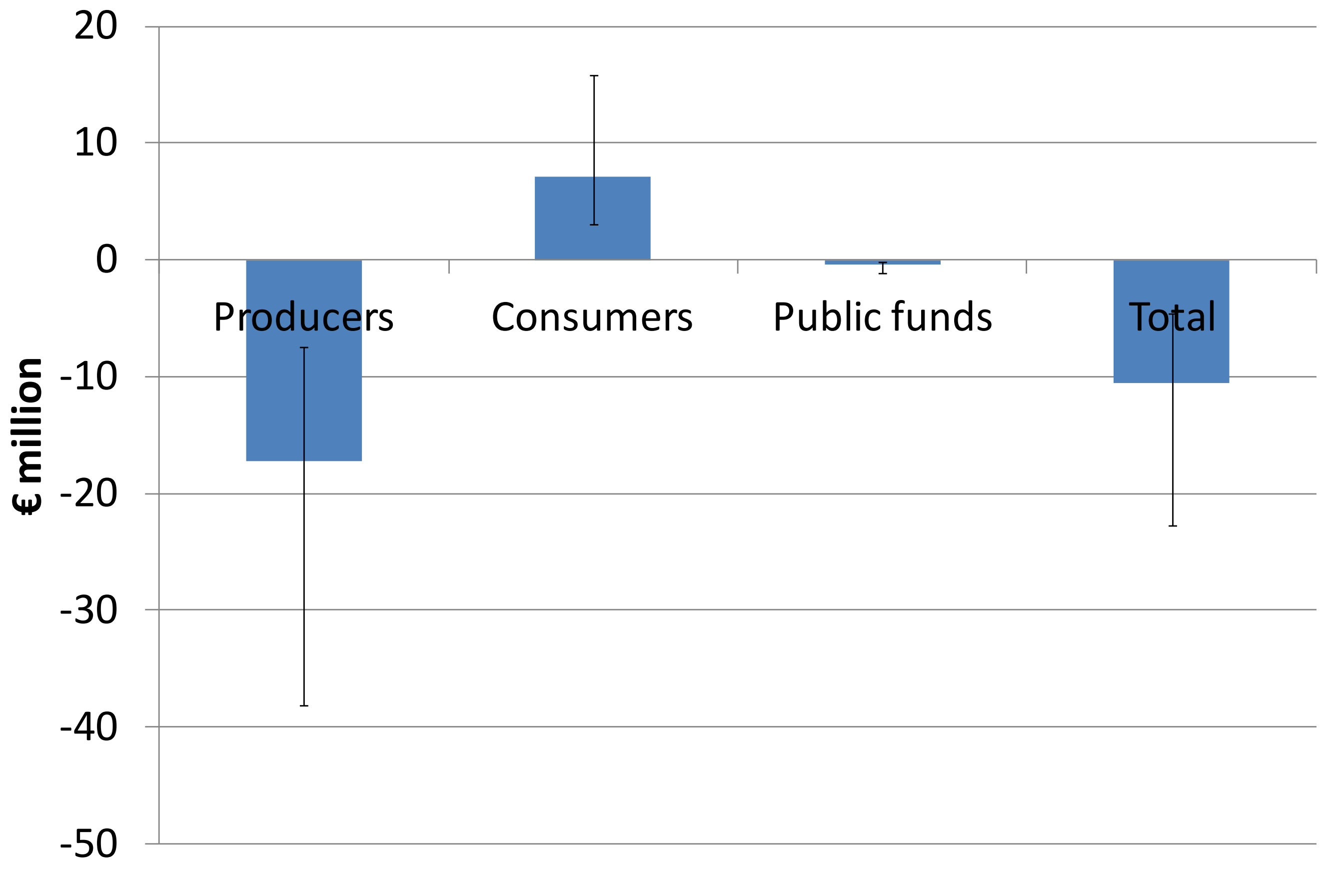
Comparison with some others studies

- Majority of simulated losses were due to distruptions in exports
- Major direct costs were depopulation, business interruption costs
- Bergevoet & van Asseldonk (2011): Apart from trade losses, animal culling costs and lost value of animals were majority of costs in a Dutch study
- Boklund et al. (2012): +90% of losses due to simulated FMD outbreak in Denmark were due to export disruptions
- We did not examine losses to tourism and rural businesses which have been found to caused substantial losses in 2001 UK epidemic (Blake et al, 2002; Franks et al. 2002).

Extra slide: Results of a similar exercise on African Swine Fever



Source: Lyytikäinen et al 2015

Examples on intervention assessment:

Protective vaccination to combat FMD in Finland – Does it pay

Based on study by
Jarkko K. Niemi & Heikki Lehtonen, Luke

Tapani Lyytikäinen, Leena Sahlström & Terhi Virtanen, Finnish Food Safety Authority (Evira)

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Summary

- Question: Does protective vaccination (emergency vaccination + culling) reduce economic losses due to FMD outbreak in Finland?
- Answer: Generally no!
- Why?
- This presentation elaborates also the importance of timing of an action

