WHO IS WORKING WITH WHOM: CO-AUTHORSHIP AND CO-CITATION NETWORKS IN AGRICULTURAL ECONOMICS LITERATURE ON CENTRAL AND EASTERN EUROPE

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Abstract

The study analyses co-authorship and co-citation networks in Central and Eastern European Agricultural Economics literature from 1990-2013. Using a sample of 238 articles selected from 17 peer reviewed journals the results show that there has been an increase in collaboration between authors during the period with Western European researchers being the major co-authors with their CEE colleagues. The co-authorship network analysis shows the existence of scientific cliques as majority of the articles was written by a few authors. Centrality measures showed that authors with the highest number of publications are not necessarily central players in the network. Co-citation analysis result shows that authors who belong to cliques are the most cited, while the pagerank scores emphasized the importance of who cites an article as articles cited by popular authors had higher pagerank scores and the most cited articles were not necessarily the most important depending on who cites them. The results also showed that authors who work together cite each other more often thereby boosting scientific advance for their clique members. For young researchers in this field, it is recommended to publish with colleagues often and identify the key players in this network, try to work with and cite them so as not to be left behind.

Keywords: co-authorship, co-citation, networks, cliques, centrality, agricultural economics, Central and Eastern Europe
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Dedication

This thesis is dedicated to my ever-loving parents Mr. and Mrs. Nkamuke for their unconditional love, guidance and support and to the world’s greatest brothers Uzoma, Uzochukwu, Uzondu and Uzodimma.
CHAPTER ONE

INTRODUCTION

CONTEXT OF THE STUDY
The theory of social networks has been long studied and is a wide spread field because social interactions can be seen in almost every sphere of life. Co-authorship and Co-Citation networks (as an area of social network) have been analysed extensively at various levels to explore the characteristics of scientific collaborations. Scientific collaborations are well established research topics utilizing three kinds of methods: qualitative methods (surveys/questionnaires, interviews, observations), bibliometrics methods (publication counting, citation counting or co-citation analysis) and complex network methods (e.g., shortest path, centralities, network parameters, or PageRank/HITS) (Ding, 2011).

Irrespective of the wide spread nature of this topic, analysis of co-authorship and co-citation networks in the field of Agricultural Economics is rare. The work of Cramon-Taubadel and Nivyevskyi (2012) “Twenty years of research on transition in agricultural economics journals” is an exception. In their paper, they accessed the performance of Agricultural Economics as a profession in connection with transition by studying related articles in international journals in the field of agricultural economics. They then analysed co-authorship networks in these articles.

This paper focuses on analysing co-authorship and co-citation networks in Agricultural Economics articles on Central and Eastern European region from 1990-2013. It adds to existing literature on scientific collaborations and tries to fill the existing gap in the study of scientific collaboration in the field of Agricultural Economics while using a whole region as case study.

The structure of this study is as follows: Chapter one is a general introduction of the study. It includes the research objectives, research hypotheses, expected results and limitations of the study. Chapter two is a literature review on the theory of social networks, co-authorship and co-citation and the methodology. Chapter three explains
how the sample was collected and describes basic patterns of the sample. Chapter four deals with the analysis of the co-authorship and co-citation networks and the discussion of the results. Finally, chapter five contains the conclusion, recommendations and suggestions for future research.

RESEARCH QUESTIONS/OBJECTIVES
As a young researcher in the field of Agricultural Economics, I am aiming to explore the effect of social networks. Specifically it would be interesting to see if social networks (in this case co-authorship and co-citation) play a significant role in this field. Does it have any effect on articles published? If it does who are the major actors? Are there any cliques that dominate this field? Are these cliques easy to penetrate? Is there a significant relationship between co-authorship and co-citation? Is it better to work as an individual or with other researchers? Does it matter who a person works/ co-authors with (if one is working with them, would it increase chances of being a key player in the field)?
These are the major questions this research seeks to analyse and answer.

RESEARCH HYPOTHESES
The following hypotheses will be tested in this research:

1. **Most of the articles were written by a small group of researchers**: while collecting the samples, we noticed that majority of them were published by the same people. In other words, a small group dominated the literature space while a few individual researchers who were not part of these groups had very few publications indicating the existence of “scientific cliques”.

2. **An authors’ role in the network increases with an increase in his/her publications**: the study wants to test if authors with the most publications play central roles in the co-authorship networks. That is, if there is a high correlation between number of publications and centrality measures.

3. **There is a high correlation between co-authorship and co-citation**: checking the reference list we noticed that authors who publish together often cite each other more than the average and want to test if this observation is true.
EXPECTED RESULTS
After analysing the data, it is expected to discover that being in the right network matters in determining how active a researcher is in this field as there are certain cliques that dominate. It is also expected to see a correlation between co-authorship and co-citation (authors that work together helping each other by mostly citing each other because citation counts matter in determining the relevance of a publication). Furthermore, it is expected that authors who publish more have more significant roles in this field.

LIMITATIONS OF THE STUDY
During the course of this research some limitations were encountered.

- We also tried gathering Agricultural Economics articles on West Africa for comparison but found out that most of the authors did not work with each other.
- Due to the numerous amount of articles on Agricultural Economics published over time, we could only limit ourselves to a certain period (1990-2013).
- Only articles written in English during the stated period were selected, to make coding and analysing easier. The growth of the sample size might have altered the results.
- There are many agricultural economics journals published yearly but it is impossible to include all of them. The journals selected however are a good representation of major journals in the field of agricultural economics.
CHAPTER TWO

THEORY AND METHODOLOGY

2.1. THEORY OF SOCIAL NETWORKS

A network is a group of two or more people/organisations/things linked together. There are many types of networks, technological, biological, social networks amongst others as almost every sphere of life or activity is linked to another somehow. Turrini et al. (2010) described networks as multiple organizations/persons which are tied by some form of structural interdependence in which one unit is not the subordinate of others by virtue of its formal position. Networks can be broadly grouped into social and non-social networks (Newman and Park, 2003).

