

A Network Analysis of the Romanian Higher Education Graduates' Intra-generational Mobility

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Abstract: We explore the early career mobility of the Romanian higher education graduates using the network analysis approach. The nodes are represented by occupations (3 digits groups according to ISCO 88), while the links represent movements of individuals from one job to another. A job change is defined as an experience of inter-organisational mobility. The network is constructed as a weighted and directed one with self-loops. Considering that the occupations are related to each other via transferable skills, we visualize paths of mobility and calculate network indicators in order to understand models of connectivity between occupations. Exploiting a dataset on working histories of higher education graduates from Romania during their early career, we provide a novel evidence on the fact that individuals move according to certain career pathways and that the entrance occupation influence their subsequent career.

Keywords: *communities, inter-organisational mobility, network motifs, occupational mobility network.*

Introduction

The job mobility has been extensively studied in the literature; scholars distinguish between inter-generational mobility and intra-generational mobility. In this article we focus on the

second type of mobility. While there is a rich literature on the structure and rate of occupational mobility, there are important gaps in understanding the career trajectories. Such a challenge should rely on understanding the individual histories of transitions among

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occupations as coherent sequences. For understanding paths of occupational mobility, we unify elements from occupational mobility, human capital theories and social networks.

During the last two decades, participation in the higher education increased significantly in Romania. Labour Force Survey data show that the share of higher education graduates in active population increased from 7.9 per cent in 1997 to 14.3 per cent in 2008. Romanian economy has witnessed dramatic changes associated in the '90 with an in-depth transition from plan to market and then with high rates of economic growth between 2000 and 2008. Job creation during the last decade was mainly concentrated in sectors and occupations placed at the bottom of the added value chain. Thus, it is obvious that the demand side and the supply side of the Romanian labour market have evolved in an uncorrelated manner (Pirciog et al., 2010). As a result, high shares of higher education graduates enter the labour market in mismatched jobs. From this point of view, occupational mobility in the first years of their career can offer them the chance of reaching jobs more appropriate for their level of education.

The purpose of this article is to highlight the idea of the occupational system as a social space characterised by the existence of more probable patterns of movement that shape careers of individuals. In order to address this objective we explore the occupational mobility of the higher education graduates during the first years after graduation using social networks.

Literature review

There is an important volume of sociological studies on social mobility using schemas comprising various occupational categories (Erikson and Goldthorpe, 1992). Moreover, Grunsky and Weeden (2001) argue that the mobility analysis should rely more on micro classes such as the occupational categories as they are deeply institutionalised and influence the conduit of individuals. Generally, inter-generational mobility was significantly more analysed as against intra-generational mobility (Barone and Schizzerotto, 2011). The latter focuses on the movements of the individuals between occupational categories over the course of their lives. One important body of research studies the individual vertical career mobility, having the 'meritocracy' as a core idea. Such studies aim to address questions regarding the relation between social origin, education and occupational destinations. The modernisation theory states that the influence of social origin has become weaker, while the effect of education increased. However, the empirical results show that the family background still is of high importance and that the role of education remained rather constant in last decades (Barone and Schizzerotto, 2011). Another stream of research studies work histories looking at individual life trajectories on labour market. Such studies try to highlight the influence of social change across birth cohorts and historical periods. However, this article departs from these major sociological approaches of

social mobility and analyses occupations as social units and characterises relations among these units as they appear from the job movements of individuals.

From an economic point of view, the classic model of turnover relies on the fact that workers look for a better match to the type or work performed and to the employer (Jovanovic, 1979; Neal, 1999). Empirical evidences suggest that matching takes place at the occupational level as information obtained by individuals working in a job is used to predict the quality of the match at other jobs within the same occupation. Thus, those working their first job are more likely to leave the current job than those working their second job in the same occupation (McCall, 1988).

Becker's human capital theory conceptualizes the existence of general and firm-specific human capital. In subsequent theoretical developments, human capital includes industry-specific skills (Neal, 1999), while investigation of wage formation showed that there is an occupation-specific skills which is transferable across employers. This means that when a worker switches the employer or the sector, he or she loses less human capital than when changing occupation (Kambourov and Manovskii, 2009). Higher loss of human capital represents higher costs for mobile workers. However, some occupations are linked to each other due to the transferability of skills. Such occupations in which skills and experience can be partially or fully transferred from one occupation to another form the career paths (Weiss, 1971; Shaw, 1985). An additional theoretical development is the concept of career ladder which means that some occu-

pations form a path of advancement for workers gaining skills and experience. Workers move up on the ladder as they gain skills and information on their productivity (Sicherman and Galor, 1990). So, a career line represents a collection of jobs which is characterized by a high probability of movement from one occupation to another for certain groups of individuals.

