Occupational mobility network of the Romanian higher education graduates

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Abstract

Although there is a rich literature on the rate of occupational mobility, there are important gaps in understanding patterns of movement among occupations. We employ a network based approach to explore occupational mobility of the Romanian university graduates in the first years after graduation (2003 - 2008). We use survey data on their career mobility to build an empirical occupational mobility network (OMN) that covers all their job movements in the considered period. We construct the network as directed and weighted. The nodes are represented by the occupations (post coded at 3 digits according to ISCO-88) and the links are weighted with the number of persons switching from one occupation to another. This representation of data permits us to use the novel statistical techniques developed in the framework of weighted directed networks in order to extract a set of stylized facts that highlight patterns of occupational mobility: centrality, network motifs.

Keywords: occupational mobility; weighted networks; econophysics

JEL classification: C31, J24

1 Introduction

Occupational mobility represents an important feature of the labour markets. 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 individual histories of transitions among occupations into coherent sequences, if such patterns exist. This paper explores the early career of higher education graduates during the first years after graduation in order to understand their occupational mobility. For understanding paths of occupational mobility, we unify elements from job mobility and human capital theories. By exploiting a unique dataset on working histories of higher
education graduates from Romania, we provide novel evidence on the fact that individuals move to similar occupations and that the entrance occupation influence their subsequent career.

During the last two decades, participation in higher education increased significantly in Romania. Labour Force Survey (LFS) data show that the share of higher education graduates in active population increased from 7.9% in 1997 to 14.3% 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 labor market have evolved in an uncorrelated manner. 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.

We investigate patterns of occupational mobility by employing a network based approach in which nodes are represented by occupations and links by the flows of individuals moving from one occupational category to another. Such an approach helps us to better visualize paths of mobility and calculate network indicators in order to understand models of connectivity between different occupations. We consider that occupations are related to each other via transferable skills which can be sector-specific or not.

The paper is structured as follows: section 2 revises the main theories in occupational mobility and youth career, section 3 describes the database that we are using, section 4 presents the methodology and the results, while section 5 concludes and outlines directions for future study.

2 Occupational mobility in the early stage of the career post graduation

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 [6]; [11]. Empirical evidences suggest that matching takes place at 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 [10].

Separately from the job mobility theory, an approach in which occupations are related to each other was developed. 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 [11], while investigation of wage formation showed that there are occupation-specific skills which are 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 [7]. 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 career paths [16]; [13].
demonstrate that some occupations are related to each other by exploiting data on task requirements. An additional theoretical development is the concept of career ladder which means that some occupations 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. However, patterns of occupational mobility cannot be explained only by advancements of individuals on a career ladder. On the other hand, a career line or job trajectory was defined as a work history that is similar for a part of labor force. Group disparities in patterns of occupational transitions should portray different career lines. 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. From the perspective of human capital theory, youth inexperience lower costs of occupational mobility due to the fact that they have invested less in their occupational-specific skills. In the literature, this period is called the shopping and thrashing stage and is characterized by exploration and testing of the market.

analyse 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 context of the occupations, so similar ones are place nearby and disimilar 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 upgrating and the retirement is present equally among occupations.

By employing a network-based approach, we complement his work producing new evidences for the usefulness of alternative methods in systematic understanding of the relationships among occupational categories.

3 Data

The database employed for this study is based on a national survey carried out between November, 2008 - January, 2009. The survey was designed to investigate the labor market entry process and early career of the Romanian university graduates in the first 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: professional status, job title, occupation, industry type, type of contract, how the job was found e.g. In total there were investigated 2194 university graduates, the sample being stratified on their educational profile according to the structure provided by Romania’s National Institute of Statistics.