Social networks as a subset of networking is an interdisciplinary research programme that seeks to predict the structure of relationships among social entities, as well as the impact of said structure on other social phenomena (Butts, 2008). Social networks differ from non-social networks in the level and extent of clustering (Newman and Park, 2003). The level of clustering seen in many non-social networks is no greater than one would expect by chance given the degree distribution. However, for social networks, clustering appears to be far greater than one would be expected by chance. This could be because social networks are often divided into groups or communities and this division could result in the observed clustering (Newman and Park, 2003). Social network has been used widely and applies to numerous fields including social and behavioural sciences as well as economics, industrial engineering, organisational science and animal behaviour (Faust and Fitzhugh, 2012). It provides a powerful tool for understanding social processes - and is of great scientific interest in its own right (Butts, 2008)

Research in a number of academic fields has shown that social networks operate on many levels, from families up to the level of nations, and play a critical role in determining the way problems are solved, organizations are run, and the degree to
which individuals succeed in achieving their goals (Passmore, 2011). To a social
network analyst, “the world is composed of networks, not groups” (Wellman and
Berkowitz, 1988). A social network analyst examines what relationships exist between
actors before labelling them as a group and “Groups emerge by being densely
connected regions of the network” (Haythornthwaite, 1996). Individuals usually belong
to various social networks based on different types of relationships, and the usefulness
of networks to its individuals/actors is determined by its shape. Smaller, tighter
networks are said to be less useful to their members than networks with lots of loose
connections (weak ties) to individuals outside the main network (Passmore, 2011).
According to Burt (2000), from an individual’s point of view, dense social networks are
likely to convey commonplace information but weak ties connecting different social
groups will usually bring more original information, though this information will be
less reliable. Consequently, there is a trade-off between weak (diverse) and strong
(reliable but redundant) information (Callois and Aubert, 2007). It is better for
individual success to have connections to a variety of networks rather than many
connections within a single network (Passmore, 2011). Putnam (2000) also introduced a
similar distinction between what he termed bonding and bridging social capital.
Bonding social capital involves strong and redundant ties, whereas bridging social
capital involves loose but non-redundant ties, i.e. ties that span different social worlds.
Similarly, individuals can exercise influence or act as brokers within their social
networks by bridging two networks that are not directly linked (Passmore, 2011). This
is what Granovetter called "the strength of weak ties".

2.1.1 SOCIAL NETWORK ANALYSIS
Any structured technique used to mathematically analyse a circuit of complex working
procedures and plot them to show their interdependencies and interrelationships is
termed network analysis.

Network analysis has been booming and developing for several decades and has
become popular in every kind of academic social science, applied social science areas
like marketing, studies of nonhuman social life, branches of mathematics, computer
science, and even physics. Just as the maxim for real estate is “location, location,
location” the maxim for social network analysis is “relationships, relationships,
relationships” (Haythornthwaite, 1996). Relationships are central to social network analysis as they indicate a connection between two or more people or things. People have used the idea of "social network" loosely for over a century to connote complex sets of relationships between members of social systems at all scales, from interpersonal to international (Passmore, 2011). Social network analysis stems from its difference from traditional social scientific studies, in the sense that unlike the latter which assumes that it is the attributes of individual actors (whether they are friendly or unfriendly, smart or dumb, etc) that matter, it produces an alternate view, where the attributes of individuals are less important than their relationships and ties with other actors within the network (Passmore, 2011). It seeks to predict not just the structure of relationships among social entities but also the impact of this structure on social phenomena.

The major elements of social network analysis are built around concepts and methods for the measurement, representation and analysis of social structure (Butts, 2008). It examines the availability and exchange of resources (which can be tangible like goods and services or intangible like information or influence) between individuals, organisations or institutions who are referred to as actors (Haythornthwaite, 1996). The type of information actors in a social network are exposed to is determined by their position in the network structure.

Network structures are usually presented in graphical form and can be compared to physical networks such as roads. The structure of roads represents the flow of resources between places and access to roads and other transport routes determines how connected a town/village is to other cities. Similarly, relationships represent the flow of resources in a social environment and the position of actors determines what resources flow to and from them (Haythornthwaite, 1996).

2.1.2. CO AUTHORSHIP NETWORKS
Collaboration amongst researchers in various fields in form of co-authorship is on the rise. Scientific papers written by more than one author were not common during the first half of the twentieth century (Acedo et al, 2006) for instance in 1950, only 6% of articles in journal of political economy (JPE) and 8% of articles in American Economic Review (AER) were co-authored, as research articles were mostly written by single authors. This rate increased to 39.6% in JPE and 54.9% in AER by 1993 (Hudson,
1996). This trend originated in, and continues to be most closely associated with the natural sciences (Biagoli and Galison, 2002), but has been on the rise in the social sciences also (Laband and Tollison, 2000). This was further proved by Laband and Tollison (2000) who discovered that both the incidence of co-authorship (proportion of articles with multiple authors) and the extent of co-authorship (the average number of authors of co-authored articles) were higher in natural sciences than in social sciences.

As a result, co-authorship has been studied in different fields and through different perspectives ranging from the reasons why authors collaborate, why the trend is increasing, if it has any impact on the quality of articles, if it increases the chances of acceptability of an article amongst others. These collaborations can be formal (joint papers, guidance of doctoral dissertations, and participation in research groups) or informal (comments of colleagues, reviewers and editors) (Laband and Tollison, 2000).

Over the years, various reasons have been identified leading to an increase in co-authorship by researchers both within a particular field, geographical location and work place and between different fields, geographical locations and work places. Factors determining the increase in co-authorship can be general (those affecting all fields) and/or specific (those affecting particular fields) (Acedo et al, 2006). General reasons include increased specialization within science and a process of division of labour as a result of the continual expansion of the stock of knowledge (Acedo et al, 2006). Furthermore, the growing number of scientists in all disciplines increases the likelihood of finding suitable collaborators for research (Hudson, 1996). Moreover, improved methods of communication due to technological advancement have facilitated easier communication among geographically separated scientists, giving them a large pool of researchers to work with. Hudson (1996) opined that the more individuals a researcher has to choose from as potential collaborators, the greater is the probability of finding someone with whom to strike up an effective working relationship, though this may also result in a more complex screening process. Specific reasons include increased technical nature of the disciplines as different studies point out that disciplines or specializations with a higher quantitative content, have a greater propensity for co-authored papers (Acedo et al, 2006). What is more, interdisciplinary research requires interaction between specialists from various fields, thus increasing the incidence of co-authorship (Hudson, 1996). In the natural sciences, the shared use of laboratories and
expensive equipment by research teams produces a greater extent of co-authorship (Acedo et al, 2006).

Barnett et al. (1988) hypothesised some reasons for the increase in co-authorship in the field of economics. They include:

**Division of labour**: growth in stock of knowledge has led to an increase in the market demand of researchers’ talent. This has caused researchers to specialise in narrowly defined areas as a result it has become increasingly necessary to combine the skills of two or more researchers in a research project.