Job mobility represents an important characteristic of the first years of employment as rate of job changing declines with age and experience of the workers (Topel and Ward, 1992). From the perspective of human capital theory, youth experience lower costs of occupational mobility due to the fact that they have invested less in their occupational-specific skills. This period is called the shopping and thrashing stage and is characterized by exploration and testing of the market.

Isoda (2008) analyzes the occupational mobility as the geographical mobility and generates a job map using the occupational change data from the British Quarterly Labour Force Surveys 2001-2005. The map has on x-axis the skill level and on y-axis the skill content of the occupations, so similar ones are placed nearby and dissimilar occupations far away. This type of mapping is intended to help the job seekers in the process of building their career. The main conclusions of the study are: most of the entrances on the labour market are in elementary or low skilled jobs; main direction of the occupation change is in career upgrading and the retirement is present equally among occupations. By employing a network-based approach, we complement his work by producing new evidences for the usage of alternative

methods for systematic understanding of relationships among occupational categories.

Lately, networks analysis has been extensively used in conceptualizing and analysing different types of systems (economic, social, physical etc.). It is employed in social studies, under the umbrella of social networks, in physics and related fields under the name complex networks, in mathematics as graph theory and so on (Jackson, 2008; Easley and Kleinberg, 2010; Newman, 2010; Kadushin, 2012). With regard to the labour market it is important to know the structure of the network in order to understand why people end up in different situations (employed/unemployed). Isolated individual with none or low-quality links with the professional networks are more prone to remain unemployed for a long period of time or end up in unmatched jobs.

A recent working paper (Gianelle, 2011) investigates the network structure of inter-firm employees' mobility, in an industrial region of Italy, during the 1990s. The study is a tentative linking of the labour mobility research based on employer-employee data and complex network analysis on empirical data, for developing a new set of tools to better understand the labour market reallocation process.

Poggi (2013) extends the former analysis and questions if there is a link between job-to-job mobility and intra-firm wage dispersion. Using the same database, but for the period 1995-2001, the author creates a labor mobility network, where the firms represent the nodes and the flow of workers between companies the edges.

Data and Method

Data

The database employed for this study is based on a national survey carried out between November - December 2008, as part of the national project 'Determinants of transition from higher education to work, PNCDI 2007-2010', coordinated by National Scientific Research Institute for Labour and Social Protection (INCSMPS). The survey was designed to investigate the labour market entry process and early career of the Romanian university graduates in the first 1, 3, respectively 5 years after graduation. The data were retrospectively recorded and they cover both personal characteristics and information regarding the jobs accessed by the subjects from graduation until the moment of investigation, such as: professional status (employee, employer, self-employed, unpaid family worker), job title, occupation, industry type, type of contract (on fixed period/ on undetermined period, part-time/ full time), how the job was found (via formal/informal channels) etc. There were investigated 2194 university graduates, the sample being stratified on their educational profile according to the structure provided by The Romania's National Institute of Statistics.

At the moment of survey investigation, 93.8 per cent of university graduates interviewed were employed. During that period the Romanian economy was growing and the labour force demand witnessed the highest level since the fall of the Communist regime. Thus, we have to underline that

our analyses is carried out in a specific labour market context with low unem-

ployment rate, high speed of filling vacancies and high job creation.

Table 1. *The distribution of university graduates by the number of jobs occupied from graduation until the moment of investigation (per cent)*

Number of jobs held after graduation	%
1 job	65.7
2 jobs	20.6
3 jobs	7.0
4 jobs	1.9
5 jobs	0.4
6 jobs	0.1
never had one	4.3
Total	100.0

A majority of 65.7 per cent university graduates had only 1 job after graduation, while 20.6 per cent of university graduates changed once their job. 9.4 per cent of university graduates changed jobs two or more times. Our study addresses the ones that changed their job at least ones, around 30 per cent of the responders (see Table 1).