Originally, the occupations were recorded as string variables, but for this analysis we post-coded them according to the International Standard Classification of Occupations ISCO-88 at 3 digits, in order to keep under control the measurement errors in occupational codes. ISCO-88 specify a system for classifying and aggregating occupations based on the degree of similarity of their constituent tasks and duties. It is the result of a series of lengthy and detailed investigations in twelve EU countries, combining the knowledge of
experts in occupational classification in each country with the practical considerations for coding occupational information collected by census and survey techniques. This classification organises the occupations in an hierarchical framework at the lowest level, beginning the job, defined as a set of tasks and duties designed to be executed by one person. Although each job may be distinct in terms 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. At 3 digits there are in total 130 occupations.

At the moment of survey investigation, 93.8% of university graduates interviewed were employed. This high insertion rate of the university graduates is explained mainly by the moment when the survey was carried out, during that period the Romanian economy was still growing and the labor force demand was at the highest level witnessed in the last 20 years. Thus, we have to underline that our analyses is carried out in a specific labor market context with low unemployment rate, high speed of filling vacancies and high job creation. On the labour market, three types of occupational mobility may appear: newly entrants, job change across occupations and labour market exits, for example due to retirement. This article is focused strictly on the second type of occupational mobility and we consider their movements as voluntary. Investigating the employment patterns of university graduates in the first years post graduation, we noticed two things: they were practically rapidly “absorbed” by the labour market and they encounter a significant job mobility (30% changed the job at least ones and around 10% changed their occupation). For this study we follow all the job changes even if they result or not in an occupational change.

4 Occupational mobility network

In the recent period, a large body of literatures employing a network-based approach has been emerging in the study of socio-economic systems [4]; [5]; [1]; [2]; [3]. Within this approach, the socio-economic systems such as markets, industries or even the global economy are viewed as networked structures. Between the main studied topics are: international trade [8]; [12], social relations structures [5], internet, peer-to-peer networks, electronic circuits, neural networks, metabolism and protein interactions etc. The network-based approach is employed in such a large diversity of subjects because it permits assessment of several underlying indicators (maximum distance between pairs of nodes, clustering tendency, distribution of degrees of the nodes, motifs, centrality measures etc.) which characterize the investigated structures.

We employ a network approach to analyse the statistical properties of the occupational mobility network ($OMN$) of the Romanian university graduates in a five years time frame (2003 - 2008). We use the records about their career mobility to built an occupational mobility network ($OMN$) that covers all their job shifts in the considered period. We generate the network by overlaying the transition matrix between jobs, without taking into account the unemployment spells between jobs. We construct the network as directed and weighted. It is important in this case to consider both the magnitude and the direction of the flow of workers between occupation in order to have a complete view. The nodes represent the occupations postcoded 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 counted the people that are changing their jobs in the same occupations as self-loops.
An occupation change means a modification in the occupational code at 3 digits at the transition from one job to another. Knowledge of such topological properties is essential, in order to have a global perspective over the occupations set and how they connect. Also, while interpreting the results is crucial to keep in mind the specificity of the country and the considered time frame. We represent \( OMN \) as a graph \( G(N) \) with \( N = 130 \) nodes, representing the total number of occupations at 3 digits according to ISCO-8 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 0.016 and it describes the general level of linkage among the nodes in the graph. The average degree is 4.15 and while the average clustering coefficient is 0.09.

### 4.1 Node Centrality

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 their likelihood the more influential is the occupation in the network. So 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: degree centrality, closeness and betweenness.
The degree centrality has been introduced by [?] and it combines both degree and strength with a positive tuning parameter $\alpha$ that controls for their relative importance. We distinguish between in and out degree centrality using (1) and (2):

$$C_{D_{\text{out}}}^{\text{w}a}(i) = k_{i}^{\text{out}} \ast (s_{i}^{\text{out}}/k_{i}^{\text{out}})^{\alpha}$$  \hspace{1cm} (1)$$

$$C_{D_{\text{in}}}^{\text{w}a}(i) = k_{i}^{\text{in}} \ast (s_{i}^{\text{in}}/k_{i}^{\text{in}})^{\alpha}$$  \hspace{1cm} (2)$$

where $k_{i}^{\text{out}}$ is the out-degree, $k_{i}^{\text{in}}$ is the in-degree, $s_{i}^{\text{out}}$ is the out-strength, $s_{i}^{\text{in}}$ is the in-strength and $\alpha$ a real positive number.