**Opportunity cost of time**: as a result of growth in information, it has become very important for economists to keep up and publication output is used as a yardstick for measuring researcher’s productivity. The upshot of the above tendencies is that the opportunity cost of time of the typical member of the profession has increased. This has caused an increase in the supply price of potential reviewers and the equilibrium price of obtaining a conscientious review. Since monetary rewards for reviews have not materialised yet, this increased price takes the form of co-authorship.

**Diversification**: this involves risk spreading by authors. The editorial review process contains a large random element as the paper might elicit a wide variety of response both favourable and unfavourable. Also the length of delay between submission and response is random. Consequently, an author faces uncertainty concerning the quality of the journal in which his/her work will be published in and the length of time to publication. A natural response therefore is to diversify the risk by co-authoring. In this way the author is able to increase the total number of papers submitted within a given period of time, thereby reducing the random element in the review process. The random element in the review process has grown and continues to grow over time because as research output increases, the workload of editors and reviewers also rise together with the diversification incentive in response to this.

Co-authorship creates a social network, the study of which allows us to understand the structure of scientific collaborations, some of the characteristics of a particular discipline and to identify the invisible colleagues and social groups that exist in all scientific fields and status of individual researchers (Acedo et al, 2006, Liu et al, 2005).
Social-network analysis allows an examination of collaborative relationships and editorial conduct from a sociological perspective (Moody, 2004).

Social network analysis has been used extensively to study co-authorship networks in different fields. Liu et al. (2005) studied co-authorship network in DLRC (digital library research community) using social network analysis, they modelled three approaches (binary undirected co-authorship networks, binary directed co-authorship networks and weighted directed co-authorship networks) and found out that author rank and page rank (another technique which can be used for network analysis) were more important than degree, closeness and betweenness centrality measures. Francisco et al. (2006) using social network analysis studied the social structures that can be identified in co-authorship in management and organisational studies, they found a non-linear growing trend towards co-authorship in management studies and that co-authored papers are more likely to be lengthier. He also found that there was a growing tendency towards collaboration in areas in which the advance of knowledge was most rapid and costly. Glänzel and Schubert (2001) studied the citation impact of international and national co-authored papers in the field of chemistry using social network analysis and found out that international co-authored papers results in publications with higher citation impact than purely domestic (national) co-authored papers but there is no correlation between the strength of co-authorship and the relative citation eminence of the resulting publications.

Many researchers have opined that co-authored papers are of better quality than single authored papers. Hudson (1996) describes co-authorship as the participation of two or more authors in the production of a study which leads to a scientific output of a greater quality or quantity than could be achieved by a single individual. Achieving scientific output of increased quality and quantity is one of the reasons for the rising trend in co-authorship (Acedo et al. 2006), this argument stems from the fact that as a result of the rise in the complexity of all disciplines, it becomes necessary to combine the skills of two or more researchers who are specialist in their various fields to improve output quality. Fox and Faver (1984) assert that “working with others, can create a social context and reality for the research which allows for better assessment of the project and higher quality research”. Pelz and Andrews (1976) gives varieties of ways through which collaboration enhances the quality of a research. One of them is by providing new ideas, another is that there is a possibility of a colleague catching an error which
the original researcher might not notice and yet another is it serves to keep a person on his toes—like. . . running a test the way it should be done. . . ’’. However, studies have yielded contradictory results. The importance of an article is measured by the number of times it has been cited by the scientific community since its publication. The use of citation is legitimate as citations can occur without authors knowing each other and can span across time (Liu et al, 2005, Medoff, 2003). Citation provides a measure of past or present influence of the work and in all is assumed to indicate the scientific utility of any paper which can also indicate the quality of the paper (Acedo et al, 2006). Citation counts have been found to be highly correlated with numerous measures of quality such as prestige of awards, awards of distinction, predicting future noble prize winners (Medoff, 2003).

Barnett et al. (1988) in testing various hypotheses for the rising trend in co-authorship did not find any evidence supporting the enhanced research quality hypothesis. Similarly, Medoff (2003), after controlling for article length, journal and author quality, and subject area, found that collaboration did not result in significantly higher quality research.

Medoff (2003) also found that collaboration did not always lead to increase in research quality and gave some reasons/explanations for this which include:

1. The possibility of authors to shirk and avoid taking responsibility for the contents of the research. This would not be possible if it was a sole author because his reputation is at stake. There is also a tendency for some researchers to free ride on the contribution of others little or insignificant contribution to the research, this may increase the output but not necessarily the quality of the paper.

2. Self-selection bias, a situation whereby researchers see collaboration as an opportunity to alleviate academic isolation since it offers opportunities for friendship. This may not be the optimal method of selecting a collaborator if the desired outcome is high quality research (Medoff, 2003).

3. Another possibility is that the decision to collaborate may be endogenous and based on the quality of the research. A research might decide to work on high quality research alone and collaborate with others on lesser quality research or vice versa.
2.1.3. CO-CITATION NETWORKS
Citations are also a kind of network. They show linkages between papers with some important content in common (Hummon and Doreian, 1989). Contrary to co-authorship networks however, authors don’t need to know each other before they can cite their works (Liu et al, 2005) - what matters is the relevance of the work to the author who wants to cite it. Citation networks are also referred to as information link graphs (Lehmann et al. 2008) or “frozen footprints in the landscape of scholarly achievement which bear witness to the message of ideas” (Cronin, 1981). Citation networks make it possible to map out the intellectual content of a field and demarcate their boundaries and also study interaction between fields (Hummon and Doreian, 1989). This makes it possible to study the historical account of development and trends of research and thoughts in particular and/or various fields. A citation (whether used in a positive or negative sense) is a measure of the significance allocated to the reference or its author. It is taken to be a valuable and reliable indicator of scientific communication and can be a basis for identifying “invisible colleges” (research networks that refer to each other in their documents without being linked by formal organisational ties. They are also known as “informal networks”) (Price, 1965, Culnan, 1987)

Co-citation analysis studies structures of scientific research, based upon citations and co-citations. It enables researchers identify groups of scientists and their publications and to draw conclusions about the inner structure of research disciplines, schools and paradigms (Gmur, 2003). Co-citation occurs when more than one reference or author appear in the same bibliography (Gmur, 2003, Culnan, 1987). Thus, it is a measure of the similarity of content of the references or authors. The proximity of any two publications in terms of content is determined by the number of co-citations.

