Understanding the role of Agriculture Knowledge and Innovation System in the Italian agroenergy sector: the case of biogas adoption in Tuscany

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Innovating for Sustainable Growth: A Bioeconomy for Europe (EC, 2012)

- Environment, resource use, food supply, energy supply:
  1. Agriculture and forestry
  2. Fisheries and aquaculture
  3. Bio-based industries
  4. Food chain
- Biogas is the most consolidated "modern" bioenergy
- Italian feed-in tariff scheme: €0.28/kWh
- Rural Development Programme: 40% cofunding
- Few analysis about the local patterns of knowledge sourcing

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Impacts of farm biogas: open debate
(Kirkels, 2012)

- Pros

  - Reduced environmental burden compared to fossil fuels
  (Ausilion et al., 2009; Yiridoe et al., 2009; OECD, 2010)

  - Labour opportunities and income increase in rural areas
  (Domac et al., 2005; Bartolini et al., forthcoming)

  - Distributed generation and energy security at the farm level
  (OECD, 2010)

- Cons

  - Competion for land uses
  (Capodaglio et al., 2016)

  - Vulnerability to food price increase
  (Walla and Schneeberger, 2008)

  - Irriversibility and High costs
  (Massé et al., 2011)

  - Dependence on public support
  (Wilkinson, 2011; European Commission, 2013; Cannemi et al., 2014)

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- Agricultural systems in Tuscany are mainly arable
- Major legal constraints (self-producing > 50% biomass; outsourcing the rest within 70 km)
- Diffusion followed the feed-in tariff scheme (2009): 3 operating plants in 2010 and 23 in 2012 (Fabbri et al., 2013)

then

-Land and water use change from food and feed to energy cropping
-Plant host firms: structural and technological change, for delivering a stable energy output
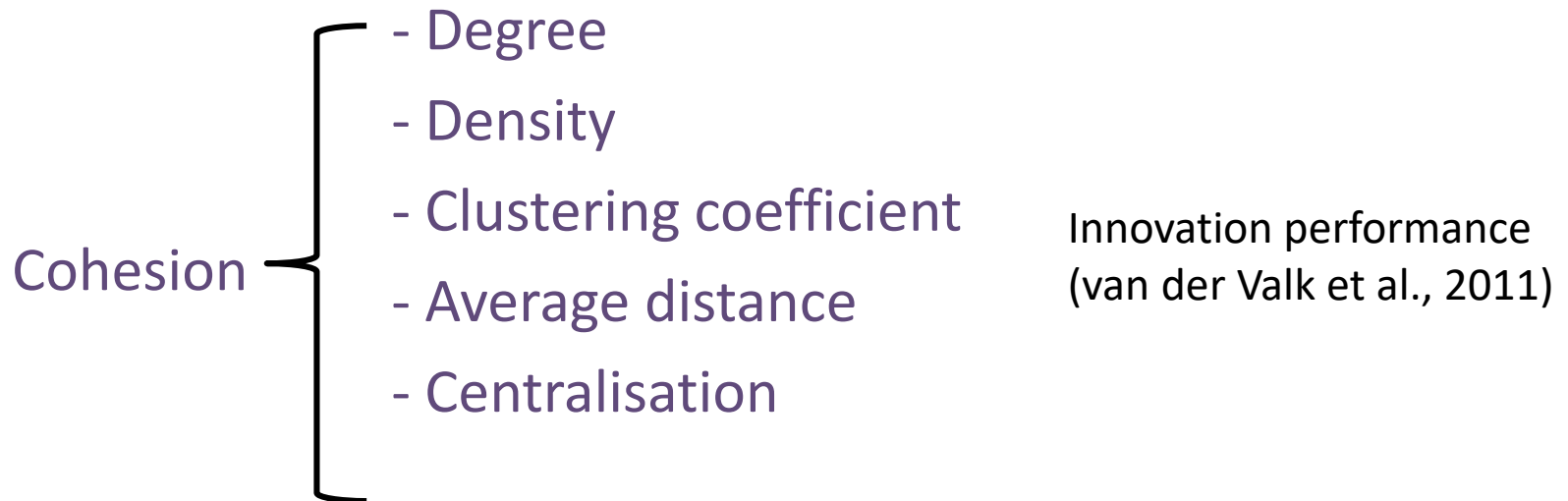
in addition

-Research findings from Tuscany may help understand biogas diffusion in other arable areas of the Mediterranean basin.

