China Economic Review 20 (2009) 414–424

Contents lists available at ScienceDirect

China Economic Review

Double-edged effects of the technology gap and technology spillovers: Evidence from the Chinese industrial sector

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ARTICLE INFO

Article history:
Received 15 June 2009
Accepted 16 June 2009

JEL classification:
F43
O11
O33

Keywords:
FDI
technology gap
technology spillovers
multiple-threshold model

ABSTRACT

This paper proposes a new insight that the technology gap plays double-edged roles in the technology spillovers of foreign direct investment (FDI) through two channels, technology choice set and technology absorptive capability. Applying a multiple-threshold model, we examine the non-linear relationship between the technology gap and technology spillovers based on the provincial panel data of the Chinese industrial sector during 1993–2006. The empirical results support the hypothesis of two thresholds, which are 0.3071 and 0.5214 in terms of the technology gap respectively. The estimated thresholds indicate the sufficient absorptive capability is the premise for FDI technology spillovers. Moreover, it implies the marginal decrease of FDI technology spillover effects in the long run.

1. Introduction

FDI is the most attractive openness pattern in that it offers the domestic country the opportunity to acquire advanced technology (Caves, 1996). Since the late 1980s, with the emergence of endogenous growth theory and the widespread application of empirical analysis, many scholars have examined FDI technology spillover effects. Several scholars have found evidence for significant technology spillovers from FDI (e.g., Görg & Strobl, 2001; Haskel, Pereira, & Slaughter, 2007). In contrast, some researchers have found little evidence for positive, or have even found negative, technology spillovers (e.g., Kokko, Tansini, & Zejan, 1996; Aitken & Harrison, 1999). The deeper reason for this contradiction, besides the source of the data (Tong & Hu, 2005), estimation method (Görg & Strobl, 2001), and variable choice (Wei & Liu, 2006), is that many researchers have analyzed the impact mechanism of FDI technology spillovers only from the perspective of the investing country, not the host country. In reality, the technology level of domestic enterprises is the crucial factor that affects technology spillovers (e.g., Kokko, 1994; Alfaro, Chanda, Kalemli-Ozcan, & Sayek, 2004). The technology gap between domestic and foreign enterprises, as one of the main indicators of the technology level of domestic enterprises, has attracted much attention from scholars (Glass & Saggi, 1998), but a consistent model of the mechanism of the technology gap's effects on technology spillovers has not been achieved.

Findlay (1978) pointed out that the technology externality from FDI is an increasing function of the technology gap; that is to say, technology spillovers will be weakened with the reduction of the technology gap. The model of Wang and Blomstrom (1992) demonstrated that spillovers from FDI have a positive relationship with the technology gap between domestic and foreign enterprises. As stated by Romer (1990), since the cost of imitation is lower than the cost of innovation, a larger original technology gap indicates that domestic enterprises have more learning opportunities and imitate more technology from advanced foreign

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doi:10.1016/j.chieco.2009.06.007

enterprises, creating an advantage of backwardness. On the other hand, Cohen and Levinthal (1989) found that the prerequisite for an enterprise to benefit from the advanced technology invented by other enterprises is a special "absorptive ability". Kokko (1994), Perez (1997), and Sohinger (2005) propose that FDI is a decreasing function of the technology gap. They pointed out that a large technology gap indicates a weak ability to learn, thereby restricting FDI spillover effects. Research on the Chinese industrial sector by Chen (2003) and Cheung and Lin (2004) also demonstrated that a decrease in the technology gap is conducive to technology spillovers. These results are often attributed to the absorptive ability of domestic enterprises.

However, these two perspectives have been continually challenged by the facts. Less developed countries and areas with large technology gaps can hardly benefit from the advanced technology of developed countries to realize their leapfrogging growth; however, the areas with small gaps also fail to exhibit significant spillover effects. As Lai, Peng, and Bao (2006) explained, based on the viewpoint of absorptive capacity, most developing countries have not yet fully used their advantage of backwardness. It is true that the larger the gap, the more learning opportunities the domestic enterprises will gain. However due to a lack of sufficient abilities to effectively learn and absorb advanced foreign technologies, the relationship between the technology gap and technology progress may be non-linear and uncertain.