Co citation analysis is a form of bibliometrics or quantitative bibliography which generally involves counting citations to other publications in a body of literature and developing statistical distributions with these counts (Culnan, 1987). Citation counts only give an idea of “who cites whom” but can’t identify networks of interconnections amongst scholars (Usdiken and Pasadeos, 1995). This is where citation analysis comes in. It is a document coupling technique which measures the number of documents that have cited any given pair of documents (Culnan, 1986).
Citation networks document citing behaviour through scholarly publications where authors are represented by nodes and a link represents the citing of one author by another (Lehmann et al, 2008). A co-citation network is created by drawing a link/line between two documents if they are cited together in a number of other documents. The strength of the co-citation depends on the number of sources which cites both documents and this can be represented by the varying number of lines linking the two documents (Usdiken and Pasadeos, 1995). Co-citation networks are useful for representing linkages amongst a number of authors or published works. These networks help assess a field’s cumulative tradition and reference disciplines at the level of an individual author or document (Culnan, 1986). They may reveal the patterns of a group consensus are good visual representations of schools of thought and can reveal “invisible colleges” and informal communications relations amongst scholars who share a common interest (Lievrouw, 1989). They are also helpful in detecting shifts in group consensus and schools of thought (Usdiken and Pasadeos, 1995).

2.2 METHODOLOGY
Social network analysis focuses on the relationship between social entities. This paradigm has gained recognition in general social and behavioural science communities as the theoretical basis for examining social structures and has been convincingly applied to substantive problems (Wasserman, 2005). The focus of these methods is the analysis of relational data measured on groups of social actors (in this case authors) using graph theory to study actor relations and interactions, locational properties such as centrality measures, prominence, prestige and so on.

Notation and core concepts of social network analysis
Social network analysts have developed various specialised jargon and notations to describe the concept of social network analysis, much of this is borrowed from graph theory and network structures and can be described in a graphical or matrix form (Haythornthwaite, 1996). A typical social network structure consists of nodes and ties. Nodes are the individual actors/organisations within the networks, and ties are the relationships between the actors (Passmore, 2011). There can be many kinds of ties between nodes if the actor has several relationships with other members of the network. Social network analysts typically study either whole networks or personal/egocentric
networks. Whole networks (also known as complete networks), describes the ties that all members of an environment maintain with all others in that environment, while egocentric networks provide a view of the network from the perspective of an actor in the network (Haythornthwaite, 1996). Egocentric networks show how many and what type of ties an individual actor has with others in the network. This approach is particularly useful when the population is large, or the boundaries of the population are hard to define whole networks (Passmore, 2011). Metrics (measures) used in social network analysis are:

**Centrality:** This includes measures like "Betweenness", "Closeness", and "Degree". It gives an indication of the social power of a node based on how well they connect the network. It focuses on how close an individual is to other individuals.

**Isolate:** This is a direct opposite of centrality and refers to an actor with no connections to others in the particular network (Haythornthwaite, 1996)

**Betweenness:** This is the extent to which a node lies between other nodes in the network. It takes into account the connectivity of the node's neighbours and gives a higher value for nodes which bridge clusters. The measure reflects the number of people who a person is connecting indirectly through their direct links. (Passmore, 2011)

**Degree centrality:** this is the total number of edges related to a node (Wassermann and Faust, 1994).

**Closeness centrality:** this refers to how close a node is to other nodes, its shortest path distance to all authors (Wassermann and Faust, 1994)

**Bridge:** An edge is said to be a bridge if deleting it would cause its endpoints to lie in different components of a graph.

**Local bridge:** An edge is a local bridge if its endpoints share no common neighbours. Unlike a bridge, a local bridge is contained in a cycle.

**Centralization:** measures the extent to which a set of actors are organized around a central point (Haythornthwaite, 1996).
Clustering coefficient: measures the likelihood that two associates of a node are associates themselves. A subgroup of highly connected actors is referred to as a “cluster”. A higher clustering coefficient indicates a greater 'cliquishness' (Haythornthwaite, 1996, Passmore, 2011)

Clique: Groups are identified as ‘cliques’ if every individual is directly tied to every other individual. Within cliques, members can reach each other directly in one step without going through an intermediary (Haythornthwaite, 1996, Passmore, 2011).

Density: can be divided into individual-level and global-level density. The former is the degree a respondent's ties know one another/ proportion of ties among an individual's nominees while the latter is the proportion of ties in a network relative to the total number possible (sparse versus dense networks) (Passmore, 2011).

Flow betweenness centrality: The degree that a node contributes to sum of maximum flow between all pairs of nodes (not that node) (Passmore, 2011).

Eigenvector centrality: measures the importance of a node in a network by assigning relative scores to all nodes in the network based on the principle that connections to nodes having a high score contribute more to the score of the node in question (Passmore, 2011).

Path length: is the distance between pairs of nodes in the network. Average path-length is the average of these distances between all pairs of nodes (Passmore, 2011).

Prominence: indicates which actor or actors have influence or power in a network, and “who is more or less in demand” (Nohria, 1992).

Radiality: Degree an individual’s network reaches out into the network and provides novel information and influence (Passmore, 2011).

Structural cohesion: The minimum number of members who, if removed from a group, would disconnect the group (Passmore, 2011).

Structural equivalence: Refers to the extent to which nodes have a common set of linkages to other nodes in the system in essence grouping actors according to similarity in relations with others (Haythornthwaite, 1996).
**Structural hole:** Static holes that can be strategically filled by connecting one or more links to link together other points (Passmore, 2011).

**Range:** indicates the extent of an actor’s network (Burt, 1992, Nohria, 1992).

**Brokerage:** indicates bridging connections to other networks (Burt, 1992, Nohria, 1992).

Co-authorship analysis involves identifying the status of an author using centrality measures. Degree centrality of an author identifies the number of edges (connections with other authors) related to it. Thus, it represents how many connections an author has with his/her direct neighbours. If an author is part of a scientific clique, the overall centrality can be low. This brings about closeness centrality which focuses on how close an author is to all other authors, that is the author’s shortest path distances to all other authors. The central author has many short connections to other authors. Betweenness centrality identifies the regularity of a node on the shortest path between any pair of nodes in the network (Passmore, 2011, Wasserman and Faust, 1994).

Citation analysis focuses on published citation as a unit of its analysis and uses that to identify and describe citation networks between authors. Citation studies can broadly be grouped into two categories: those measuring prominence or importance of journals and publications and those analysing citation networks structure (Hummon and Doreian, 1989). Connections are established by coding the works as to year, type of study, type of publication and author (Usdiken and Pasadeos, 1995).