Purpose of the study

Describing the networks of knowledge retrieval that had led to the adoption of farm biogas in Tuscany, thereby highlighting the functions carried out by the Agricultural Knowledge and Innovation System (AKIS)

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- AKIS components contribute to knowledge development and diffusion through networks towards the development and establishment of an innovation (Jacobsson and Johnson, 2000; Hekkert et al. 2007)

- Assessing the performance of the innovation system involves evaluating the extent to which system elements correctly carry out those functions (Bergek et al., 2008)

- Social network analysis is an appropriate analytical tool (Klerkx et al., 2012) for mapping and understanding knowledge dynamics (Spielman et al., 2011; Klerkx and Proctor, 2013) within the AKIS (e.g. Klerkx et al., 2010)

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Network indexes

Cohesion
- Degree
- Density
- Clustering coefficient
- Average distance
- Centralisation

Innovation performance (van der Valk et al., 2011)

Centrality
- Betweenness centrality

Ability to access new knowledge (Gilsing et al., 2008)

Structural holes
- Effective size
- Efficiency

Role of different network elements in firms' innovation output; effectiveness of knowledge flow (Ahuja, 2000)
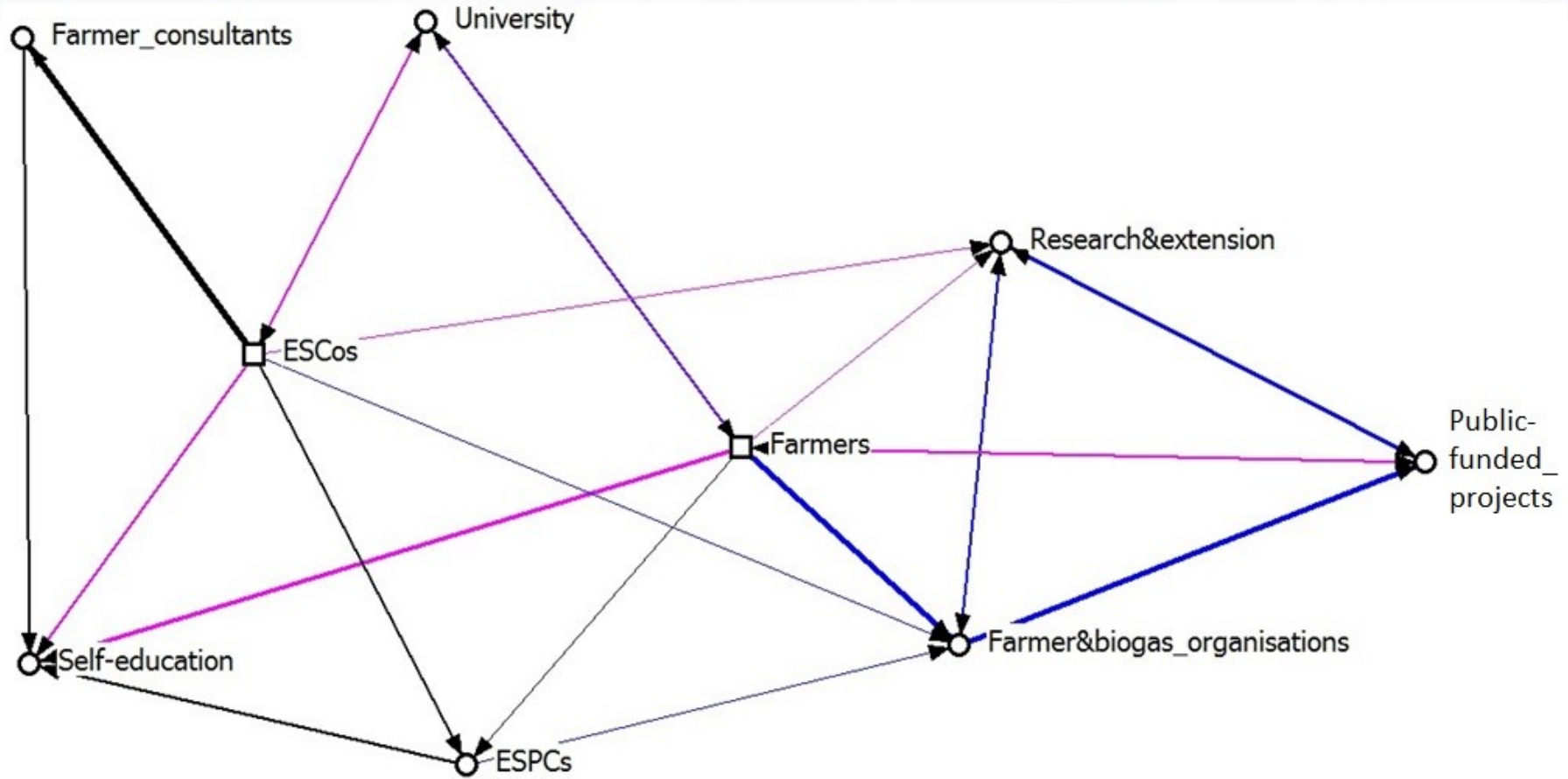
Exploratory interviews with experts (Italy and Tuscany)