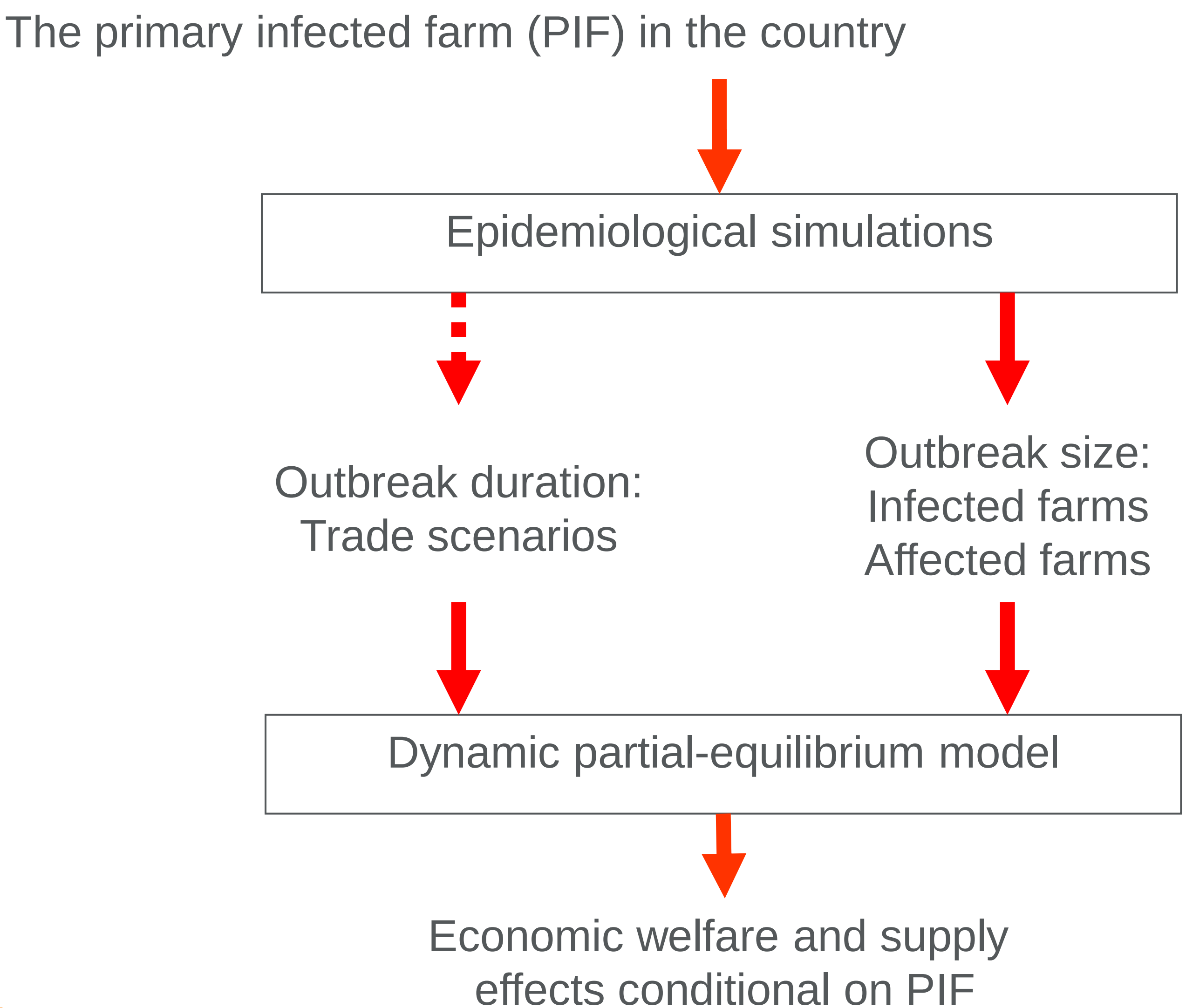
Introduction

- The rationality of FMD vaccination-to-live policy vs. stamping-out policy has been debated in the EU
- Little research focusing on countries where farm density and other production environment is similar to the Nordic countries
- Finland has been free from FMD since 1959
- Our goal was to study whether protective vaccination could be economically rational disease control policy

Data and models

- Results from epidemiological Monte Carlo simulations (n=100 000) are used as input in this study
  - Spatial farm data (n=23 439)
  - Explicit event-based animal movements data
  - Other contact information
- Economic simulations
  - Price, import, export and consumption statistics
  - Production costs for pigmeat, beef and six dairy product groups
  - Direct costs of disease eradication based on Finnish sources and the 2001 UK outbreak
  - Minimize indirect losses conditional on uncertainty