Originally, the occupations were recorded in the database as string variables and we post-coded them according to the International Standard Classification of Occupations ISCO-88 at 3 digits. ISCO is one of the main international systems for classifying and aggregating occupations based on the degree of similarity of their constituent tasks and duties. It falls under the responsibility of the International Labour Organization (ILO) and it is the result of a series of lengthy and detailed investigations in twelve EU countries, combining the knowledge of experts in occupational classification with the practical considerations for coding occupational information collected by census and survey techniques. This classification organises the occupations in a hierarchical framework at the low-

est level being the job, defined as a set of tasks and duties designed to be executed by one person and at the highest level eight major occupational groups. Although each job may be distinct in term of outputs required, they are sufficiently similar in terms of the abilities needed as inputs in order to be regarded as a single occupational unit for statistical purposes. There are several versions of ISCO and for this study we use ISCO-88¹.

Most of the university graduates found their 1st job after graduation in occupations belonging to the 2nd (professionals) and the 3rd (technicians and associated professionals) major groups of occupation) (see Table 2). Occupations such as 244 - social science and related professionals, 241 - business professionals, 232 - secondary education teaching professionals, 214 - architects, engineers and related professionals (8.6 per cent), 222 - health professionals (8.0 per cent) and 341 - finance and sales associate professionals (4.4 per cent) exercised the higher 'attraction' on the university graduates when entering on the labor market (see Table 2).

Table 2. *Distribution of university graduates in the 1st job by the Occupation ISCO-88, major groups (per cent)*

ISCO-88	Major Group	%
1	Legislators, senior officials and managers	5.5
2	Professionals	63.3
3	Technicians and associate professionals	16.6
4	Clerks	7.5
5	Service workers and shop and market sales workers	3.9
6	Skilled agricultural and fishery workers	0.9
7	Craft and related trades workers	1.1
8	Plant and machine operators and assemblers	0.5
9	Elementary occupations	0.4
0	Armed forces	1.1

Social network analysis

On the labour market, three types of occupational mobility may appear: newly entrants, job change across occupations and labour market exits. We focus strictly on the second type of occupational mobility. Investigating the employment patterns of university graduates in the first years post-graduation, we notice two aspects: (1) they were rapidly ‘absorbed’ by the labour market and (2) they encounter a significant job mobility, 30 per cent of them changed their job at least ones. We focus strictly on this 30 per cent of the responders and follow all their job movements even if they resulted or not in an occupational change.

We use the records about their career mobility to build an occupational mobility networks (OMN) that covers all their job shifts in the considered period, 2003 - 2008. We generate the network by overlaying the transition matrix between occupations, without taking into account the unemployment spells between jobs. An occupation change means a modification in the occupational code at 3 digits at the transition from one job to another.

We constructed the network as

weighted and directed, because we think it is important for a complete view to consider both the magnitude and the direction of the flow of workers between occupations. The nodes represent the occupations post coded at 3 digits according to ISCO-88 and the links are weighted with the number of persons moving from one occupation to another. We also represented the people that are changing their jobs in the same occupations as self-loops. Knowledge of such topological properties is essential, in order to have a global perspective over the occupations set and how they connect.

We represent OMN as a graph $G(N)$ with $N = 130$ nodes, representing the total number of occupations at 3 digits according to ISCO-88 and $n = 322$ edges. The real-valued $N \times N$ matrix $A = a_{ij}$ has positive elements if there is a flow of persons between occupations (nodes). The graduates that are changing their job in the same occupation are represented in OMN as self-loops. The network density is very low, 0.016 showing that the labour market is a sparse network (Gianelle, 2011). The giant component includes 52 per cent of the vertexes while the rest of the nodes are isolated meaning that the

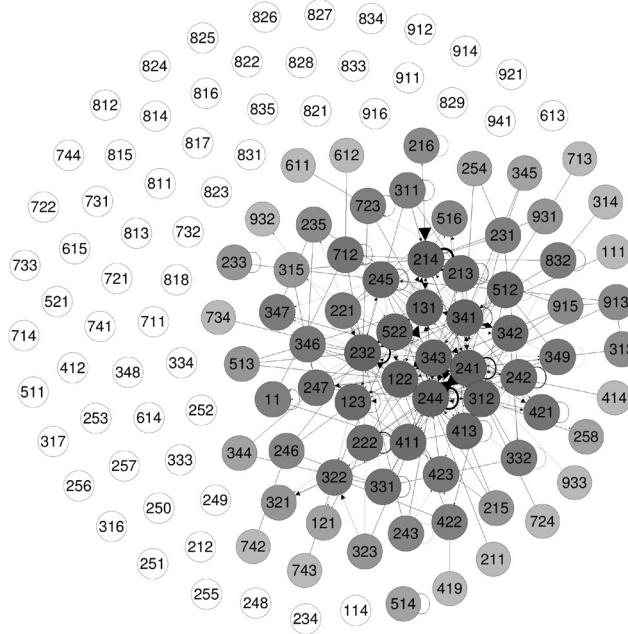


Figure 1. *Visualization of the empirical occupational mobility network (OMN). The thickness of the links is proportional to their weights and the colour of the nodes reflects their total strength (white - isolated node (48 per cent of all the nodes), black - highly connected node). The numbers in vertexes represent the occupational codes according to ISCO-88, 3 digits.*