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

In order to see how sensitive is the node centrality to small variations of the parameter $\alpha$ we performed a sensitive analysis on the first 10 vertexes according to their in-strength (2a, 2b) and out-strength (2c, 2d). The considered nodes are involved in 70% 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 inflow 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 we vary $\alpha \in [1,2]$ the most central occupation becomes architects, engineers and related professionals.
and after that 244, 241, 232 etc. These means that social science and related professionals (244) and business professionals (241) receive university graduates from a lot of occupations, but with whom the strengths are rather low, while architecs, engineers and related professional (214) receive work force from a limited set of occupations with whom they have strong ties. If we look at this issue from the transferable skills perspective, it means that it’s smoother the transfer from other occupations to social science related ones then to architects, ingineers and related occupations which are more specialized and technology intensive.

If we look at the out-degree centrality for $\alpha \in [0, 1]$ we see that again 244, 214 and 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 244 it could be explained by being a “transit” occupation and for 232 by the low wages that are typically here. This order is preserved also for $\alpha \in [1, 2]$.

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 performe the same sensitivity analysis. In this case we notice a relatively low in flow of graduates into the occupational group 214 while for the occupations 244, 232 the high flow (both in and out) of persons is preserved. This shows us that the group 214 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, in which case they move into occupational group 232 [?]. Also after ’90 there had been a great influx of graduates in economics and this is visualized in the high dynamics of group 244.

Closeness centrality is defined as the inverse sum of the shortest distance to all other nodes from a specific node.

$$C_C(i) = \frac{1}{\sum_{j} d(i,j)}$$

(3)

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 that managers, social science and business related occupations are the best connected in the network.

Betweenness centrality is the average number of short paths between pairs of the nodes that pass between a certain node.

$$C_B(i) = \frac{g_{jk}(i)}{g_{jk}}$$

(4)

where $g_{ij}$ is the number of shortest paths between two nodes and $g_{jk}(i)$ is the number of shortest paths that pass node $i$.

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).


4.2 Network motifs

The concept of network motifs had been introduced by [?] 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, Fig. ?? shows all the possible combinations.

\[
I(g) = \left( \prod_{(ij) \in l_g} w_{ij} \right)^{1/|l_g|}
\]

where \(|l_g|\) is the number of links in subgraph \(g\).

The total intensity \(I_M\) of a three-nodes motif is calculated as the sum of the 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 \(\tilde{z}_M\) for each of them.

\[
\tilde{z}_M = \frac{I_M - \langle i_M \rangle}{\left( \langle i_M^2 \rangle - \langle i_M \rangle^2 \right)^{1/2}}
\]

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. [?], [?].

Fig. 4 shows the motif intensity scores for all 13 three-nodes cliques: subgraphs number 2 and 3 can be considered structural anti-motifs and subgraphs 4, 8, 9, 12, 13 structural motifs. The total empirical intensity of the structural motifs versus the corresponding histogram of random networks are presented in Fig. 5.
We can see that in the OMN exist strong connections between certain occupations, being favored the motifs with both sides connections.

The frequency of occurrence (motif intensity) of different motifs around a certain node can be considered as motif fingerprint. It gives us a measure of similarity between occupation. We consider again the first 10 nodes ordered according to their strength and calculate their motif fingerprint (Table 1). A motif is presented around a node if its intensity is at the right of the random network histogram and absent if the motif intensity overlaps the histogram.