Models

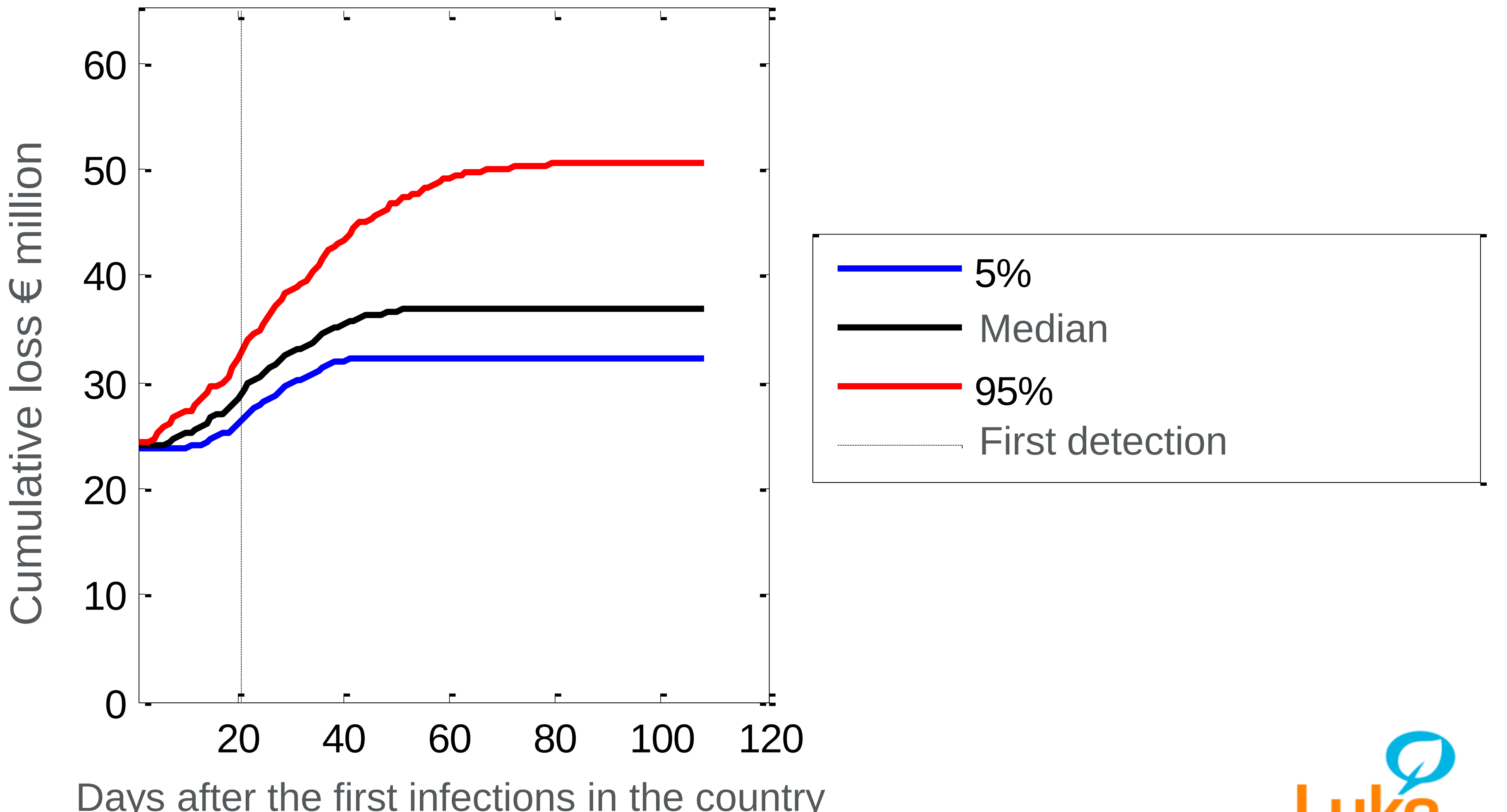

The primary infected farm (PIF) in the country
Epidemiological simulations
Outbreak duration:
Trade scenarios
Outbreak size:
Infected farms
Affected farms
Dynamic partial-equilibrium model
Economic welfare and supply
effects conditional on PIF

Results

- Typical outbreak
  - Approximately 5 infected farms
  - Duration 1-2 months
  - Losses under stamping-out policy €24 million
- In the subset of 5.5% largest epidemics
  - The protective vaccination resulted in up to 45% higher losses than stamping-out policy when trade losses are accounted for
  - If only direct costs are taken into account, the costs of protective vaccination still exceed those of stamping-out policy
  - In 95% of cases no losses could be reduced after some 60 days after the first infection
- Vaccination was not able to reduce epidemic size significantly because the earliest possible time to vaccinate was too late!

When the costs are incurred?

5.5% most severe outbreak as an example



The next slide...

- In the next slide, time since the introduction of FMD into Finland is in the horizontal axis
- Curves represent the costs of protective vaccination policy (median, range where 90% of losses are situated) for 5.5% most severe outbreaks.
- Horizotal dashed lines represent the *final* costs of stamping-out policy for a similar situation as curved lines of the same colour.
- The difference between these lines (curve-dashed) represents, expected benefits of vaccination
- Expected costs are
  - Implementation costs + prolonged trade losses