Public and private research/research and extension centres (including university) | Regional Government of Tuscany | Regional Authority for Environmental Protection of Tuscany | Energy Service Company (ESCo) | Energy System Provider Company (ESPC) | agronomist
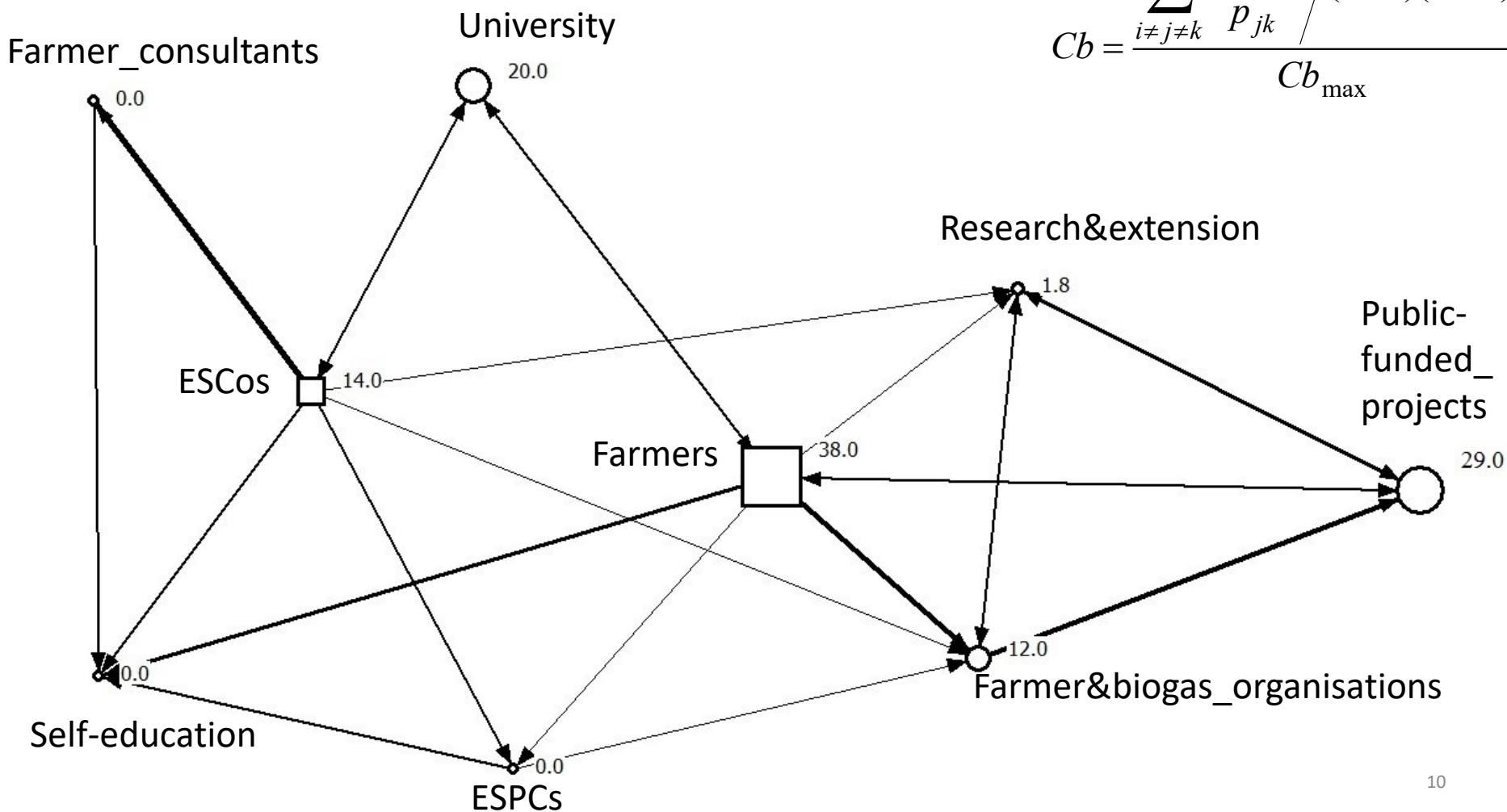
Survey to adopters