One evidence clearly steps out here: 222 (Health professionals (except nursing)) and almost 242 (Legal professionals) don’t have statistically significant motifs around them.
Table 1: Motif fingerprint of the first 10 occupations ordered according to their total strength (1 - present, 0 - absent)

| ISCO 88 | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | M9 | M10 | M11 | M12 | M13 |
|---------|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| 244     | 1  | 1  | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 1   | 1   | 1   | 1   |
| 214     | 0  | 0  | 0  | 1  | 0  | 1  | 0  | 1  | 1  | 0   | 1   | 1   | 1   |
| 232     | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 1  | 1  | 1   | 1   | 1   | 1   |
| 241     | 1  | 0  | 0  | 1  | 0  | 1  | 0  | 1  | 1  | 0   | 1   | 1   | 1   |
| 341     | 0  | 0  | 0  | 1  | 1  | 1  | 0  | 1  | 1  | 1   | 1   | 1   | 1   |
| 122     | 0  | 0  | 0  | 1  | 0  | 1  | 0  | 1  | 1  | 1   | 0   | 1   | 1   |
| 222     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0   | 0   | 0   |
| 242     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0   | 0   | 0   | 0   |
| 232     | 0  | 0  | 1  | 0  | 1  | 0  | 1  | 1  | 0  | 1   | 1   | 1   | 0   |
| 213     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0   | 0   | 0   | 1   |

Around 242 is present just one type of motif (M9, Fig.??), a bilateraly exchange with other two occupations, which aren’t connected between them. These two occupations are highly specialized, require a lot of investment in education and have a strict reglementation.

5 Conclusions

Employing a network based approach to occupational mobility helps to identify and investigate patterns, connections between occupations and visualise career paths. Up to now we managed to identify the central occupations in the network (node centrality) and see what type of connections they have with the other occupations (motifs). Further research will be directed to build this kind of occupational mobility networks for different EU countries and produce a comparative analysis. Also we are interested in explaining and the magnitude of workers flow between occupations using a gravitational model and nevertheless threat this networks as dynamic ones.

6 Appendix

Table 2: List of occupations at 3 digits according to ISCO 88 (the ones marked with (*) are present just in the Romanian classification)

| ISCO 88 | Name                                      |
|---------|-------------------------------------------|
| 111     | Legislators and senior government officials|
| 114     | Senior officials of special-interest organisations|
| 121     | Directors and chief executives            |
| 122     | Production and operations managers         |
| 123     | Other specialist managers                  |

Continued on Next Page...
| ISCO 88 | Name |
|--------|------|
| 131    | Managers of small enterprises |
| 211    | Physicists, chemists and related professionals |
| 212    | Mathematicians, statisticians and related professionals |
| 213    | Computing professionals |
| 214    | Architects, engineers and related professionals |
| 215*   | Engineers in textile, leather and food industry |
| 216*   | Engineers in timber, glass and ceramics, pulp, paper and building materials |
| 221    | Life science professionals |
| 222    | Health professionals (except nursing) |
| 231    | College, university and higher education teaching professionals |
| 232    | Secondary education teaching professionals |
| 233    | Primary and pre-primary education teaching professionals |
| 234    | Special education teaching professionals |
| 235    | Other teaching professionals |
| 241    | Business professionals |
| 242    | Legal professionals |
| 243    | Archivists, librarians and related information professionals |
| 244    | Social science and related professionals |
| 245    | Writers and creative or performing artists |
| 246    | Religious professionals |
| 247    | Public service administrative professionals |
| 248*   | Researchers and research assistants in physical and chemical sciences |
| 249*   | Researchers and research assistants in mathematics and statistics |
| 250*   | Researchers and research assistants in informatics |
| 251*   | Researchers and research assistants in technical sciences |
| 252*   | Researchers and research assistants in the fields of textiles, leather, food industry |
| 253*   | Researchers and research assistants in wood and oxide materials |
| 254*   | Researchers and research assistants in life sciences |
| 255*   | Researchers and research assistants in medicine |
| 256*   | Researchers and research assistants banking |
| 257*   | Researchers and research assistants in legal sciences |
| 258*   | Researchers and research assistants in humanities and social sciences |
| 311    | Physical and engineering science technicians |
| 312    | Computer associate professionals |
| 313    | Optical and electronic equipment operators |
| 314    | Ship and aircraft controllers and technicians |
| 315    | Safety and quality inspectors |
| 316*   | Technicians and foremen in textile, leather and food |