Pagerank is another method which can be used to analyse co-authorship and co-citation networks apart from centrality measures (Liu et al. 2005). It defines prestige by modelling inherited or transferred status. If a page has some important incoming links to it, then its outgoing links also become important (Sharma et al. 2010). It propagates ranking through links, thus, a page has a high rank if the sum of the ranks of its backlinks is high. This applies both to cases where a page has many backlinks and few highly ranked backlinks (Liu et al. 2005, Page et al. 1999). It helps to obtain a good approximation to importance just from link structure. Pageranking is immune to manipulation as a page can only get a high rank if it convinces an important or lots of non-important pages to link to it (Page et al. 1999). It also predicts future citation counts better than citation counts. This is because it avoids the local maxima that
citation counting gets stuck in and gives preference to highly cited pages and it's children as well as is a good way to help find representative pages to display for a cluster centre (Page et al. 1999).

In unidirectional co-authorship graph, pagerank can be used by transforming each unidirectional edge into a set of two directional asymmetrical edges. This, however, results in a reduction in edge weight and loss of severe information, so a modified page ranking called “author ranking” considering link weights is introduced (Liu et al. 2005). It is based on the assumption that a node transfers its pagerank values evenly to all nodes it connects to (Liu et al. 2005) and takes into account that inlinks from highly ranked authors are more important than inlinks from authors with low rank (Radicchi et al. 2009). Pagerank and authorank can be used to evaluate research impact and provide objective measures of the importance of journals, papers, programs, people, disciplines, social interactions/networks amongst others (Radicchi et al. 2009).

**GEPHI SOFTWARE**

Gephi is an interactive visualization and exploration platform for all kinds of networks and complex systems, dynamic and hierarchical graphs. It is a tool which helps to explore and understand data graphs by assisting data analysts to make hypothesis, intuitively discover patterns, isolate structure singularities or faults in data.

Some applications of Gephi are:

Link analysis: reveals the underlying structures of associations between objects, in particular in scale-free networks.

Social Network Analysis: easy creation of social data connectors to map community organizations and small-world networks.

Biological Network analysis: representing patterns of biological data.

Poster creation: scientific work promotion with hi-quality printable maps.

It also analyses network metrics like centrality, path density, clustering coefficient, modularity, diameter etc.
CHAPTER THREE

DATA SOURCES AND DESCRIPTION

3.1 THE SAMPLE
The sample was collected in two steps. First, 17 peer reviewed journals were selected using Cramon-Taubadel and Nivyevskyi (2012)’s guide and suggestions from colleagues. The list consist of eight agricultural economics journals that are in the journal citation reports produced by ISI (Agricultural Economics, American Journal of Agricultural Economics, Canadian Journal of Agricultural Economics, European Review of Agricultural Economics, Food Policy, Journal of Agricultural Economics, Journal of Agricultural and Resource Economics and Review of Agricultural Economics) and the others are agricultural economics journals that have broad circulation (Agribusiness, International Food and Agribusiness Management Review, Journal of International Agricultural Trade and Development, Post-Communist Economies, The World Economy, Quarterly Journal of International Agriculture and World Development) and two journals that cover transition economics (Eastern European Economics and Economics of Transition). Only journals written in English language were included to make coding and evaluating more accurate and easier. The journals considered are a good representation of internationally acclaimed journals amongst agricultural economists.

All articles published from January 1990- December 2013 on CEE agricultural transition in these journals were reviewed.

Secondly, the references of these articles were searched for other relevant articles published in other journals.

The criteria guiding the selection and inclusion of articles are:

1. Topics: Articles which considered any area relating to agricultural transition and agri-food sector in any CEE country.
2. CEE in focus: the only countries considered were CEE countries. Former Soviet Union and other countries are not included.
3. References: only published articles with references were included.
4. High scientific standards: only articles from journals published in Thomson Reuters Journal citation reports were considered. Book reviews, books, comments, discussions, reflections, presentations, reports, seminars, conference materials were not included.

3.2 DATA PREPARATION AND PRELIMINARY ANALYSIS

DESCRIPTIVE STATISTICS

Figure 3.1 shows the number of articles selected published per journal from 1990-2013. The majority of the articles (68%) were published in six journals: Post-Communist Economies (PCE), American Journal of Agricultural Economics (AJAE), Food Policy (FP), European Review of Agricultural Economics (ERAE), Eastern European Economics (EEE) and Agricultural Economics (AE) with Post-Communist Economies having the highest number of publications (32, 13.5%) in the sample.
Figure 3.1. Number of articles on CEE agricultural transition per journal from 1990-2013.

*The numbers represent journals (table in the appendix)*

Source: own calculations
Figure 3.2 shows the number of articles published per year from 1990-2013. Research on agricultural transition increased from the 90s and peaked in 1999 when twenty-one articles were published on the topic. A decline followed for a while and an increase is seen again from 2004 as a result of the Eastern enlargement of the European Union from 2004 and 2007 accessions. By 2013, the issue of transition was not so popular anymore as only two articles on the topic were published in Post-Communist Economies.

**Figure 3.2. Articles on CEE agricultural transition per year from 1990-2013**

Source: Own calculations

The 238 articles selected were written by 564 authors (when counted with repetition), which gives an average of 2.4 authors per article. There is an increase in collaboration from 1.5 authors per article in 1990 to 2 authors per article in 2013. This is in line with literature (Acedo et al 2006). Without repetition, the number of authors is 277 as many authors have written more than one paper. This gives an average of 0.86 publications for an average author per year.
Figure 3.3 Articles and authors by year, 1990-2013 (%)

Source: Own calculations

Figure 3.4 shows the authors’ distribution by country. We see that US has the highest number of authors followed by other Western European countries (UK, Belgium and Germany). Hungary has the highest number of authors amongst other CEE countries, though it is the lowest when compared to the other top countries. On the whole, the top 5 countries make up 61% of the authors.
Figure 3.4: Distribution of authors by country

Others are countries with less than 10 authors.

Source: Own composition.
There have also been changes in collaboration patterns over time. In the 1990’s, CEE agricultural economists mostly worked with their Western-European colleagues but by the end of the period, CEE researchers mostly worked together. What is also noticeable is that after the EU accession, collaboration of CEE researchers with colleagues outside Europe was non-existent. Western European researchers, however, have been major co-authors with CEE researchers within the period analysed.

**Figure 3.5. Collaboration by region, 1993-2013, (%)**.

No collaborations existed before 1993.

Source: own calculations
The papers were grouped into ten broad topics following Cramon and Nivyevskiy’s (2012) groups and own discretion. The most important topic covered was Integration/Transition/EU accession (27%), followed by Agricultural policy and reforms (14%), closely followed by trade/prices and competitiveness (13%) and land and farm issues (12%). These four topics gave 66% of the sample. Other topics covered less than 10% of the sample.