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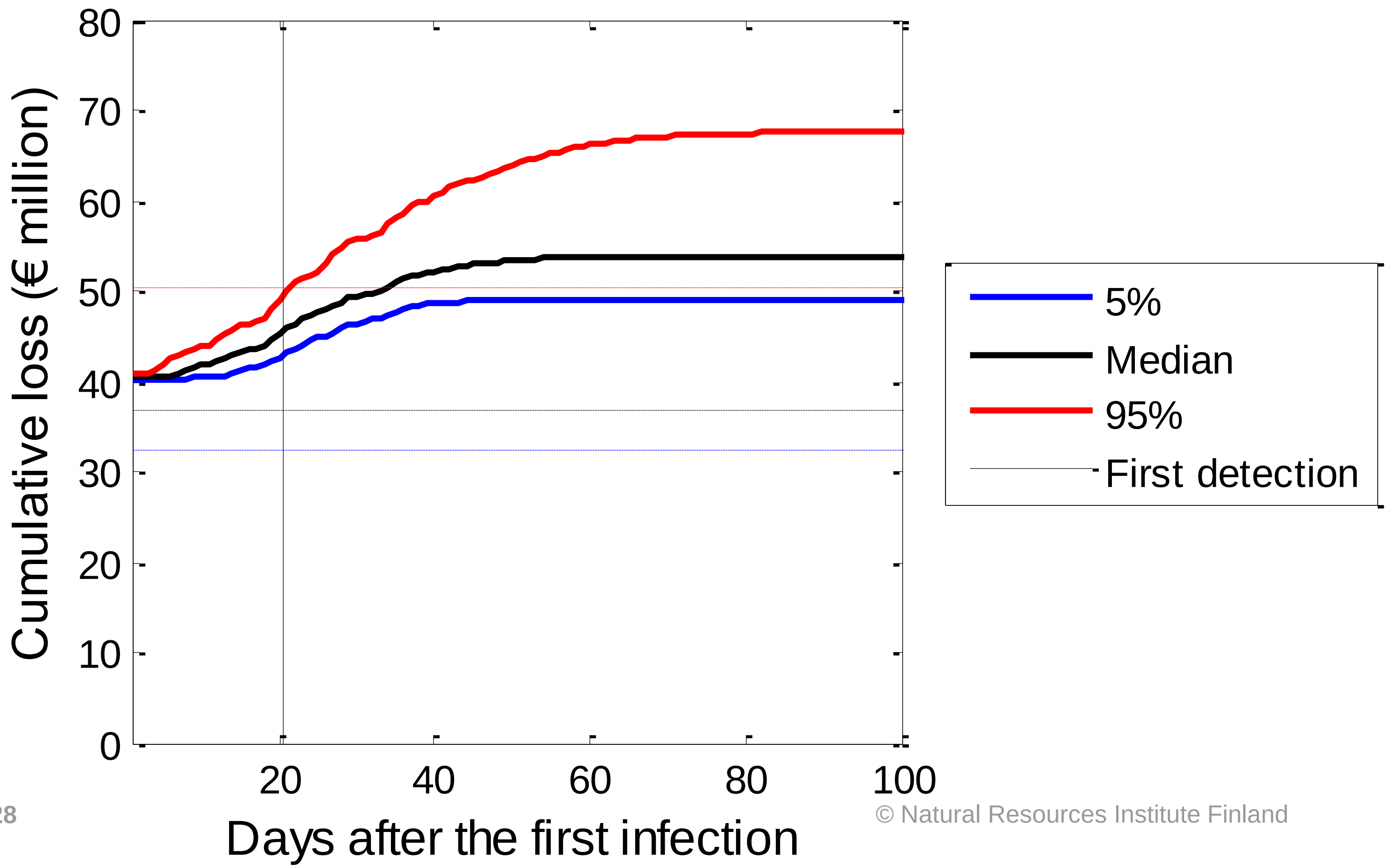
Costs are accumulated early during an epidemic

Curves represent the costs of protective vaccination policy (median, range where 90% of losses are situated) for 5.5% most severe outbreaks. Horizotal dashed lines represent the *final* costs of stamping-out policy for a similar situation as curved lines of the same colour.



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Why protective vaccination can increase epidemic's costs?

- Large number of vaccinated animals, implementation costs
- In the case of Finland, only few farms, if any, could be saved
  - Difficult to identify situations where benefits could be available
- Early action would be important!
  - Time is required to obtain protective effect
- Non-EU countries unlikely to accept products originating from vaccinated animals in their markets
  - Prolonged trade distortions matter, because exported products have limited demand on the domestic market
  - In Finland >35% of milk (milk equivalent) and 20% of pigmeat are exported
- Similar conclusion also if trading partners would fully accept vaccination-to-live policy

Controlling *Actinobacillus pleuropneumoniae* infections in fattening pig production

Anna Stygar, Jarkko K. Niemi, Tapio Laurila,
Claudio Oliviero and Mari Heinonen

Economic impact of APP

- *Actinobacillus pleuropneumoniae* (APP)
  - Reduces of daily gain and feed efficiency
  - Increases mortality
  - Increases medication and veterinary expenses
- The objective of this study was to assess the value of vaccination against APP at different levels of risks of disease introduction, severity of the disease and efficacy and costs of vaccination.