higher education graduates ‘covered’ half of the entire occupational space during their early career. There are not movements between the last groups of ISCO-88 classification which it is expectable since we are analysing a segment of the Romanian labour force (highly educated individuals).

Results

Centrality measures

Node centrality is a key issue of the social networks. The relevance of this measure emerges from the fact that job mobility defines a certain degree of dependency of an occupation to another. In this case the vertex (occupation) centrality denotes the likelihood

of a given occupation to appear along a randomly selected mobility flow within the OMN. The higher is its likelihood the more influential is the occupation in the network. Shocks affecting central occupation are more likely to be transmitted in the whole network, to all the occupations. We consider three measures to quantify the centrality of a node: (1) degree centrality, (2) closeness and (3) betweenness.

The degree centrality combines both degree and strength with a positive tuning parameter α that controls for their relative importance (Opsahl et. al., 2010). We distinguish between in and out degree centrality:

$$C_{D_{out}}^{w\alpha}(i) = k_i^{out} * \left(\frac{s_i^{out}}{k_i^{out}}\right)^\alpha$$

$$C_{D_{in}}^{w\alpha}(i) = k_i^{in} * \left(\frac{s_i^{in}}{k_i^{in}}\right)^\alpha$$

Where k_i^{out} is the out-degree, k_i^{in} is the in-degree, s_i^{out} is the out-strength, s_i^{in} is the in-strength and α , a real positive number.

If $\alpha=0$ the in/out centrality is equal with in/out degree and if $\alpha=1$ the in/out node centrality is equal with the in/out strength. When $\alpha \in (0,1)$ the greatest importance is given to the number of ties versus ties weight, while if $\alpha>1$ vice versa.

In order to see how sensitive the node centrality is to small variations of the parameter we performed a sensitivity analysis on the first 10 vertexes according to their in-strength and out-strength. The considered nodes are involved in 70 per cent of the total in-flow and out-flow of the empirical network. In the case of in-degree centrality, we notice that when $\alpha \in (0,1)$ the occupations that have the highest in-flow of graduates are social science and related professionals (244), business professionals (241) and after that are architects, engineers and related professionals (214), secondary education teaching professionals (232) and at the bottom all the other 6 occupations.

When $\alpha>1$ the most central occupation are architects, engineers and related professional (214) and after that the others. These means that social science and related professionals (244) and business professionals (241) receive university graduates from a high range of occupations, but with whom the strengths are rather low, while architects, engineers and related professional (214) receive work force from a limited set of occupations with whom they have strong ties. Considering the transferable skills, it means that it is smoother the transfer from other occupations to social science related ones

then to architects, engineers and related occupations which are more specialized and technology intensive.

If we look at the out-degree centrality for $\alpha \in (0,1)$ we notice that again social science and related professionals (244), architects, engineers and related professional (214) and secondary education teaching professionals (232) are the occupations from where a lot of the university graduates are leaving at one point in their early career. In the case of social science and related professionals (244) it could be explained by being a 'transit' occupation and for secondary education teaching professionals (232) by the low wages that are typically here. This order is preserved also for $\alpha>1$.

Because a lot of higher education graduates are changing their job in the same occupation during their early career we eliminate the self-loops and perform the same sensitive analysis. In this case we notice a relatively low in-flow of graduates into the occupational group architects, engineers and related professional (214) while for the other occupations the high flow (both in and out) of persons is preserved. This shows us that 214 group (architects, engineers and related professional) has many characteristics of a profession. What distinguishes a profession from other occupational forms is the balance between general and specialized knowledge. Engineers have long periods of training, a good balance between general and specialized knowledge but they can also take further responsibilities by becoming managers and executives (Volti, 2008).