Based on the existing literature, we propose that the technology gap has double-edged effects on FDI technology spillovers. On the one hand, the technology gap could be considered as an indicator of effective technology choice set that reflects the degree of technological complexity of learning and imitation. In this way, the FDI technology spillover is an increasing function of the technology gap. On the other hand, the technology gap could be considered as the domestic technology level relative to the foreign technology level. In other words, it can be considered as an indicator of absorptive capability as well, making FDI technology spillovers a decreasing function of the size of the gap. Unfortunately, the existing literature has not fully considered these double-edged effects.

This paper intends to re-evaluate the effects of technology spillovers from FDI using panel data from 28 provinces[1] in China covering the period of 1993-2006. In contrast to the literature, this paper considers the double-edged effects of the technology gap on spillovers. Based on the threshold regression model of Hansen (1999), we test the existence of thresholds and further estimate the non-linear relationship between the technology gap and FDI technology spillovers following endogenous grouping. The empirical results provide a sufficient and reasonable economic explanation for the observed paradox, and will help to deepen the understanding of FDI technology spillover effects.

2. Theoretical Framework and Methodology

2.1. Framework and model

Unlike the classic model that has been used in analyzing FDI technology spillovers, this paper considers the double-edged effects of the technology gap on technology spillovers through two channels: effective technology choice set and absorptive capability. If this proposition of double-edged effects is correct, then technology spillovers from FDI should have threshold points and present a nonlinear process.

Among the literatures on the technology spillovers of FDI, the most common method is estimating the contribution of FDI to domestic total factor productivity (TFP) based on the production function by considering FDI as an explanatory variable (Kinoshita, 2001; Sabirianova, Svejnar, & Terrell, 2005). In addition, as Aitken and Harrison (1999) pointed out, there exists an endogeneity problem in the estimation of technology spillovers of FDI because FDI often takes place in those regions or industries that have relatively higher productivity. We follow Liu (2008) in using the variable $FDI_{i(t-1)}$, which is lagged by one year to reduce the possible endogeneity problem. Thus, the empirical model is as follows:

$$\ln A_{it}^{D} = \theta \cdot \ln FDI_{i(t-1)} + \delta \cdot X_{it}^{D} + \varepsilon \tag{1}$$

A_{it}^{D} represents the TFP, where superscript D denotes the domestic enterprise (differing from the foreign one, F), and the subscripts i and t represent the province and year, respectively. *FDI* is an indicator of foreign direct investment, and therefore, a positive coefficient θ indicates that the introduction of FDI has had positive spillover effects on domestic technical progress, and vice versa. X_{it}^{D} represents the control variables containing the factors influencing TFP, excluding FDI. Balasubramanyam (2002) suggested that FDI stimulates the economic growth of a host country given a stable economic environment, sufficient human capital, and perfect infrastructure. Therefore, we choose the degree of marketization (*Mar*), human capital stock (*Hc*), and infrastructure indicators (*Inf*) as control variables.

In order to determine the influence that the technology gap exerts upon FDI technology spillovers, we add the interaction term $I = \ln FDI_{i(t-1)} \cdot \ln Gap_{it}$ into Eq. (1). Then, our main estimating model is:

$$\ln A_{it}^{D} = \theta \cdot \ln FDI_{i(t-1)} + \eta \cdot I + \delta \cdot X_{it}^{D} + D_j + D_t + \varepsilon \tag{2}$$

The technology spillover effects of FDI are reflected by the partial effect of the variable *FDI* on domestic TFP. Furthermore, when we estimate the technical spillover effects, several unobserved factors that influence both A_{it}^{D} and *FDI* should be controlled. For this

[1] Chongqing, which became a municipality in 1997, was merged into Sichuan province to maintain consistency of the data. In addition, due to a lack of data, the sample does not contain data on Tibet or Qinghai.