Figure 3.6 shows changes in article topics during the period. From the figure we notice changing trends in topics analysed. Integration/transition/EU accession was popular in the 90’s and early 2000’s after the EU accession. However, its relevance seems to have decreased over time. Agricultural policy/reforms were also popular in the 90s (transition period) and 2000s but its relevance decreased significantly afterwards. Land and farm issues were popular almost throughout the period especially in the early 2000s where its popularity increased while trade/prices and competitiveness were spread throughout the study period.
Figure 3.6. Changes in topics of articles, 1990-2013, (%)

Source: own calculations
Majority of the research articles covered the CEE region as a whole while some looked at individual countries (Figure 7). CEE as a region had the highest coverage (38%), followed by research on Poland (14%) and FSU (10%).

**Figure 3.7: Countries/region covered**

Source: own calculations
CHAPTER FOUR
RESULTS AND DISCUSSION

4.1. CO-AUTHORSHIP NETWORKS: WHO PUBLISHES WITH WHOM?
Authors with the highest number of publications are shown in Table 1. The top ten authors published 123 articles out of the total 238, suggesting a high level concentration (52%) and an average of 2 articles per author amongst the top ten indicating that a small number of authors are writing the majority of the articles. Swinnen was the author with the highest number of articles (28), followed by Davidova with 15, Ferto and Gorton with 14 each and Bojnec with 13.

Table 4.1: Top 10 authors and centrality measures.

<table>
<thead>
<tr>
<th>Number of articles</th>
<th>Degree centrality</th>
<th>Betweenness centrality</th>
<th>Closeness centrality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Score</td>
<td>Author</td>
<td>Score</td>
</tr>
<tr>
<td>Swinnen, JFM</td>
<td>28</td>
<td>Gorton, M</td>
<td>25</td>
</tr>
<tr>
<td>Davidova, S</td>
<td>15</td>
<td>Mathijs, E</td>
<td>15</td>
</tr>
<tr>
<td>Fertő, I</td>
<td>14</td>
<td>Davidova, S</td>
<td>14</td>
</tr>
<tr>
<td>Gorton, M</td>
<td>14</td>
<td>Swinnen, JFM</td>
<td>12</td>
</tr>
<tr>
<td>Bojnec, S</td>
<td>13</td>
<td>Fogarasi, J</td>
<td>11</td>
</tr>
<tr>
<td>Dries, L</td>
<td>9</td>
<td>Erjavec, E</td>
<td>10</td>
</tr>
<tr>
<td>Latruffe, L</td>
<td>8</td>
<td>Fuller, FH</td>
<td>10</td>
</tr>
<tr>
<td>Mathijs, E</td>
<td>8</td>
<td>Beghin, JC</td>
<td>10</td>
</tr>
</tbody>
</table>
Based on the centrality measures, we notice that those publishing the most are not necessarily the most important in terms of the network as the centrality measures give us a different list of authors. From the degree centrality, we notice that Gorton, Mathijs and Davidova published with the most co-authors respectively. This implies that Gorton has worked with more co-authors than all the others. Notice that Swinnen who has the highest number of articles published is missing from the top three authors when degree centrality is considered. Gorton’s degree centrality value is more than double that of Swinnen while Swinnen wrote twice as many articles as Gorton. Mathijs has a high degree centrality value (15) almost double the number of articles he published. This indicates that he published with many co-authors.

Gorton again has the highest value for betweenness centrality. This implies he has the highest bridging role, which means he could be reached the easiest if taking pairwise relationships between authors into consideration. It also suggests that he acted as a “central hub” in working with others. Other authors with high betweenness centrality are Latruffe and Fogarasi, implying that they also had a high bridging role. Notice that Fogarasi is not amongst the top ten authors, implying that he published a few articles with authors in different cliques (see table two for cliques) acting as a connection between various cliques and Swinnen is missing from the top ten authors when betweenness centrality is considered implying that he published mostly with authors from his clique.

As for closeness centrality, Swinnen leads, followed by Gow and Dries. This suggests that they were the easiest to be reached by other authors. Notice that Gorton, irrespective of his high betweenness and degree centrality measures, is missing from this list. This implies he had fewer but a stable list of co-authors.

All this suggests that the number of articles published is not in line with the centrality of authors as expected. Some authors publish a lot with few co-authors while others publish few articles with a wide range of co-authors.

<table>
<thead>
<tr>
<th>Bakuc, LZ</th>
<th>7</th>
<th>Fabiosa, JF</th>
<th>10</th>
<th>Lingard, J</th>
<th>373</th>
<th>Fertő, I</th>
<th>3.53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Csáki, Cs</td>
<td>7</td>
<td>Dries, L</td>
<td>8</td>
<td>Falkowski, J</td>
<td>336</td>
<td>Bakuc, LZ</td>
<td>3.53</td>
</tr>
</tbody>
</table>

Source: own composition by Gephi.
Figure 4.1 gives a graphical representation of the co-authorship network.

Figure 4.1: Graphical illustration of the co-authorship network

Source: Own composition using Gephi
From the figure above we can see the extent of the relationships between the authors. The thickness of the links represents the strength of the relationship. We see that the relationship between Gorton and Davidova is the strongest. We also clearly see the hub functions of Gorton, Mathijs, Swinnen and Davidova and that we have two big cliques. Notice that a lot of groups do not have any links or have loose links with the biggest cliques. Latruffe seems to be the major intermediary/connection between the two largest scientific cliques. This corresponds with her high betweenness centrality value as shown in Table 4.1.

Numerous “cliques” can also be observed in the author sample. Almost half of the authors worked in a clique consisting of at least three researchers and only 10% of the authors were part of the two largest cliques suggesting a high concentration and high barriers for entry into these cliques. This also points out that collaborations amongst cliques are not commonplace.

Table 4.2: Members of the six largest cliques in the network.