- Respondents' education, past work experience and role in farm management, farms' specialisation, surface area, land use beside energy cropping, potential alternative investments, plant rated power, energy system provider company, and labour supply due to plant establishment; open-end questions about adoption reasons and prospected alternatives to biogas

- Flexible roster-recall tables for tracking knowledge retrieval, thereby distinguishing information from know-how

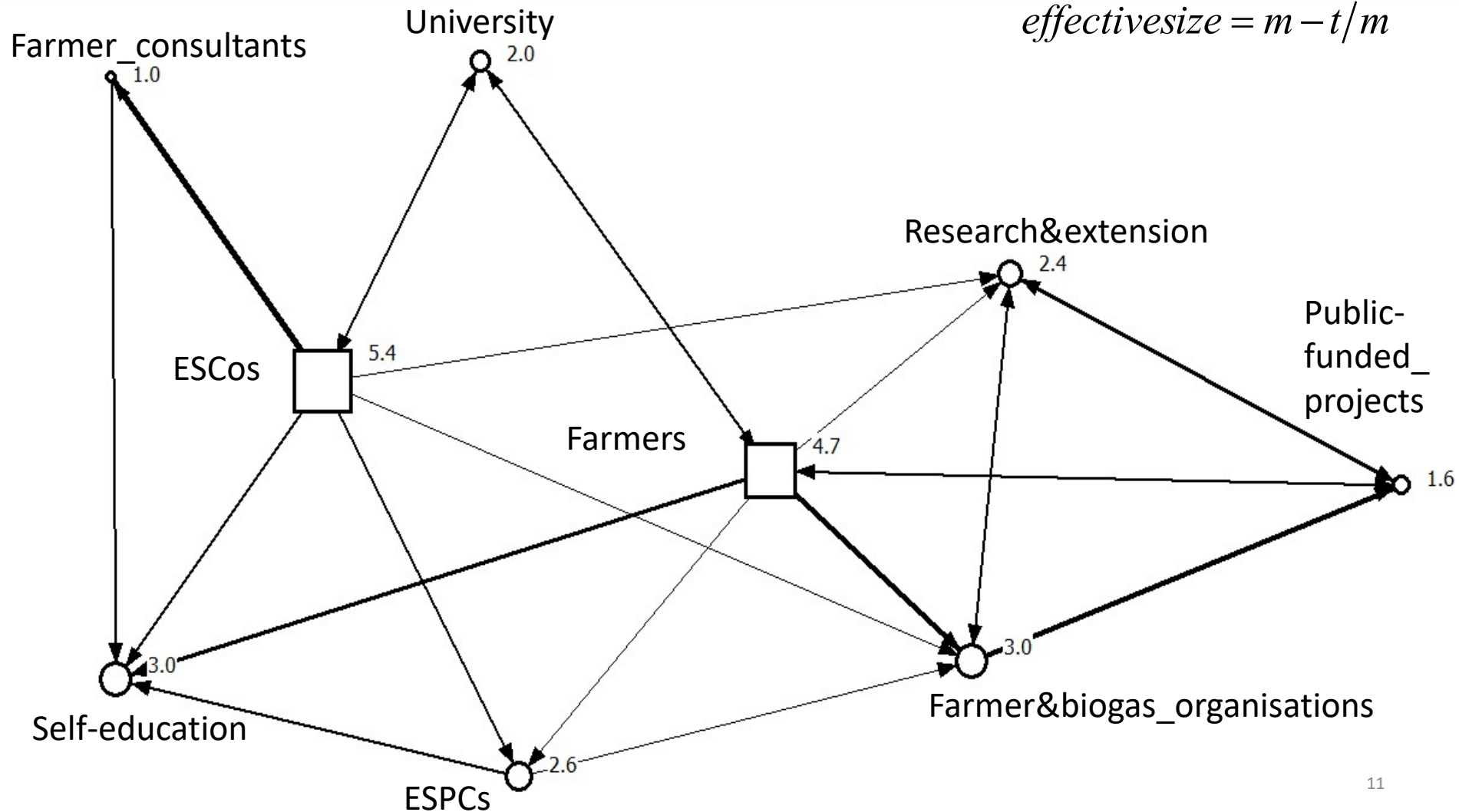- Survey to all 29 adopters: collected 13 valid questionnaires

