## **SCIENTIFIC REPORT 2021**

# **RESONATE:** Worker flows, labor market outcomes, and agent-based modeling (Project PN-III-P1-1.1-PD-2019-1180)

## I. Summary- Stage 2021

*Stage 2- Objective 1:* Building a complex synthetic network of flows between workers and firms on the labor market, typical of national (or regional) economies - part 2

Activity 2.1: Agent-based model design and implementation (part 2)

Starting from the conclusions of the first stage of this research, the second stage (2021) aims to continue the approach of designing the agent-based model and to take the necessary steps that will facilitate its subsequent implementation. To this purpose, this stage aimed at deepening the analysis on the elements related to the design of the agent-based model starting from the requirements of the ABM methodology. In the following, we briefly present: i) the context in which the use of such a model is justified, and ii) the functional particularities of the model.

# II. Scientific approach

## 1. Methodological view

From viewpoint of the implementation setup, modeling labor market dynamics is concerned with the interactions between firms and employees (generically called agents) in the process of searching and finding a job. Until recently, research in the field used "searching and matching" models that aimed to match employers and potential employees based on a random matching algorithm. However, more recent literature (Guerrero and Lopez, (2015); Fagiolo et al., (2004)) has highlighted a number of limitations of these approaches, limitations arising from the way in which these associations are built. In effect, this approach based on association functions treats the process of searching and finding of a job as an aggregate one, without specifically modeling the dynamics of work flows between employers and employees.

A number of authors, including: Axtell et al. (2019), Guerrero and Lopez (2015), Guerrero and Lopez (2016), tried - based on theoretical and applied models - to eliminate these shortcomings by explicitly modeling the relationships between employees and employers on the labor market. These models are built on the idea of explicitly modeling the structure of the labor flow network, taking into account the particularities of companies and employees in the job search process. Whether they use undirected networks (Guerrero and Axtell, 2013); reallocations based on the concept of firm-specific unemployment, in which each employee is connected within the network with his previous employer (Lopez et al., 2015); the expansion of networks at the level of national markets or at a disaggregated level (Guerrero and Lopez, 2015); or even the structures (Tong et al., 2017); all these studies consider an approach that takes into account the typology of the existing network on the labor market. In other words, the aggregate phenomena related to the dynamics of the labor market are analyzed through the lens of the role played by the relationships that are established between the two categories of agents. The aim for using this

particular approach is to determine the economic policy implications that derive from the existence of these complex structures.

In this context, the agent-based modeling technique has a wide range of applicability, because it allows the study of some phenomena at a disaggregated level, offering a perspective from specific to general, which allows the inclusion of heterogeneity elements that are essential and particular for both employees and companies.

## 2. Model description (extension)

The model used in this research aims on capturing the particularities that characterize the dynamics of the labor market and the labor relations that are formed between employees and employers, by relying on a formal representation of the simulated world. The main purpose for which we try to develop and implement this model is to offer a realistic (as detailed as possible) perspective on the labor market, so as to capture with the highest possible accuracy the particularities that define it. This perspective will give us the opportunity to extract a series of reliable conclusions at an aggregate level.

In a first stage, building the model involves defining the characteristics of the agents and the environment in which they operate, as well as outlining the rules that govern the interactions between agents and between agents and the environment.

a) *The agents* that populate the model are of two types: the firms and the workers existing on the labor market at a given time. Symbolically, within the network, they will be represented as nodes. Both companies and employees will have a series of associated attributes, included in the model by associating each agent class with some parameters/states. Each type of agent, after being activated within a simulation stage, will perform a series of actions based on the parameters that define it. An example could be represented by a company's decision to hire a new worker depending on the level of salary it would be willing to offer or based on the labor productivity of that worker agent; or the decision of an employee to accept a job offer depending on the labor market.

b) The interactions between the above mentioned agents will take place in an *environment* characterized by a series of properties, and the effective associations between agents (in the form of collaboration relationships in the employer-employee relationship) will be represented by connecting edges. Specifically, when the job search process is completed, it will be represented as an employment contract between an employee and the hiring firm, and it will be highlighted in the network model by means of a link between the two types of agents.

When all these model attributes are defined, the model is populated with agents, and they are allowed to interact. In each period of a simulation, a series of steps will be completed. Initially, companies will decide the strategy they will follow in offering vacancies and in hiring potential candidates or firing existing ones (for example: the number of vacancies, the criteria for employee selection, the salary level). Each worker will then be able to evaluate his status, based on its own utility function, and subsequently will make a decision on whether to keep his current job (if employed) or to apply for a job (if it is unemployed). By confronting the decisions of the two categories of agents, associations can occur and employer-employee collaboration starts, enforced by an employment contract. As a result of these decisions and interactions, the configuration of the workflow network will change throughout the simulation, generating new results.

The utility of using agent-based modeling derives precisely from the dynamic character of these interactions, and -through repeated runs of the model- it will be possible to draw conclusions resulting from the evolution of these work flows.

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