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# Journal of Economic Behavior & Organization

journal homepage: [www.elsevier.com/locate/jebo](http://www.elsevier.com/locate/jebo)

## Inter-industry labor flows

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### ARTICLE INFO

#### Article history:

Received 26 January 2017

Received in revised form 12 June 2017

Accepted 5 July 2017

Available online 22 July 2017

#### Keywords:

Labor mobility

Relatedness

Skills

Regional growth

Germany

Human capital specificity

### ABSTRACT

Using German social security data, we study inter-industry labor mobility to assess how industry-specific human capital is and to determine which industries have similar human capital requirements. We find that inter-industry labor flows are highly concentrated in just a handful of industry pairs. Consequently, labor flows connect industries in a sparse network. We interpret this network as an expression of industries similarities in human capital requirements, or skill relatedness. This skill-relatedness network is stable over time, similar for different types of workers and independent of whether workers switch jobs locally or over larger distances. Moreover, in an application to regional diversification and local industry growth, skill relatedness proves to be more predictive than colocation or value chain relations. To facilitate future research, we make detailed inter-industry relatedness matrices online available.

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## 1. Introduction

Labor mobility plays an important role in economics. On the one hand, industry-specific technology or demand shocks often necessitate a transfer of productive capacity, and thus of workers, from shrinking to growing industries. On the other hand, labor mobility diffuses know-how across firms, industries and locations, and is therefore important in organizational learning (March 1991; Simon, 1991) and regional and national growth (Saxenian, 2007). Unsurprisingly, therefore, labor mobility has received much scholarly attention from both labor economists and innovation economists. However, one aspect of labor mobility has hitherto been relatively neglected, namely, the mobility patterns of workers across industry boundaries. As a consequence, the inter-industry structure of labor flows is still poorly understood. This is surprising, given that if inter-industry labor flows exhibit a high degree of structure, mobility of workers across industries will be constrained by this structure. Because any constraints to such mobility will limit both, the reallocation of labor, and the diffusion of knowledge, a deeper understanding of inter-industry labor flows may shed light on a wide range of economic phenomena, from individual careers to economic development, structural change and innovation.

In this paper, we contribute to our understanding of inter-industry labor flows, showing that they exhibit strong regularities. We summarize these regularities in a set of stylized facts that are organized around three related topics: (1) the expression of human capital specificities in the structure labor flows, (2) the use of labor-flow-networks as measures of inter-industry relatedness and (3) the way in which the constraints on inter-industry labor-flows these networks express affect diversification and labor reallocation in local economies. In particular, we ask a number of interrelated questions: Do labor flows concentrate in relatively few industry pairs? How stable is the network of inter-industry labor flows? Is this net-

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work general or specific to an occupation? Does the sparseness of the inter-industry labor-flow-network condition a region's growth path? And, finally, does this sparseness constrain a local economy's capacity to reallocate labor from contracting to expanding industries?

These questions complement a vast literature on general labor flows and job switching. For instance, labor economists have extensively studied job-switching rates (or, their complement, employment durations) and how they depend on business cycles, industry and worker characteristics. Recent work in this tradition finds that workers often change jobs across industries that belong to completely different sectors (Parrado et al., 2007; Kambourov and Manovskii, 2008). This finding may lead to the conclusion that human capital has no strong industry-specific component. However, because this research fails to take into consideration which industries exchange workers, it implicitly assumes that all industries are equidistant from one another in terms of human capital requirements. We show that a closer analysis of the network structure of inter-industry labor flows casts doubts on this conclusion. These analyses are collected in a first set of stylized facts that describe how much structure inter-industry labor flows exhibit.

A different group of scholars at the intersection of innovation economics and economic geography has studied the role of labor flows as conduits of knowledge diffusion, typically focusing on the mobility of highly skilled workers, such as inventors. However, although the spatial limits to mobility are central in much of this research (Breschi and Lissoni, 2005; Agrawal et al., 2006; Casper, 2007), also here, the question of whether there are *inter-industry* constraints to labor mobility has typically been neglected.

A second debate to which our work relates takes place in the literature on inter-industry relatedness. In spite of the relative neglect of inter-industry labor flows in labor and innovation economics, an increasing number of papers has turned to such flows as an expression of inter-industry relatedness. These papers assume that human capital is to some extent industry specific. Consequently, labor flows are constrained and will predominantly take place between industries with similar human-capital requirements. This has resulted in labor-flow-based *skill-relatedness*<sup>1</sup> measures (Neffke and Henning, 2013), which have been used in a variety of papers (e.g., Timmermans and Boschma, 2014; Boschma et al., 2014; Diodato and Weterings, 2015). In accordance with this literature, a second set of stylized facts analyzes inter-industry labor flows through the prism of skill relatedness. In particular, we are interested in four issues. First, how volatile are skill-relatedness structures? That is, do they change much from one year to the next or are they relatively stable? Second, how general are skill-relatedness measures? That is, do different types of workers exhibit different skill-relatedness patterns? Third, given that many workers tend to search for jobs in their own region, skill-relatedness measures may just reflect industrial colocation patterns. We therefore ask: do short-distance and long-distance flows differ in the skill-relatedness structure they exhibit? Fourth and finally, we ask: what is the predictive validity of skill-relatedness measures vis-à-vis alternative relatedness measures?

We derive stylized facts from Germany's social security records between 1999 and 2008, which cover over 80% of the working population. We find that, although workers often do switch industries, even at a very high level of aggregation (stylized fact 1), labor flows are highly structured (stylized fact 2). In particular, on average, related industries that together represent just 5% of total German employment absorb over 60% of an industry's total worker outflow. Moreover, the underlying network of labor flows is largely independent of a worker's occupation: workers in different occupations tend to make the same industry switches. This suggests that, independently of any occupational specificities, job switches are guided by a non-negligible industry-specific component in human capital. When we turn to labor flows as a measure of inter-industry relatedness, we find that the derived skill-relatedness index is remarkably stable (stylized fact 5), general across occupations and wage levels and similar in former East and West Germany (stylized fact 4). Furthermore, given that intra-regional flows follow a similar skill-relatedness structure as long-distance flows (stylized fact 3), skill-relatedness is not simply a reflection of the industrial composition of local economies. Moreover, in a direct comparison, our labor-flow-based measure outperforms commonly used alternative relatedness measures in predicting entry and growth rates of local industries (stylized fact 6). Finally, skill-related industries have uncorrelated growth patterns, suggesting that skill-relatedness should typically not impede the reallocation of labor from shrinking to growing industries (stylized fact 7).

Although we limit the analysis in the paper to skill-relatedness among the industries of the classification systems in use between 1999 and 2008, we have constructed skill-relatedness matrices for various industrial and occupational classification systems between 1975 and 2014. To facilitate future research, these matrices are available for online download.<sup>2</sup>

The paper is structured as follows. In Section 2, we discuss the literature on human capital specificities and job switches and the literature on inter-industry relatedness measures. Section 3 describes the data. In Section 4, we develop a number of statistical tools to analyze labor-flow networks and present the stylized facts uncovered with these tools. Section 5 discusses future research and concludes.

<sup>1</sup> Neffke and Henning (2013) argue that, although workers may select a new job for reasons other than skill relatedness (such as preferences and social networks), in the aggregate, inter-industry labor flows seem to predominantly express skill similarities. We will return to this issue later on.

<sup>2</sup> A link to these matrices, as well as detailed description of the procedure used to create these matrices, is provided on the first author's personal website.

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