After '90 there had been a great influx of graduates in economics and this is visualized in the high dynamics of

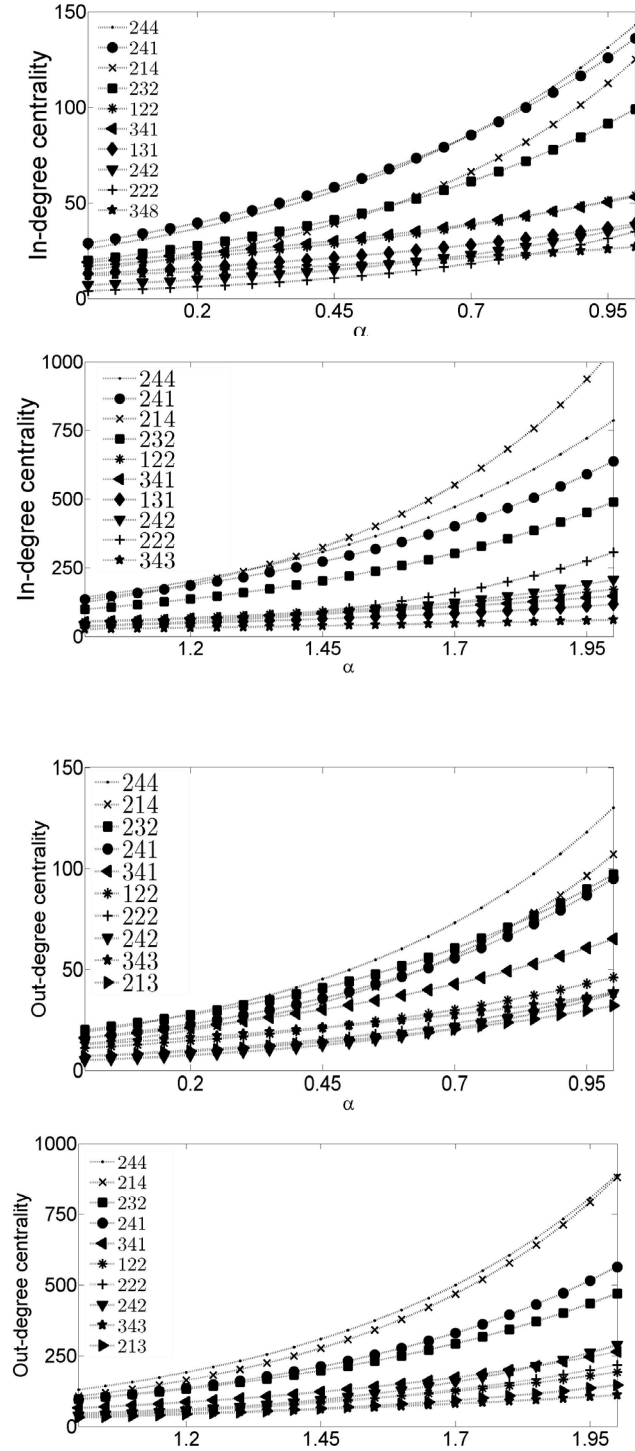


Figure 2. Degree centrality scores when different values of α are used: $\alpha \in [0,1]$ (a,c) and $\alpha \in [1,2]$ (b,d)

group social science and related professionals (244).

Closeness centrality is defined as the inverse sum of the shortest distance to all other nodes from a specific node and it shows the ease of reaching other nodes

$$C_C(i) = \left[\sum_j^N d(i, j) \right]^{-1}$$

where $d(i, j)$ is the length of shortest path between two nodes. According to this node centrality measure the first four nodes are: 241 (Business professionals), 244 (Social science and related professionals), 122 (Production and operations managers) and 131 (Managers of small enterprise). This shows again those managers, social science and business related occupations are best connected in the network.

Betweenness centrality is the average number of short paths between pairs of the nodes that pass between a certain nodes and it has the role of an intermediary, connector. In this case the

first four occupations are: 244 (Social science and related professionals), 241 (Business professionals), 232 (Secondary education teaching professionals) and 341 (Finance and sales associate professionals).

Network motifs

The concept of network motifs had been introduced by Milo (2002) to denote ‘patterns interconnections occurring in complex networks at numbers that are significantly higher than those in randomized networks’. Studies regarding the occurrence of these patterns had been done in several fields: protein interaction network, inter-firm network, complex biological, technological and sociological networks. For this study we are interested in the identification of the three-nodes connected motifs that are statistically significant in our network (see Figure 3).

