Exploring Informative Scales of Labor Networks in Argentina

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Labor flows are a key factor explaining economic activity through the interplay of workers' supply and firms' employment demand in the labor market. Particularly, job-to-job transitions are relevant labor flows, with recognized pro-cyclical behavior [6] that carry tacit information about the relevance of past jobs' experience for new employers, specially those occurring between firms with different economic activities. Traditionally, economists analyze labor flows with data at high level of aggregation of the standard classifications of productive activities, in order to correlate it with conventional national accounts data of sectoral activity.

De Raco and Semeshenko [1, 2] studied inter-industry labor flows in Argentina from administrative data at high level of details (four digits of the ISIC[1] Rev.3 classification) using a network representation between economic sectors, and revealed that labor networks extracted are typically very dense, not sparse, with clear core-periphery structures, and present small-world properties.Although these microscale networks provide new and useful information, they also pose several challenges for their interpretation and applications in, for example, policy design and analysis.

Ensuing, Semeshenko and De Raco [3] inspect the evolution of the connectivity structure in (binary) labor flows networks at different scales of aggregation using standard classification aggregation schemes, and evidenced that more disaggregated data can bring insights into the evolution of the connectivity of the network. Data granularity defines the size of a network, which in turn determines its structure and functioning. Naturally, several questions and issues arise related to the granularity of the data. What is an adequate level of granularity providing enough information of sectoral aggregation that allows to characterize employment flows as well as the structure of inter-industrial relations? When is best to look for more detail in labor flows? What is the best informative scale of the network?

Finding an appropriate scale/size for a network can be made with different algorithmic techniques *via* two alternative schemes [4]: (a) by changing the observation scale, coarse-graining or grouping their nodes by a common attribute; or, (b) by keeping the observation scale through filtering or pruning edges by keeping only those meeting some specified criteria. In this work we search for an appropriate and informative scale of labor flows networks using the efficient entropy method [5]. The network is reduced using a measure called effective information which

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[1]The International Standard Industrial Classification of All Economic Activities (ISIC)

is a general measure for causal interactions because it uses perturbations to capture effectiveness of the mechanisms of the system in relation to the size of its state space. Networks with higher effective information contain more information in the ties between the nodes.

Data. We use administrative data of year-to-year private labor flows between economic activities at four digits (ISIC Rev.3 classification) between 1996 and 2020, provided by the Ministry of Labor, Employment and Social Security. After filtering out temporary employment agencies and other (13) economic activities for which there is no employment data available for the whole period, we use the remaining 287 economic activities, or sectors, for the analysis. Regarding labor flows, we focus on intersectoral labor flows that is to say we leave out the analysis of transitions occurring within the same sector. Using sectors as nodes and labor flows as edges, we build 24 interanual labor flows directed and weighted node-aligned networks.

Methods. Network analysis is typically performed on the full microscale representation of a network, and it can be extremely noisy and uninformative. Networks can have macroscales that can exhibit different network properties than their underlying microscales. The procedure to find informative macronodes is similar to community detection, is focused on subgraphs that have more in-group connectivity that out-group. The connectivity of a network contains information about the interactions between the nodes (sectors), their associations and dependencies. We use here the global network measure -effective information (entropy-based)- which measures the uncertainty contained in paths along nodes and links, and best captures the connectivity information of the network [5]. Using this technique, a network can be recast into a new one, wherein subgraphs of nodes are grouped into individual macronodes, reducing the size of the original network. These macronodes summarize the behavior of the subgraph in a manner that it increases the effective information in connectivity (causal emergence) of the network, when compared to the original network.

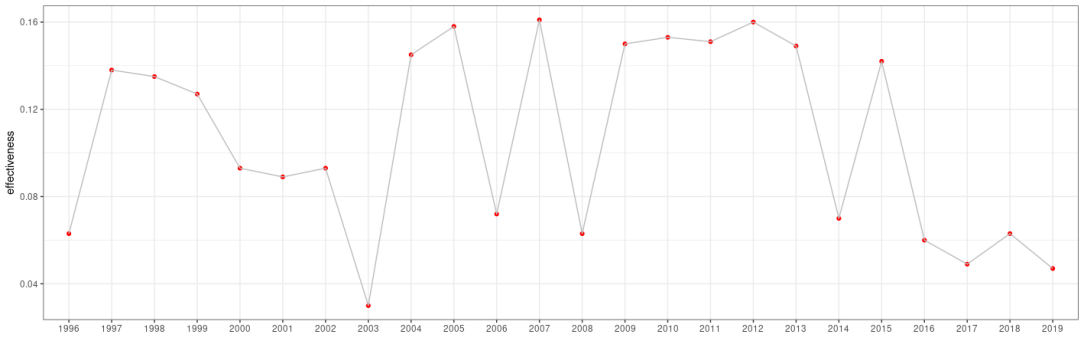

Figure 1: Effectiveness of the network 1996-2020. High effectiveness observed in periods of relative macroeconomic stability, low effectiveness in periods of crisis or lower economic activity.

In preliminary experiments, the existence of macronodes increases the informative quality of the system and confirms the causal emergence measured as effectiveness in the periods under study. The obtained effectiveness exhibits bounded volatility over time during the periods analyzed in the range $[0.03, 0.17]$, with high effectiveness in years of relative macroeconomic stability, and low values in years of macroeconomic crisis or lower economic activity, see Fig. 1. Additionally, the existence of a significant number of micronodes that share macronodes over time was confirmed, raising expectations of the partial stability of some mesoscale organization of the economic sectors involved.

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