Materials and methods

Tool:

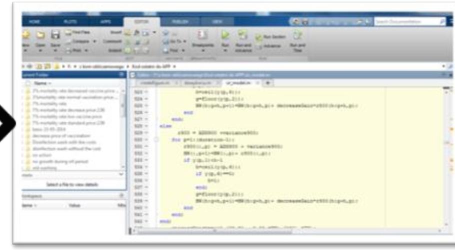
- Dynamic programming model
- The optimization problem was solved numerically using an algorithm programmed in Matlab 8.1
- 721 different scenarios were run and their results compared

Data:

- Statistical market price data were used
- Model parameters were estimated on the basis of the literature review and experts consultations

Dynamic programming

MATLAB



General stochastic epidemic model (SIR)

Scenarios:

Different disease prevalence	Different severity of disease	Different efficacy & costs of vaccination
The risk of disease introduction (0.1, 0.3, 0.5, 0.7, 0.9)	Increased mortality (3%, 7%). Decreased ADG during the infection (0, 25, 50,75,100%)	High, medium or low vaccination efficacy. Standard or decreased vaccine cost.

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Materials and methods – parameters

Number of animals in the batch

Maximum duration of fattening period (days)

Initial body weight of piglets (kg)

Prices of feed, piglet, labour, other inputs and pigmeat

ADG during a fattening period (g) in examined scenario

Coefficient of variation for ADG

α_0 - recovery rate in a base situation and in a vaccinated population

α_1 - recovery rate after applying medicine

β_0 - infection rate in a base situation and after applying medicine

β_1 - infection rate in a vaccinated population – low efficiency of vaccination

β_2- infection rate in a vaccinated population – medium efficiency of vaccination

β_3 - infection rate in a vaccinated population – high efficiency of vaccination

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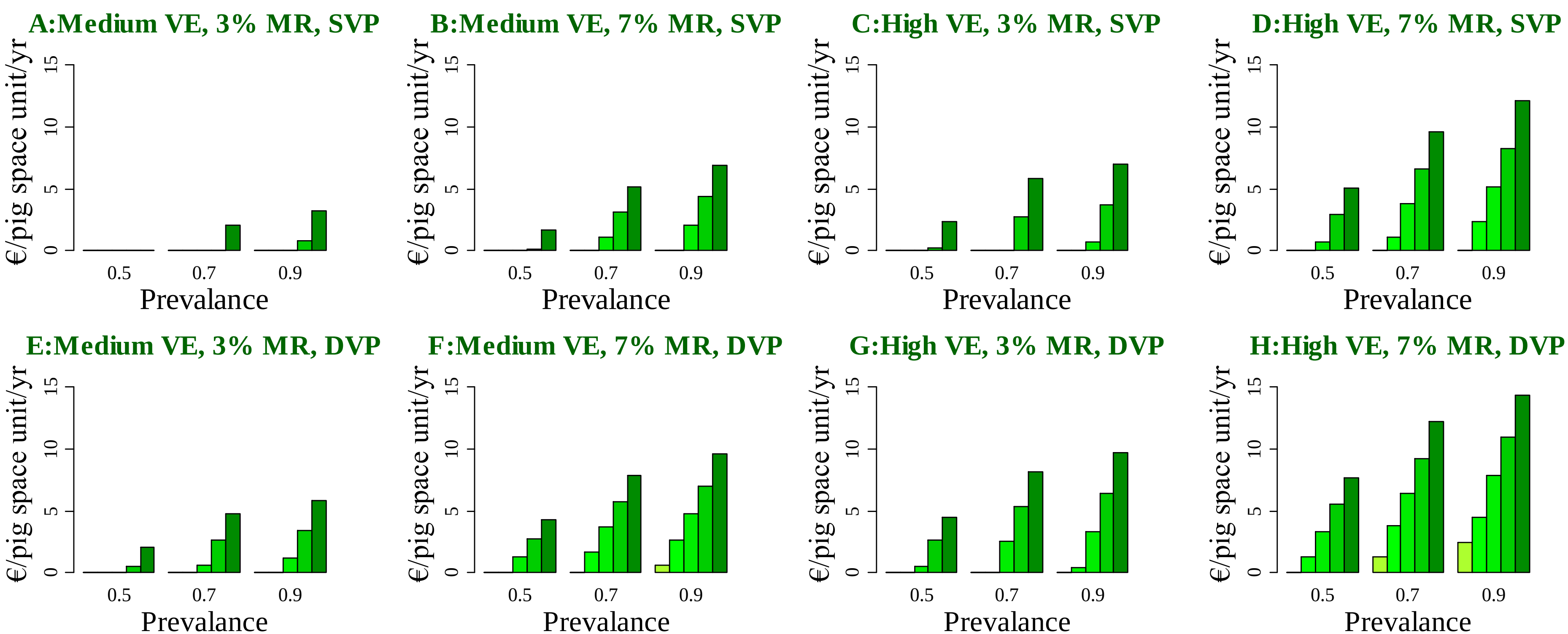
Results: Economic benefit of vaccination by the severity of the disease, risk of disease introduction and efficacy and costs of vaccination



VE- vaccination efficacy, MR- mortality rate, SVP- standard vaccination price, DVP - decreased vaccination price

Decrease in ADG:

0% 25% 50% 75% 100%

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Discussion

- Vaccination was economically beneficial if the prevalence of disease was high (risk of disease introduction > 0.3).
- With increased mortality rate (3%), substantial decrease in ADG (100%) and high risk of disease introduction (0.9), vaccination was able to increase net return even by 20-45%
- Decreasing the price of vaccination improved the profitability of vaccination on farms with high disease prevalence.
- Vaccination against APP is an effective preventive measure only when there is a high risk of the disease introduction and if the outbreak is severe.
- High efficacy of vaccination is essential in order the measure to be implemented