Betweenness centrality

$$Cb = \frac{\displaystyle\sum_{i \neq j \neq k} \frac{p_{i(jk)}}{p_{jk}} \Big/ (n-1)(n-2)}{Cb_{max}}$$
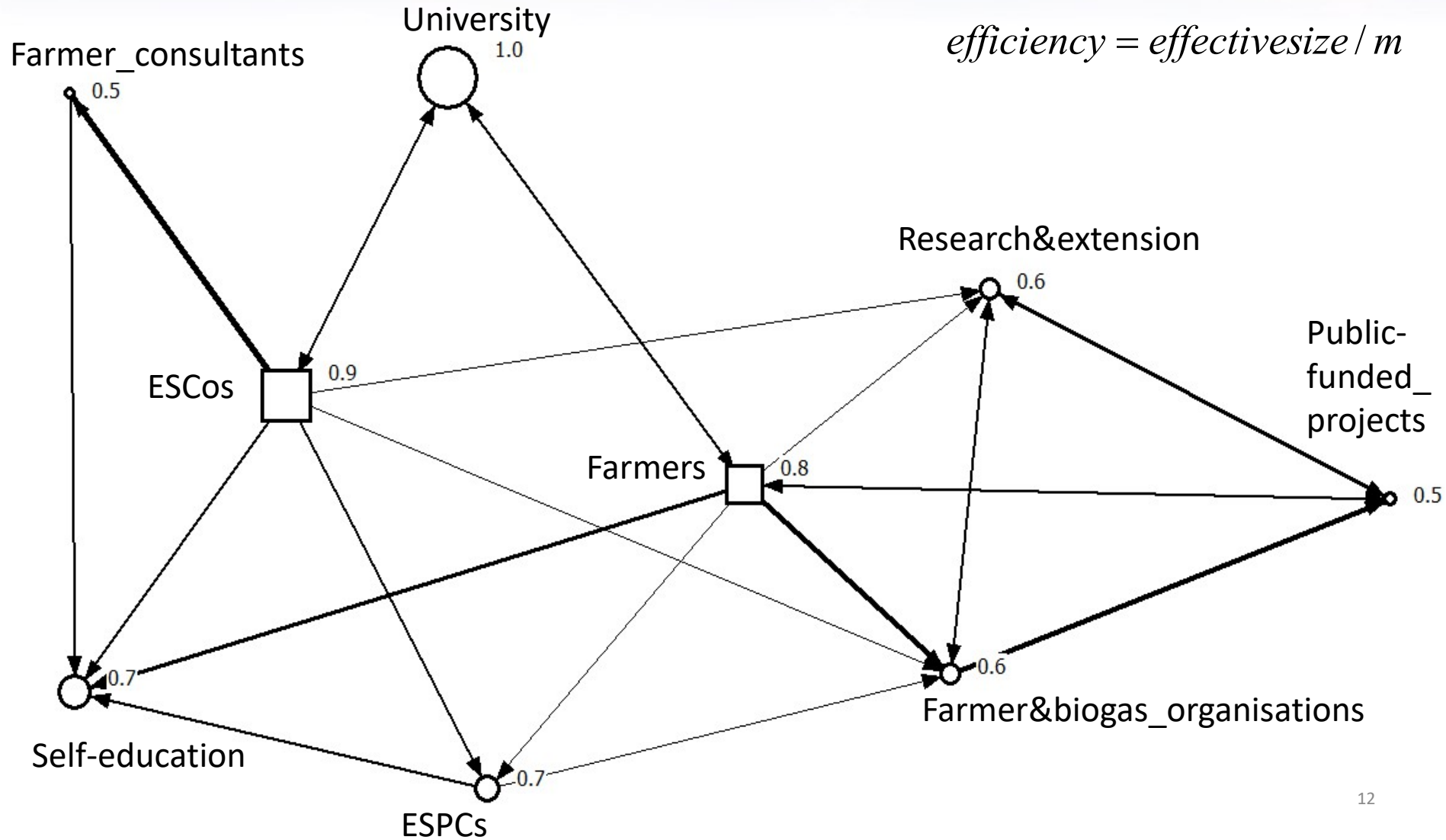
University
20.0