Continued on Next Page...
| ISCO 88 | Name                                                                 |
|---------|----------------------------------------------------------------------|
| 317*    | Technicians and foremen in timber, glass and ceramics, pulp, paper  |
|         | and building materials                                                |
| 321     | Life science technicians and related associate professional          |
| 322     | Health associate professionals (except nursing)                      |
| 323     | Nursing and midwifery associate professionals                         |
| 331     | Primary education teaching associate professionals                    |
| 332     | Pre-primary education teaching associate professionals                |
| 333     | Special education teaching associate professionals                    |
| 334     | Other teaching associate professionals                                |
| 341     | Finance and sales associate professionals                             |
| 342     | Business services agents and trade brokers                           |
| 343     | Administrative associate professionals                               |
| 344     | Customs, tax and related government associate professionals           |
| 345     | Police inspectors and detectives                                     |
| 346     | Social work associate professionals                                  |
| 347     | Artistic, entertainment and sports associate professionals           |
| 348     | Religious associate professionals                                    |
| 349*    | Technicians in tourism and leisure activities                         |
| 411     | Secretaries and keyboard-operating clerks                            |
| 412     | Numerical clerks                                                     |
| 413     | Material-recording and transport clerks                              |
| 414     | Library, mail and related clerks                                     |
| 419     | Other office clerks                                                  |
| 421     | Cashiers, tellers and related clerks                                 |
| 422     | Client information clerks                                            |
| 423*    | Community officials in public service                                |
| 511     | Travel attendants and related workers                                |
| 512     | Housekeeping and restaurant services workers                         |
| 513     | Personal care and related workers                                    |
| 514     | Other personal services workers                                      |
| 516     | Protective services workers                                          |
| 521     | Fashion and other models                                             |
| 522     | Shop, stall and market salespersons and demonstrators                 |
| 611     | Market gardeners and crop growers                                    |
| 612     | Animal producers and related workers                                 |
| 613     | Crop and animal producers                                            |
| 614     | Forestry and related workers                                         |
| 615     | Fishery workers, hunters and trappers                                |
| 711     | Miners, shotfirers, stone cutters and carvers                        |
| 712     | Building frame and related trades workers                            |
| 713     | Building finishers and related trades workers                         |
| 714     | Painters, building structure cleaners and related trades workers      |

Continued on Next Page...
| ISCO 88 | Name |
|---------|------|
| 721     | Metal moulders, welders, sheet-metal workers, structural-metal preparers, and related trades workers |
| 722     | Blacksmiths, tool-makers and related trades workers |
| 723     | Machinery mechanics and fitters |
| 724     | Electrical and electronic equipment mechanics and fitters |
| 731     | Precision workers in metal and related materials |
| 732     | Potters, glass-makers and related trades workers |
| 733     | Handicraft workers in wood, textile, leather and related materials |
| 734     | Craft printing and related trades workers |
| 741     | Food processing and related trades workers |
| 742     | Wood treaters, cabinet-makers and related trades workers |
| 743     | Textile, garment and related trades workers |
| 744     | Pelt, leather and shoemaking trades workers |
| 811     | Mining and mineral-processing-plant operators |
| 812     | Metal-processing plant operators |
| 813     | Glass, ceramics and related plant operators |
| 814     | Wood-processing- and papermaking-plant operators |
| 815     | Chemical-processing-plant operators |
| 816     | Power-production and related plant operators |
| 817     | Industrial robot operators |
| 818*    | Operators of technical means of active intervention in the atmosphere |
| 821     | Metal- and mineral-products machine operators |
| 822     | Chemical-products machine operators |
| 823     | Rubber- and plastic-products machine operators |
| 824     | Wood-products machine operators |
| 825     | Printing-, binding- and paper-products machine operators |
| 826     | Textile-, fur- and leather-products machine operators |
| 827     | Food and related products machine operators |
| 828     | Assemblers |
| 829     | Other machine operators not elsewhere classified |
| 831     | Locomotive engine drivers and related workers |
| 832     | Motor vehicle drivers |
| 833     | Agricultural and other mobile plant operators |
| 834     | Ships’ deck crews and related workers |
| 835*    | Harbor workers |
| 911     | Street vendors and related workers |
| 912     | Shoe cleaning and other street services elementary occupations |
| 913     | Domestic and related helpers, cleaners and launanders |
| 914     | Building caretakers, window and related cleaners |
| 915     | Messengers, porters, doorkeepers and related workers |
| 916     | Garbage collectors and related labourers |
| 921     | Agricultural, fishery and related labourers |
Table 2 – Continued