<table>
<thead>
<tr>
<th>Clique 1</th>
<th>Clique 2</th>
<th>Clique 3</th>
<th>Clique 4</th>
<th>Clique 5</th>
<th>Clique 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gorton, M</td>
<td>Falkowski, J</td>
<td>Erjavec, E</td>
<td>Fogarasi, J</td>
<td>Lingard, J</td>
<td>Brooks, K</td>
</tr>
<tr>
<td>Latruffe, L</td>
<td>Swinnen, JFM</td>
<td>Turk, J</td>
<td>Mathijs, E</td>
<td>Ivanova, N</td>
<td>Braveman, A</td>
</tr>
<tr>
<td>Davidova, S</td>
<td>Bakucs, LZ</td>
<td>Majkovic, D</td>
<td>Sarris, A</td>
<td>Hubbard, LJ</td>
<td>Guasch, JL</td>
</tr>
<tr>
<td>Zawalinska, K</td>
<td>Fertő, I</td>
<td>Mergos, G</td>
<td>Doucha, T</td>
<td>Szymanski, A</td>
<td>Csaki, Cs</td>
</tr>
<tr>
<td>Banse, M</td>
<td>Dries, L</td>
<td>Stoforos, C</td>
<td>Deininger, K</td>
<td>Zaharieva, E</td>
<td>Lerman, Z</td>
</tr>
<tr>
<td>Balcombe, K</td>
<td>Gow, HR</td>
<td>Rednak, M</td>
<td>Savastano, S</td>
<td>Hubbard, C</td>
<td>Kislev, Y</td>
</tr>
<tr>
<td>Bailey, A</td>
<td>Bojnec, S</td>
<td>Volk, T</td>
<td>Blaas, G</td>
<td>Webster,</td>
<td>Biton, D</td>
</tr>
</tbody>
</table>
Only cliques where authors have published more than once together are published.

Source: Own composition.

From the table above, one can notice that the six largest cliques have not less than nine authors each. Only 93 authors which makes 34% of the author sample was part of these cliques, implying that researchers are working in smaller groups and also buttressing the opinion that the cliques are difficult to penetrate. The largest clique consists of twenty-two
authors while the smallest consists of nine authors. Another thing worth pointing out is the fact that 40% of the articles were written by the two largest cliques and 60% were written by the six largest cliques also buttressing the suggestion of high knowledge concentration and capacity.

4.2 CO–CITATION NETWORKS

The co-citation networks are also interesting to look at and analyse for a better understanding of the relationships. This stems from the logic that it is as important to have good citations to publish papers with colleagues.

From the 238 articles sampled we gathered 1983 citations which give an average of 8 citations per article. 509 out of these citations were original articles of the sample. This implies that 18% of the total citations were inner citations and this gives an average of two inner citations per article.

On table 4.3 we list the top ten most cited articles.

Table 4.3. TOP 10 cited articles in the sample with pagerank scores

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Year</th>
<th>Journal</th>
<th>Citations received</th>
<th>Pagerank score</th>
<th>Article number in Figure 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gow, HR. – Swinnen, JFM</td>
<td>Up- and downstream restructuring, foreign direct investment, and hold-up problems in agricultural transition</td>
<td>1998</td>
<td>ERAE</td>
<td>11</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Brümmer, B.</td>
<td>Estimating confidence intervals for technical efficiency: the case of private farms in Slovenia</td>
<td>2001</td>
<td>ERAE</td>
<td>10</td>
<td>7</td>
<td>298</td>
</tr>
<tr>
<td>Sarris, A. – Doucha, T. – Mathijs, E.</td>
<td>Agricultural restructuring in central and eastern Europe: implications for competitiveness and rural development</td>
<td>1999</td>
<td>ERAE</td>
<td>9</td>
<td>2</td>
<td>132</td>
</tr>
<tr>
<td>Mathijs, E. – Swinnen, JFM</td>
<td>The economics of agricultural decollectivization in East Central Europe and the Former Soviet Union</td>
<td>1998</td>
<td>EDCC</td>
<td>8</td>
<td>3</td>
<td>249</td>
</tr>
<tr>
<td>Tangerman n, S.</td>
<td>Aspects of integration between Western and Eastern Europe: West looks East</td>
<td>1994</td>
<td>ERAE</td>
<td>8</td>
<td>9</td>
<td>274</td>
</tr>
<tr>
<td>Munroe, D.</td>
<td>Economic efficiency in Polish peasant farming: an international perspective</td>
<td>2001</td>
<td>Regional Studies</td>
<td>8</td>
<td>8</td>
<td>306</td>
</tr>
<tr>
<td>Brooks, J.</td>
<td>Agriculture and the transition to the market</td>
<td>1991</td>
<td>JEP</td>
<td>7</td>
<td>4</td>
<td>169</td>
</tr>
<tr>
<td>Mathijs-Blaas-Doucha</td>
<td>Organisational form and technical efficiency of Czech and Slovak farms</td>
<td>1999</td>
<td>MOCT-MOST</td>
<td>5</td>
<td>10</td>
<td>713.</td>
</tr>
</tbody>
</table>

Source: Own composition
From Table 4.3, we can see that the top three cited articles were published in the European Review of Agricultural Economics (ERAE) with at least nine citations per article. Another issue worth pointing out is that from the pagerank scores we notice that the number of citations an article receives is not equal to the importance of the citation, which implies that who cites an article matters. Looking at the citations through this phenomenon changes the list of the most important cited articles. Either way (top cited or pagerank scores), the most important articles are from the second and fourth cliques in Table 4.2. Swinnen’s central role is visible both in the top cited and top ranked articles, though none of them were written by him alone. Also, the top cited articles were written before 2004 EU accession which suggests that they acted as a basis of knowledge for the articles written after them.

It is also important to see citations from the point of view of the authors. The authors who published the most seem to be the most cited authors. Table 4.4. shows the top 10 most cited authors.

**Table 4.4: TOP 10 cited authors in the sample with citation rates**

<table>
<thead>
<tr>
<th>Author</th>
<th>Number of authors citing</th>
<th>Number of citations received</th>
<th>Average citation per article</th>
<th>Average citation per author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swinnen, JFM</td>
<td>83</td>
<td>155</td>
<td>1.39</td>
<td>1.87</td>
</tr>
<tr>
<td>Mathijs, E</td>
<td>42</td>
<td>83</td>
<td>1.48</td>
<td>1.98</td>
</tr>
<tr>
<td>Davidova, S</td>
<td>28</td>
<td>38</td>
<td>1.31</td>
<td>1.36</td>
</tr>
<tr>
<td>Gow, HR</td>
<td>27</td>
<td>49</td>
<td>1.20</td>
<td>1.81</td>
</tr>
<tr>
<td>Gorton, M</td>
<td>27</td>
<td>43</td>
<td>1.47</td>
<td>1.59</td>
</tr>
<tr>
<td>Csáki, Cs</td>
<td>27</td>
<td>34</td>
<td>1.06</td>
<td>1.26</td>
</tr>
<tr>
<td>Lerman, Z</td>
<td>26</td>
<td>33</td>
<td>1.18</td>
<td>1.27</td>
</tr>
<tr>
<td>Doucha, T</td>
<td>20</td>
<td>26</td>
<td>1.17</td>
<td>1.30</td>
</tr>
<tr>
<td>Brooks, K</td>
<td>19</td>
<td>23</td>
<td>1.08</td>
<td>1.21</td>
</tr>
<tr>
<td>Brümmer, B</td>
<td>15</td>
<td>32</td>
<td>1.09</td>
<td>2.13</td>
</tr>
</tbody>
</table>

Source: Own composition
It is evident from Table 4.4. that Swinnen, Mathijs and Davidova are the three top cited authors and they are also among the top ten authors with the most published articles. Swinnen alone has about twice as much citations as Mathijs who is the second most cited author. Average citation per article, however, is highest for Mathijs while average citation per author was highest for Brummer, implying he was cited the most by a single author. Notice that the top 10 authors are all members of a scientific clique.