Economic aspects of immunocastration in pigs

Jarkko K. Niemi[1], Anna Ollila[2], Liisa Voutila[1], Anna Valros[2], Claudio Oliviero[2], Mari Heinonen[2] and Olli Peltoniemi[2]

[1]Natural Resources Institute Finland (Luke)
[2]University of Helsinki, Faculty of Veterinary Medicine, Production Animal Medicine

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Introduction

- Male pigs are castrated because intact boars can develop unpleasant odour in the meat at usual slaughter weights

  ➔Consumers observe this when the meat is heated
- Castration causes pain and inflammation in the animal

  ➔A group of stakeholders have agreed to cease traditional castration in Europe by year 2018.
- Alternatives to traditional castration of male pigs include
  - Slaughtering at a lower weight
  - Immunocastration, i.e. vaccination against boar taint

Introduction

- Immunocastration may change operating pattern and increase costs along the supply chain
- Immunocastration requires that the pigs are grouped by sex
- Hence, all costs and benefits along the supply chain should be evaluated
- Our goal was assess the costs and benefits of switching from the current castration practice to immunocastration
- We analyze how different factors affect economic incentives to apply immunocastration

Material and methods

- Biological data from an animal experiment conducted at an experimental farm in Finland
- The effects of castration and the level of feeding were tested

  ➔Two groups of male (castrated, immnocastrated) piglets were raised from birth until slaughter

  ➔Three levels (low, “recommended”, high) of lysine in feed
- Economic data were retrieved from statistics
- A value chain simulation to assess the financial impacts of alternative castration practices considering three stakeholders: a piglet producer, a finishing farm and a slaughterhouse buying the pigs
- Consumer demand was assumed not to change

Stakeholder considerations

- Assuming that price and demand are unaffected, piglet producer gains a small benefit due to avoided castration work
- Fattening pig producer either benefits or gains depending on assumptions regarding production technology and meat price
  - Does breeding segregated by sex require separate piglet logistics?
  - Can males and females be fed separately?
  - Does slaughterhouse discount meat price?
- Slaughterhouse faces some costs due to extra labour and investments

Items included in the analysis

- **Revenues**
  - Income from selling the pig to slaughter (adjusted by carcass leanness)
- **Costs**
  - Feeds (piglet, sow, fattening pig)
  - Costs of castration/immunocastrateion (measured in trial)
  - Water, electricity, carcass disposal, cleaning animal shelters, mischellaneous costs at farms
  - Cost of capital, insurance, decpreciation
  - Labour costs
  - Costs of piglet and slaughter pig logistics

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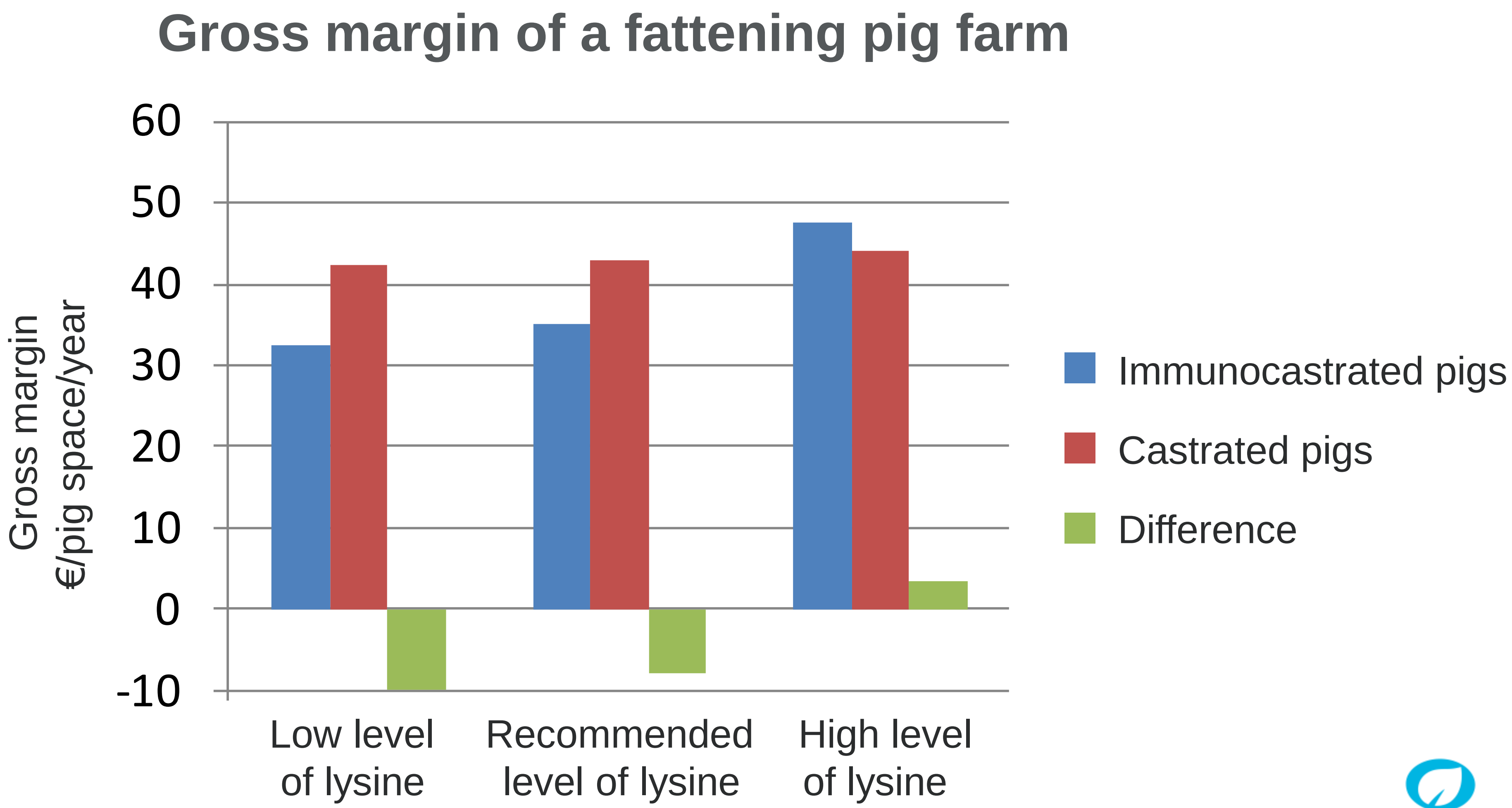
Immunocastrated pigs can be fed differently than castrated pigs