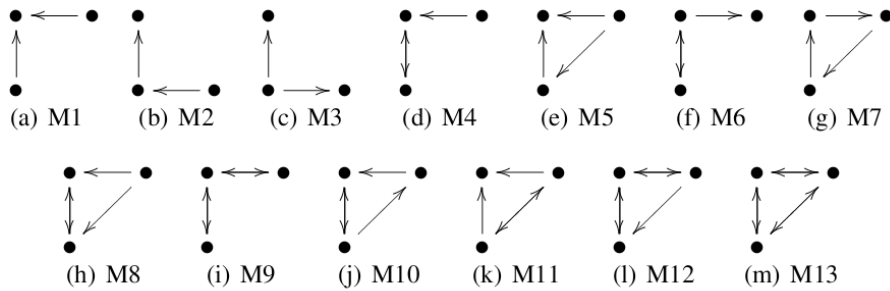


Figure 3. All types of three-node connected subgraphs (motifs)

For detecting them we employ Onnela's algorithm and compute the motif intensity $I(g)$ of a subgraph g with links l_g as the geometric mean of the weights w_{ij} .

$$I(g) = \left(\prod_{(ij) \in l_g} w_{ij} \right)^{\frac{1}{|l_g|}}$$

Where $|l_g|$ is the number of links in subgraph g .

The total intensity I_M of a three-node motif is calculated as the sum of its subgraph intensities I_g .

$$I_M = \sum_{g \in M} I(g)$$

There are 13 structural three-nodes motifs and to evaluate their statistical significance we calculate the motif intensity score for each of them.

$$\tilde{z}_M = \frac{I_M - \langle i_M \rangle}{(\langle i_M^2 \rangle - \langle i_M \rangle^2)^2}$$

where i_M is the total intensity of motif M in the reference networks. The null-model network is constructed as an ensemble of random networks generated by reshuffling the empirical weights.

Over all the network the statistically significant motifs are M2 and M3, while the anti-motifs are M4, M8, M9,

M12 and M13. The last ones appear less frequent than in the random networks. We can see that in the OMN exist strong connections between certain occupations, being favourite the motifs with both sides' connections.

The frequency of occurrence (motif intensity) of different motifs around a certain node is the node's motif fingerprint and may be interpreted as a measure of similarity between occupations. We consider again the first 10 nodes ordered according to their strength and calculate their motif fingerprint (Table 3).

Table 3. Motifs present around the first 10 occupations ordered according to their total strength.

ISCO 88	Minor group title	Motifs
244	Social science and related professionals	M1, M2, M4, M5, M6, M7, M8, M9, M10, M11, M12, M13
214	Architects, engineers and related professionals	M4, M6, M8, M9, M11, M12, M13
232	Secondary education teaching professionals	M1, M2, M3, M4, M5, M6, M8, M9, M10, M11, M12, M13
241	Business professionals	M1, M4, M6, M8, M9, M10, M12, M13
341	Finance and sales associate professionals	M4, M5, M6, M8, M9, M10, M11, M12, M13
122	Production and operations department managers	M4, M6, M8, M9, M10, M12, M13
222	Health professionals (except nursing)	-
242	Legal professionals	M9
232	Secondary education teaching professionals	M3, M5, M7, M8, M19, M11, M12
213	Computing professionals	M9, M12

There are occupations that have almost all the motifs present around them such as social science and related professionals (244), while others do not have any statistical significant ones around them, such as Health professionals (except nursing) (222). Legal professionals (242), have just one mo-

tif statistical significant around them M9, which symbolize a bilaterally exchange with other two occupations disconnected between them. The last two occupations mentioned are highly specialized ones, that required a lot of investment in education and also they have strict regulations.

Conclusion

Employing a network based approach to occupational mobility helps to identify and investigate patterns, connections between occupations and visualise career paths. Using different measures for node centrality (degree centrality, closeness and betweenness) we identify the central occupations in the network: (a) social science and related professionals and (b) business professionals. Further we study how the occupations are connected with each other identifying the motifs present around the most central nodes. Most of the central nodes seem to be very well connected, beside two occupational groups: (a) health professionals (except nursing) and (b) legal professionals, which do not have statistical significant motifs around them. So, our analysis brings new evidence

on the fact that there still are some professional domains such as health, legal and computing professionals in which careers remain highly predetermined and predictable, while the other professional domains, especially social science and related professionals, secondary education teaching, as well as finance and sales associate professionals display unstructured careers paths with movements that are less defined and predictable and where the mobility opportunities are higher and more diverse.

Note

¹ Further details regarding ISCO-88 may be consulted on ISCO web page - <http://www.ilo.org/public/english/bureau/stat/isco/isco88/index.htm> Retrieved: October 20, 2013.

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