Figure 4.2 shows the co-citation network for the authors. From the figure, we see that Swinnen is at the core of this network which is expected as he is the most cited author. From the strength of the lines, we can also notice that members of the biggest cliques cite Swinnen more, while within cliques, members cite themselves more than the average. Authors not citing major authors mostly don’t belong to the largest cliques.
Last but not least, citation by article is analysed as evident from Figure 4.3. The articles have been numbered from 1-1983.
By analysing co-citation networks by article, further patterns of our social network become apparent (Figure 4.3). It is evident that those citing leading authors have more central
positions than those citing marginal authors. This implies that leaders cite leaders more often. This can be either because they know their works better and/or because of scientific traditions.

Furthermore, according to the pagerank method, who cites an article is very important as citations received by leading authors have more value. Another interesting point here to note is that articles with the highest number of citations (indicated by ellipses in Figure 4.3) are relatively located far from the centre, meaning that authors retain their marginal position if they don’t cite their leading colleagues. Finally, we see the role of cliques in citation as all the most cited articles were written by members of scientific cliques and none of the marginal articles were written by big clique members.

4.3 RESULT DISCUSSION
The descriptive analysis done on the sample showed that:

- A few journals dominated the publishing sphere during the period analysed.
- There was an increase in collaboration during the period.
- Majority of the authors were from the US and some western European countries.
- Changes in collaboration patterns were observed overtime with Western European researchers being the major co-authors with their CEE colleagues.
- The most popular topics researched were Integration/Transition/EU accession, Agricultural policy and reforms, trade/prices and competitiveness, land and farm issues covering 66% of the sample.

As was expected, the results show that networks indeed exist among authors in this field and that the key players belong to “cliques”. Authors who do not belong to the largest cliques have few publications. This confirms the first hypothesis that majority of the articles were written by a small group of researchers which is in line with literature (Acedo et al., 2006)

Our second hypothesis, however, can be rejected as the results show that authors who publish the most do not necessarily play a central role in the co-authorship networks. Some
of them publish a lot of articles with the same people (those in their cliques) and have little or no connection with authors in other cliques. This implies that quantitative and qualitative indicators should not be compared directly.

The third hypothesis would be accepted as the result indicates that there is a correlation between co-authorship and co-citation. Authors who work together cite each other more than the average and this result is in line with literature (Fischbach et al., 2011).
CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This study analysed co-authorship and co-citation networks in CEE Agricultural Economics literature from 1990-2013. A sample of 238 articles from 17 peer reviewed Agricultural Economics journals was selected based on four criteria: topics, focus on CEE, references and high scientific standards. Using descriptive statistics, it was discovered that majority of the articles were published in a few journals, most of the authors were from USA and Western Europe and a few from CEE region even though the articles were about the region, collaboration increased overtime and Integration/Transition/EU accession, Agricultural policy and reforms, trade/prices and competitiveness, land and farm issues were the most researched topics.

Analyses of the co-authorship and co-citation network in the sample were done with the aid of Gephi. Results from the co-authorship analysis showed the existence of six large scientific cliques and that majority of the articles were written by a few researchers who belonged to these scientific cliques. Authors who do not belong to the largest cliques have few publications. The centrality measures revealed that authors who have the most publications do not necessarily play central roles in the network as some of them publish mostly with authors in their clique. Finally, results from the co-citation analysis show that the top three cited articles were published in European Review of Agricultural Economics (ERAE) with at least nine citations each. The most cited articles were not necessarily the most important as indicated by the pagerank score and the importance of an article was determined by who cited it. It also revealed that the most important and most cited articles were written by authors in the largest cliques indicating that authors who work together cite themselves more than the average and authors who do not cite major authors do not belong to the largest cliques and are left at the edges.
As a young researcher in the field of Agricultural Economics, I would make the following recommendations:

- It is important to publish with colleagues and not opt on being an island as publishing with others gives greater chances of having more publications and penetrating the network.
- To become a key player in this field, it is equally important to identify the major authors and try to work with them, otherwise one would remain at the edge of the networks as shown in Figure 4.1 where authors who do not publish with the major authors do not belong to the largest cliques and have few publications.
- Try to cite the major authors and articles as we can see from Figure 4.2 and 4.3 that those who do not cite the major authors or articles remain at the margins.

As to future research topics, it would be interesting to see if the results would be similar if a different time period is used. Another suggestion would be to select a popular agricultural economics journal like Food policy and make a similar analysis for all the articles. This would give a global view of co-authorship and co-citation networks in agricultural economics literature.

Finally, the work was associated many times to a table game when writing about these networks. It is evident that not everyone likes the rules of the game but only the best strategy results in winners. However, if one decides to play, s/he should get accustomed to the rules. I hope this study gives a better understanding on how this game looks like and hopefully helps more young agricultural economist to win his/her own game.
REFERENCES


Gephi.org – *About Gephi*.


## APPENDICES

### Appendix A. The sample of peer-reviewed journal articles selected (1990–2013)

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<td>2011</td>
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<td>2013</td>
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| TOTAL | 288 |

| 1990 | 3.361 |
| 1991 | 9.244 |
| 1992 | 10.084 |
| 1993 | 2.128 |
| 1994 | 8.824 |
| 1995 | 1.261 |
| 1996 | 9.244 |
| 1997 | 10.084 |
| 1998 | 4.622 |
| 1999 | 1.68 |
| 2000 | 1.68 |
| 2001 | 100.024 |
| 2002 | 3.361 |
| 2003 | 3.361 |
| 2004 | 3.361 |
| 2005 | 3.361 |
| 2006 | 3.361 |
| 2007 | 3.361 |
| 2008 | 3.361 |
| 2009 | 3.361 |
| 2010 | 3.361 |
| 2011 | 3.361 |
| 2012 | 3.361 |
| 2013 | 3.361 |
Appendix B: JOURNALS AND THEIR CORRESPONDING NUMBERS AS IN FIGURE 3.1.

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<td>ECON DEVT AND CULT CHANGE</td>
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