Farmer_consultants
0.0

Research&extension
1.8

Public-funded_projects
29.0

ESCos   14.0

Farmers   38.0

0.0

Self-education

ESPCs
0.0

Farmer&biogas_organisations
12.0

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Effective size

$$effective size = m - t/m$$

Farmer_consultants 1.0

University 2.0

Research&extension 2.4

ESCos 5.4

Public-funded_projects

Farmers 4.7

1.6

Self-education 3.0

ESPCs 2.6

Farmer&biogas_organisations 3.0

![impresa The Impact of Research on EU Agriculture]

Efficiency

$$efficiency = effectivesize / m$$

University
Farmer_consultants
ESCos
Research&extension
Public-funded_projects
Farmers
Self-education
ESPCs
Farmer&biogas_organisations

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- Respondents show marked entrepreneurship
- The patterns of knowledge retrieval differ between farmers and ESCos
  1. Knowledge sources accessed by farmers are more diverse, which can lead to greater resilience
  2. ESCos have better gating abilities
  3. Information manged by research and extension centres may help investment decisions and facilitate access to public-funded research and demonstration projects, but ESCos hardly turn to them
  4. Lacking farming background, ESCos might rely on farmer consultants
- Participating to public-funded projects (Ministry of Agriculture) deliver access to both information and know-how
- Private enterprises (ESPCs) have an important role in the management of know-how
- Universities are active seeker of know-how (and information) and make effective use of that knowledge

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Thank you!

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Network indexes

Cohesion
- Degree $Dg = \Sigma e_i$
- Density $D = e/(n(n-1))$
- Clustering coefficient $Cc = f/(k(k-1))$
- Average distance $Di = \sum_{i \neq j} d(u_i, u_j) \Big/ n(n-1)$
- Centralisation $Cn = \sum_{i}(Cb_{\max} - Cb_i) \Big/ \max \sum_{i}(Cb_{\max} - Cb_i)$

Centrality
- Betweenness centrality $Cb = \dfrac{\sum_{i \neq j \neq k} \dfrac{p_{i(jk)}}{p_{jk}} \Big/ (n-1)(n-2)}{Cb_{\max}}$

Structural holes
- Effective size $effectivesize = m - t/m$
- Efficiency $efficiency = effectivesize/m$

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