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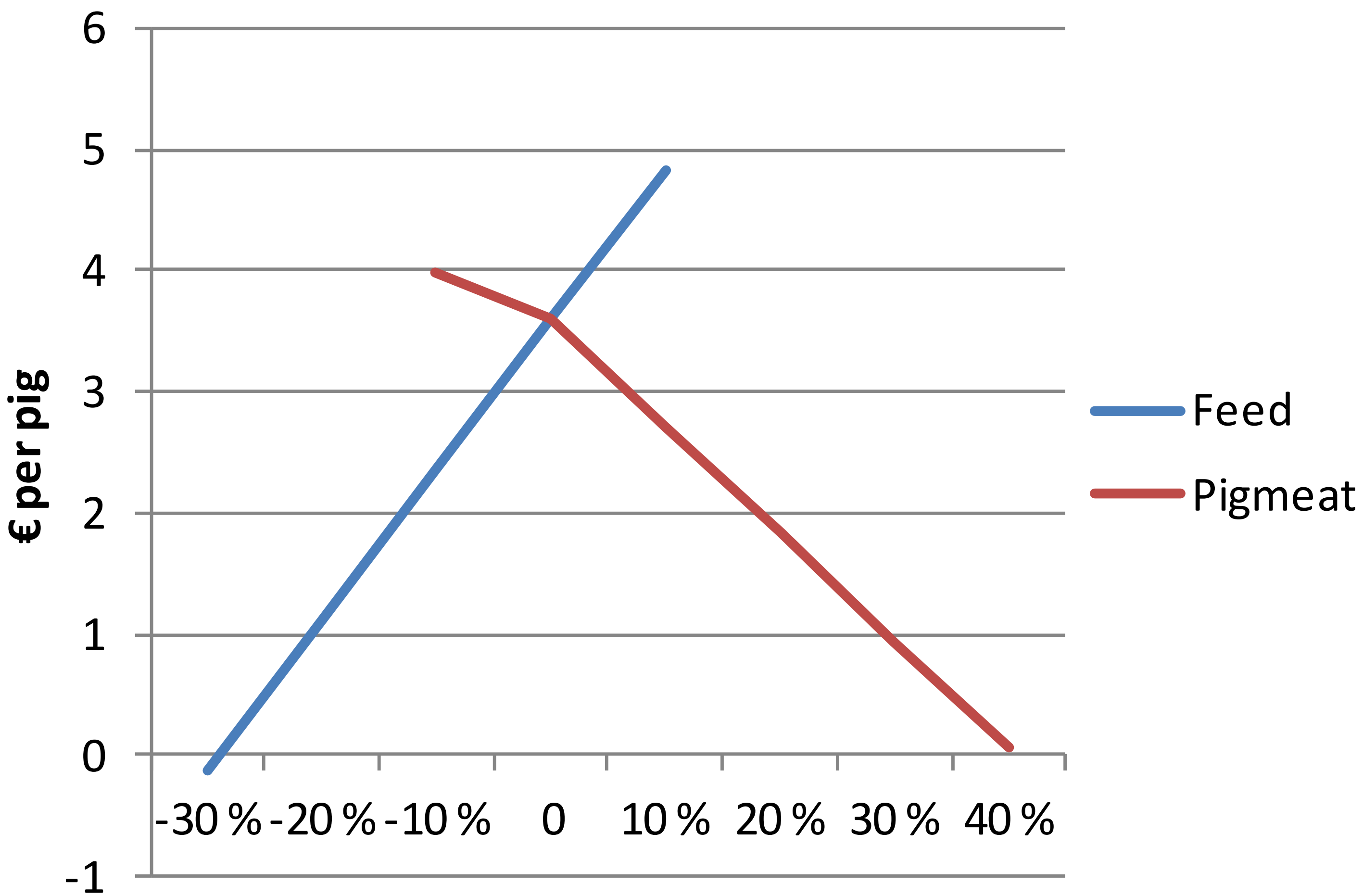
Impact of changing feed or pigmeat price by -30%...40% on gross margin improvement due to intervention