| ISCO 88 | Name                                      |
|---------|-------------------------------------------|
| 931     | Mining and construction labourers         |
| 932     | Manufacturing labourers                    |
| 933     | Transport labourers and freight handlers   |
| 941*    | Apprentices                               |

References

[1] Albert-Laszlo Barabasi, Reka Albert, and Hawoong Jeong. Mean-field theory for scale-free random networks. *Physica A*, 272:173–187, Jul 1999.

[2] G. Caldarelli, A. Capocci, P. De Los Rios, and M. A. Munoz. Scale-free networks from varying vertex intrinsic fitness. *Phys. Rev. Lett.*, 89(25):258702, Dec 2002.

[3] Giorgio Fagiolo. Clustering in complex directed networks. *Phys. Rev. E*, 76(2):026107, Aug 2007.

[4] Mark Granovetter. *Getting a Job: A Study of Contacts and Careers*. University Of Chicago Press, 2 sub edition, March 1995.

[5] Matthew O. Jackson and Brian W. Rogers. Meeting strangers and friends of friends: How random are social networks? *American Economic Review*, 97(3):890–915, June 2007.

[6] Boyan Jovanovic. Job matching and the theory of turnover. *Journal of Political Economy*, 87(5):972–90, October 1979.

[7] Gueorgui Kambourov and Iourii Manovskii. Occupational specificity of human capital. *International Economic Review*, 50(1):63–115, 02 2009.

[8] Xiang Li, Yu Ying Jin, and Guanrong Chen. Complexity and synchronization of the world trade web. *Physica A: Statistical Mechanics and its Applications*, 328(1-2):287 – 296, 2003.

[9] Davia M. Job mobility and wage mobility at the beginning of the working career: a comparative view across europe. ISER working papers 2005-03, Institute for Social and Economic Research, January 2005.

[10] Brian P. McCall. Occupational matching: A test of sorts. Working Papers 617, Princeton University, Department of Economics, Industrial Relations Section., Aug 1988.

[11] Derek Neal. The complexity of job mobility among young men. *Journal of Labor Economics*, 17(2):237–61, April 1999.

[12] J. Reichardt and D.R. White. Role models for complex networks. *Eur. Phys. J. B*, 60(2):217–224, 2007.
[13] Kathryn L. Shaw. Occupational change, employer change, and the transferability of skills. Working Paper Series / Economic Activity Section 55, Board of Governors of the Federal Reserve System (U.S.), 1985.

[14] Nachum Sicherman and Oded Galor. A theory of career mobility. *Journal of Political Economy*, 98(1):169–92, February 1990.

[15] Robert H Topel and Michael P Ward. Job mobility and the careers of young men. *The Quarterly Journal of Economics*, 107(2):439–79, May 1992.

[16] Yoram Weiss. Learning by doing and occupational specialization. *Journal of Economic Theory*, 3(2):189–198, June 1971.