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EXTENDED ABSTRACT

Title: Location Determinants of the Software Industry in Madrid

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Abstract: *(minimum1500 words)*

Location determinants of firms have always been a topic of great interest to most urban and regional economics researchers with the aim of understanding firm's behaviours. This interest is even greater when it comes to key industries for regional and urban growth and development. One of the industries that has won relevance and importance in recent decades is the software industry. This industry has been one of the fastest growing knowledge-intensive industries in the last decades. Software industry is a key sector in the knowledge economy, which is characterised by a high intensity of innovation. Due to the high pace of innovation in the software industry, knowledge linkages and partnerships are vital to firms in this sector (Segelod and Jordan 2004). As said by Trippl et al. (2009), knowledge interactions are crucial in the innovation process in the software sector.

Software industry has emerged from cities in the USA, Europe and Asia. Cities are considered centres of software clusters, and thanks to their roles as centres of knowledge flows and creativity are the key determinants of their competitiveness in the knowledge-intensive software industry (Tsang, 2005). Moreover, this industry is dominated by entrepreneurs and small companies. Despite a few major players, is a sector composed mainly by small firms (Nowak and Grantham, 2000; Trippl et al.,

2009). Thus, due to the intrinsic features of the sector, it will need to create strategic alliances to survive in our global and competitive economy.

The global economic crisis transformed the practices and meanings of work in the knowledge economy and, as consequence in the software industry. Especially in cities, it has been seen a significant shift towards freelance work, (solo) self-employment and microbusinesses (Bögenhold and Klinglmair, 2016; Houston and Reuschke, 2016). Some literature suggested that nonstandard forms of employment have become usual within a highly individualised labour market in which urban professionals work as a casualised, project-based and freelance workforce (Cappelli and Keller, 2013; Osnowitz, 2010). This raises the question of the extent to which knowledge workers are encouraged in finding new ways to live a precarious worklife in this professional context. As a consequence, the literature review addresses one of the most interesting phenomena in recent years, the spread of co-working spaces. These sharing spaces are a recent urban phenomenon that shapes the innovative urban ecosystems and grow worldwide due to the increase in knowledge-based economy (Mariotti et al, 2017; Merkel, 2019). Digital transformation and new workspaces are facilitating the collaborative co-working, which has the potential of creating a new kind of economy that supports community and innovation (Davies and Tollervey, 2013). Merkel (2015) argues that co-working spaces can be observed as a new form of urban social infrastructure, enabling contacts and collaborations between people and ideas. The need for a new location to work and share ideas and knowledge, the need for a flexible office that supports mobile and collaborative work creates the co-working phenomenon.

Thus, the global economic changes, the growth of entrepreneurship, the specific characteristics of the software industry, the collaboration technologies in the workplace and the requirements of sociability have created new needs in the software industry. These needs may influence the decisions of location of firms in this industry and modify their location behaviours. Consequently, we introduce in our analysis a new variable as possible determining factor of the location decisions of software firms. This variable is the ‘co-working spaces’ and, so far, it had never been taken into account in the literature.

The aim of this paper is to analyse which factors determine the location choices/behaviours of software firms in Madrid and detect the relevance of the new

variable introduced, 'co-working spaces'. As possible location determinants we consider the distance to public transport infrastructures (i.e. accessibility), the distance to urban amenities, the distance to places where knowledge spillovers and knowledge linkages are present (universities, technology parks and co-working spaces), the distance to other software firms (i.e. agglomeration economies and spillover effects) and other covariates.

We focus in the software industry due to its strategic relevance for developed economies in the last two decades. This industry has been one of the fastest growing knowledge-intensive industries and, last years, has been forced to transform its way of working. As consequence, maybe the behaviour of software firms to locate in cities has been modified.

To do that we use a Gibbs model, which allows to decompose the conditional intensity of the spatial point process into trend and interaction components. On the one hand, the trend captures the covariates effect (distance to amenities, public infrastructures and other covariates), while, on the other hand, interaction captures spillover effects (proximity to other software firms). We sort our estimations dividing the sample in size (big, medium and small firms) and age (young, middle age and old firms) in order to find different location patterns through different firm characteristics.

According to the firms' age, we will consider three groups. The first group comprises those software firms established during the computer revolution, or Internet revolution, i.e. between 1996 and 2000. The second group comprises software firms created before the world economic crisis (between 2004 and 2007); and, finally, the third group comprises software firms established after the world economic crisis (between 2013 and 2016). We chose these periods because we wanted to analyse the location patterns before and after the 2008 financial crisis. We believed that studying entries of firms during the crisis was a bit risky, since there were many entries and exits in that period.

According to the firms' size, we take into consideration a classification alternative to ORBIS classification, because we do not consider it appropriate.

ORBIS classifies according to the size of the firms as follows, using the number of employees, the operating income, or the size of their assets. Consequently, they consider as very large firms when operating income ≥ 100 million EUR, or total assets ≥ 200 million EUR or employees ≥ 1,000. As large firms if operating income ≥ 10 million

EUR, or total assets ≥ 20 million EUR, or employees ≥ 150. As medium firms when operating income ≥ 1 million EUR, or total assets ≥ 2 million EUR, or employees ≥ 15. Any other firm is considered small.

In this way, they consider small firms those with less than 15 employees, a very elevated number if we take into consideration other studies in Europe (Trippl et al., 2009) or the characteristics of the software sector itself. So, if we followed ORBIS classification, the 87.2% of the sample would be classified as small firms, finding very heterogeneous firms within this group.

For this reason, in this paper, we will consider small firms those up to 3 employees, medium-sized firms those with between 4 and 20 employees, large firms those with more than 20 employees and up to 250 and very large firms those with a number of employees higher than 250.

The methodology used in this paper, the Gibbs model allows us to consider the space as being continuous. In fact, we use geo-referenced point data of the firms as an explained variable and covariates as an explanatory variables defined on a continuous space. Nevertheless, until now, most of the methodology used in the empirical research on location determinants was based on administrative boundaries.

Keywords: *(Industrial location, Gibbs models, Software Industry, Madrid)*