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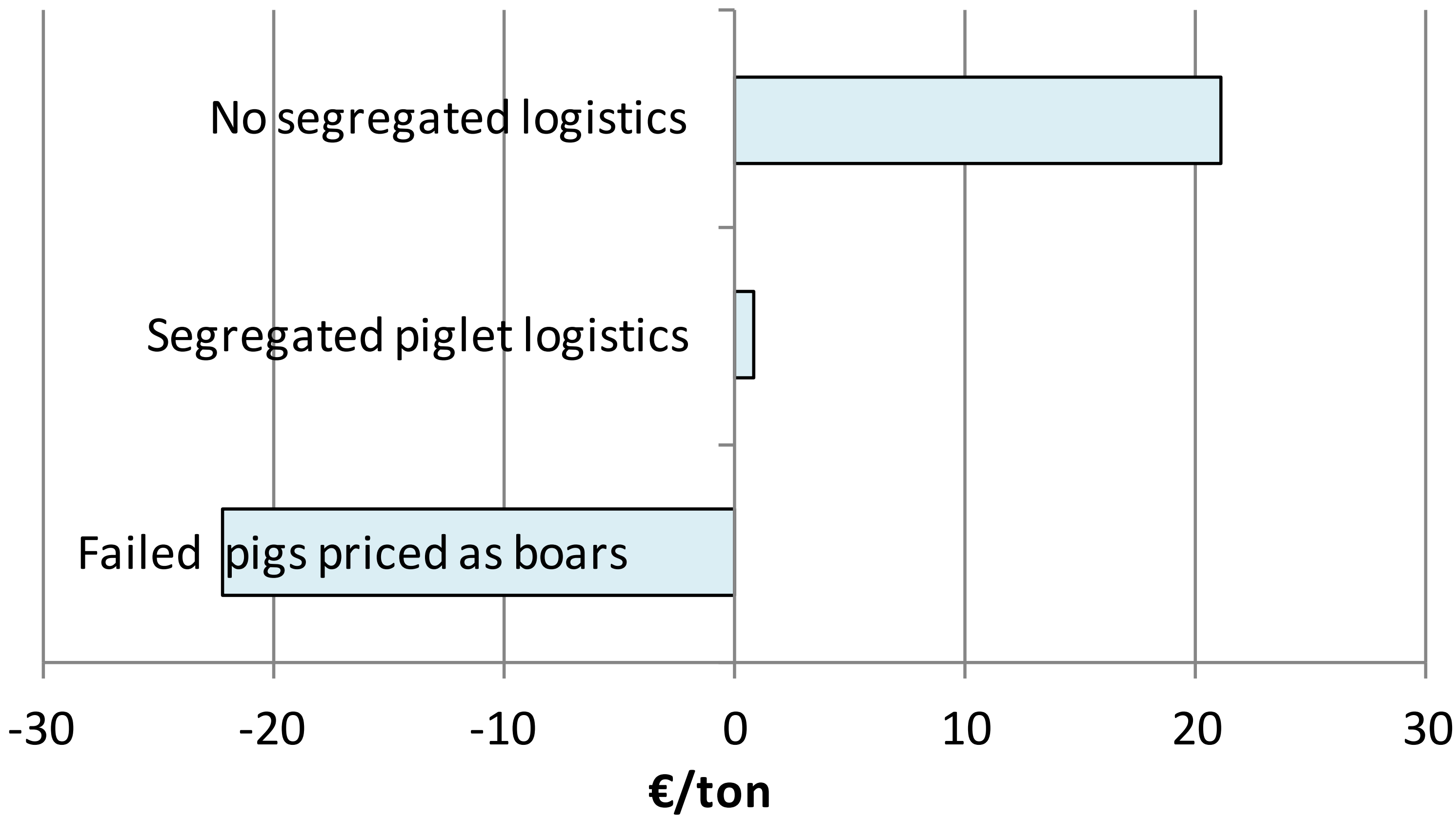
Selected results at the chain level (€/t pigmeat)



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Discussion

- Improved FCR and lean meat % provided some benefits
- The results are to some extent sensitive to changes in prices
- Critical factors to adopt immunocastration were
  - Slaughterhouse incentives (costs vs. benefits)
  - Pricing applied upon failed immunocastration
  - Impact on piglet logistic & handling costs
- In the baseline scenario the slaughterhouse paid the same price for castrated and immunocastrated pigs, immunocastrated pigs' logistics were separated from female pigs and the slaughterhouse hired extra staff to handle and inspect immunocastrated pigs.

  ➔ Small impact on net income
- If no separate piglet logistics needed, there was a potential benefit

Conclusion

- Economic incentives to adopt immunocastration depend on the production technology that is available and on meat procurement policy
- Integration of the supply chain is vital to widespread adoption of immunocastration as a production practice.
- Coordination between farms and meat buyers is needed.
- Immunocastration is an opportunity also for a niche market.

Thank you!

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