

# Interbank networks and the multilayer structure of economic-financial transactions

Proposal for joint doctoral fellowships in  
Economics and Network Science

## Area of research for the joint doctoral studies

The economy consists of a network of interactions: supplier-customer relationships, contracts, friendships. On the one hand, network science, which is par excellence interdisciplinary, provides tools and insights for economist to solve problems in economics and finance. Moreover, economics raises interesting questions for network scientists to consider.

The current proposal deals with *the multilayer structure of economic-financial transactions*. The entities are connected to each other within one layer (intra-layer links) and between the layers (inter-layer links). In the first layer, banks and other financial institutions interact with each other through loans, debt and ownership in a sophisticated manner producing a complex network of interdependence. In the second layer, companies interact in supplier-customer relationships. In the third layer, consumers are linked through personal interactions and social media, spreading information and rumours. All these three layers are linked: banks and firms through loans provided to firms, consumers buy the products of certain firms and also take loans from banks. Moreover, within each network layer, the relations are very heterogenous – simply consider the large variety of financial instruments within the banking layer, like securities and derivatives.

Recent experience has shown that this complex system is vulnerable: some local disturbance can spread through the whole system. It is of major interest to study how the different layers and interactions affect the stability of the whole. How do we map such a multilayer network in the first place? How do we model propagation? Which local disturbances spread and which do not? How can these insights guide the regulation of banks, industry and social media? These are fundamental questions of general interest.

The investigation involves both deep understanding of economics and finance as well as a good command of the tools of network science. Therefore, we believe that this is an ideal area for the CEU joint doctoral fellowships. The proposed approach uses the most recent development in both involved disciplines and their suggested novel combination is very promising. Results in this area are expected to have impact on policy making, especially in the form of regulatory advice. The present financial regulation system is rather *ad hoc* and there is much room for evidence based improvement.

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## Draft of the curriculum

According to the call for the joint doctoral fellowships we are planning for two candidates, one at CNS and one at DEB. The course work for the students will be constructed such that the students will fulfill all requirements of the program they will belong to and take courses from the other discipline as electives. The selection of the elective courses will be carried out under supervision, considering the student's background and interest.

a) Credit table of the PhD program in Network Science (CNS student)

First year: 28 credits

Mandatory courses	16 credits
<i>Elective and track courses</i>	<i>6 credits</i>
Proposal development	6 credits

Second Year: 32 credits

Research	26 credits
<i>Reading courses</i>	<i>4 credits</i>
Colloquium	2 credits

Third Year: 30 credits

Dissertation writing	28 credits
Colloquium	2 credits

<b>Total</b>	<b>90 credits</b>
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For the detailed program see the [handbook](#). The altogether 10 credits for *Elective and track courses* and *Reading courses* provide sufficient room for the necessary economics courses. The following course is mandatory:

- Economic and social networks (DEB cross-listed to CNS, 2 credits)

At least 8 credits have to be selected from the following list:

- Macroeconomic Theory I (DEB, 5 credits)
- Macroeconomic Theory II (DEB, 5 credits)
- Microeconomic Theory I (DEB, 5 credits)
- Microeconomic Theory II (DEB, 4 credits)
- Financial Economics (DEB, 4 credits)
- Introduction to Econometrics (DEB, 3 credits)
- Econometrics 2 (DEB, 5 credits)

b) Credit table for the PhD program in Economics (DEB student)

The student needs to achieve 120 credits to graduate, out of which at least 40 credits needs to be from PhD courses in Economics (or courses cross-listed to the Economics PhD program):

Mandatory courses	13 credits
<i>Elective Economics courses</i>	<i>27 credits</i>
<i>Optional additional courses</i>	<i>4 credits</i>

The detailed credit requirements can be found in the [doctoral regulation](#).

The network science courses will be inserted as electives into this scheme. The student will have to take the course

- Fundamental ideas in network science (CNS cross-listed to DEB, 4 credits)
- Economic and social networks (DEB, 2 credits)

and select courses for at least 4 credits from the following list:

- Structure and dynamics of networks (CNS, 2 credits)
- Agent based modeling (CNS, 2 credits)
- Data and Network Visualization (CNS, 2 credits)
- Introduction to Data Mining and Big Data Analytics (CNS cross-listed to DEB, 2 credits)
- Statistical Methods in Network Science and Data Analysis (CNS, 4 credits)
- Scientific Python (MATH cross-listed to DEB, 2 credits)

Out of the above courses 10 credits can be used towards the elective requirement, the others can be taken to fulfill the 4 optional course credit requirements.