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Effects of knowledge capital on total factor productivity in China: A spatial econometric perspective

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ABSTRACT

The transformation of China into a knowledge based economy is one of the most intensively debated research issues in Economic Geography. The focus of this study is on effects of knowledge capital on manufacturing total factor productivity (TFP) in China through the lens of the regional knowledge capital model (KCM). The objective is to estimate the impact of region-internal and region-external knowledge capital — measured in terms of patents granted by the Chinese patent office — on TFP across Chinese regions. We derive a Spatial Durbin Model (SDM) for empirical testing, using panel data on 29 Chinese regions for the years 1988–2007. The results indeed point to a shift of Chinese productivity growth to a more knowledge based one, statistically confirming the impact of knowledge capital on regional TFP after 1998. Furthermore, this shift is not only based on region-internal knowledge capital, but also on inter-regional knowledge spillovers.

1. Introduction

The tremendous growth performance and catching-up process of the Chinese economy over the past three decades is — undisputedly — unique since the industrial revolution at the beginning of the 18th century (see, e.g., Wu, 2011). The average annual growth in Gross Domestic Product (GDP) has been maintained at 9.7% since the opening up of the Chinese economy in 1978 until 2008 (see, e.g., Tian & Yu, 2012), which is sometimes referred to as the Chinese growth miracle (see Gilboy, 2004, among others). During the late 1970s and early 1980s, the Chinese government — recognising the failure of the *Great Leap Forward* policy and the cultural revolution in terms of economic development (see Huang, 2010) — had launched a series of reforms which have lead to an internationalisation and opening of the country to the outside world (see, e.g., OECD, 2008). These reforms clearly constitute the landmark as a starting point for the transition of China from a centrally planned to a market-based economy, and, subsequently, to the extensive growth of the manufacturing sector, in the earlier phases mostly driven by Foreign Direct Investments (FDIs), accompanied by massive urbanisation (Guo, Dall'erba, & LeGallo, 2013). Until today, the growth of the Chinese manufacturing sector has represented by far the most important component of overall GDP growth (see Guo et al., 2013, among others).

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The characterisation of the sources of this tremendous growth performance has attracted burst of attention in the scientific domain over the past decades (see, e.g., Bosworth & Collins, 2008; Chow, 2008; Chow & Li, 2002; Ozyurt, 2009; Zhang & Stough, 2013), and is still one of the most interesting research issues, given the fact that opinions on the sustainability of Chinese growth have hardly reached consensus. From a New Economic Geography (NEG) perspective (see Krugman, 1991), the Chinese growth performance fits very well to theoretical models of NEG, explaining how low transportation costs in combination with the spatial concentration and specialisation of economic activities — referred to as agglomeration effects — increase economies of scale (see Huang, 2010)[1]. In fact, during the opening up period, China's entry into the world market was mainly defined by its role as a major supplier of labour-intensive manufactured products, such as textiles and clothes, based on the massive pool of cheap labour providing an immense competitive advantage for manufacturing industries in an increasingly globalised economy. In this sense, it may be assumed that the Chinese growth dynamics will be levelled out when, on the one hand, the supply of cheap labour is absorbed and, on the other hand, productivity-driven growth — mainly based on new technological knowledge and, generally speaking, innovation — is not becoming a more prominent factor in the Chinese growth nexus (see Krugman, 1994; Wu, 2011; Zhang & Stough, 2013).

Thus, the focus of the current study is on investigating the link between productivity in the manufacturing sector, and knowledge capital, including knowledge spillovers, in China. The last decade has seen the development of a significant body of empirical research in this direction, mainly for the US and Europe, but also for China. Generally speaking, this research has shown that the productivity of firms or industries is related to their R&D productivity, and also to the R&D spending of other firms or other industries (see, e.g., Mairesse & Sassenou, 1991). Fischer, Scherngell, and Reismann (2009) characterise the relation between productivity in manufacturing and knowledge capital at a regional level for the European case by spatial econometric methods, showing that a region's total factor productivity (TFP) in manufacturing depends on its own knowledge capital, but — as suggested by theory — also on inter-regional knowledge spillovers. Robbins (2006) finds similar evidence for the US. While for the Chinese case different determinants of economic growth and productivity have been widely investigated in previous empirical works, there is only scarce evidence on effects of knowledge capital and knowledge spillovers. One notable exception is the study of Kuo and Yang (2008) that relates knowledge capital and knowledge spillovers to regional economic growth in China. The study provides statistically significant evidence for the positive impact of knowledge capital on Chinese economic growth and suggests the existence of knowledge spillovers.

The current study follows this research tradition by investigating effects of knowledge capital on Chinese productivity in manufacturing sectors from a regional perspective. In doing so, we focus — in contrast to Kuo and Yang (2008) — on manufacturing TFP at the level of Chinese regions through the lens of the regional knowledge capital model (KCM) as, e.g., used for the European case by Fischer et al. (2009) and LeSage and Fischer (2012). The objective is to estimate the impact of region-internal and region-external knowledge on TFP in the manufacturing sector across Chinese regions, and, by this, providing evidence on the crucial question whether TFP in China is increasingly based on knowledge capital. Relying on the regional KCM as theoretical framework, we derive a Spatial Durbin Model (SDM) relationship that is used for empirical testing. The Chinese coverage is achieved by using regional data on 29 Chinese provinces for the years 1988–2007. The dependent variable denotes regional TFP in manufacturing, describing how efficiently each province transforms physical capital and labour in manufacturing into gross industrial output. We explain manufacturing TFP — starting from the regional KCM — by region-internal and region-external knowledge stocks, the latter referred to as the inter-regional knowledge spillover pool. We measure regional knowledge stocks in terms of patents from all technological sectors granted by the Chinese patent office.

Methodologically, we implement a panel version of the standard SDM that controls for spatial autocorrelation, individual heterogeneity across regions as well as time-specific effects. The specification incorporates a spatial lag of the dependent variable as well as spatial lags of the independent variables, allowing for the endogenous estimation of TFP effects resulting from region-external knowledge stocks. In order to identify the point in time of China shifting towards a knowledge-based economy, we employ panel LM unit root tests, providing statistical evidence for structural breaks in the time dimension of the data.

By this, the study departs from previous research for the Chinese case in at least four major aspects (see, e.g., Guo et al., 2013; Kuo & Yang, 2008; Wu, 2011). *First*, we use — following LeSage and Fischer (2012), Fischer et al. (2009) and Robbins (2006) — patent stocks to proxy regional knowledge capital stocks using an extended data set on regional patent applications across Chinese provinces for the years 1988–2007. *Second*, the study accounts directly for spatial knowledge spillovers by adding a spatially discounted knowledge spillover variable to the regional KCM framework. *Third*, we employ a spatial econometric perspective in specifying a panel version of the SDM relationship. This allows us to elegantly trace knowledge diffusion across geographical space using spatial weight matrices. *Fourth*, by focusing on an extended time period from 1988 to 2007, we are able to disentangle different phases of Chinas transition into a knowledge economy by applying unit root tests. These are utilised to split our panel data set into different time periods and to estimate separate models for these time periods. This will provide important insights into whether the impact of knowledge capital on Chinese TFP in manufacturing has increased over time.

The remainder of the study is organised as follows. The section that follows characterises China's way to a knowledge economy, providing information on different phases of Chinese growth between 1978 and 2010, laying special emphasis on policy measures to foster science and technology in order to stimulate productivity growth. Section 3 sets forth the theoretical

[1] Likewise, China's recent growth is in line with NEG models of human capital accumulation in urban centres that serves as a driving force for economic development. Micro-foundations of NEG models with growth being modelled as dependent on knowledge capital accumulation, and knowledge spillovers as facilitated by labour mobility from rural to urban regions are discussed, among others, by Eaton and Eckstein (1997) and Lucas (2004).