Mutual Productivity Spillovers between Foreign and Local Firms in China

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Abstract

The existing literature treats advanced technology sourcing as the only cause for reverse productivity spillovers from local to foreign firms and implies that mutual spillovers between foreign and local firms can only happen in the developed world. This paper argues that the diffusion of indigenous technology and local knowledge helps the productivity enhancement of multinationals. There can be mutual spillovers even in a developing country. The results from a large-sample firm-level econometric analysis and a comparative case study of seven companies in Chinese manufacturing support this new argument as mutual spillovers are identified between local Chinese firms and overseas Chinese or OECD invested firms.

Key words: Foreign direct investment, indigenous knowledge, mutual productivity spillovers

JEL Classifications: F23, D62.

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1. Introduction

Following an early theoretical discussion of productivity spillovers or external effects from foreign direct investment (FDI) by MacDougall (1960), a large number of empirical studies have been produced. These include Caves (1974), Globerman (1979), Liu et al. (2000), Driffield (2001), and Harris and Robinson (2004) for developed countries; Blomström and Persson (1983), Haddad and Harrison (1993), Kokko (1994), Aitken and Harrison (1999), Wei and Liu (2001, 2006), Li et al. (2001), Hu and Jefferson (2002), Liu (2002), Mencinger (2003), Nunnenkamp (2004), Javorcik (2004), and Kohpaiboon (2006) for developing countries. The fundamental purpose of these studies is to investigate whether the presence of multinational enterprises (MNEs) leads to productivity or efficiency benefits in local firms in a host country. Blomström and Kokko (1998), Saggi (2002) and Görg and Greenaway (2004) provide detailed surveys and Görg and Strobl (2001) offer a meta-analysis of this literature.

More recent FDI literature has begun to recognise reverse productivity spillovers, i.e. FDI may be motivated by technology sourcing (see, for example, Kogut and Chang, 1991; Cantwell, 1995; Neven and Siotis, 1996; Driffield and Love, 2003). Firms decide to invest abroad not so much to exploit advantages they already possess but to acquire new technological knowledge (Fosfuri and Motta, 1999). The reverse spillover hypothesis suggests that firms might benefit from technological spillovers when they locate close to market leaders. As developed countries are leaders in technology, reverse spillovers are naturally thought to be the phenomenon in developed countries only. This explains why both theoretical and empirical studies so far are confined to the developed world.

To our best knowledge, we are the first to argue that reverse productivity spillovers can occur in a developing country. Although technological capabilities are generally lower in developing than in developed countries, MNEs can benefit from *indigenous knowledge* in a host developing economy. Indigenous knowledge spillovers contribute to productivity enhancement in foreign subsidiaries.

Methodologically, we combine both illustrative case studies with a large sample econometric investigation. Seven local and foreign-invested firms located in Chong Qing, China were interviewed during August and September 2005 to examine the mechanisms through which mutual productivity spillovers occur. To provide statistical generation, we also conduct firm-level econometric analysis to obtain evidence of mutual productivity spillovers between foreign and local firms in China.

The rest of the paper is organised as follows. Section 2 discusses the possible impact of indigenous knowledge on productivity of foreign firms in a developing country, and possible channels for indigenous knowledge acquisition by foreign firms. This provides the theoretical underpinning of the study. The comparative case study is reported in section 3. The econometric methodology and regression results are presented in sections 4 and 5, respectively. Finally, section 6 offers concluding remarks and discusses policy implications.

2. Indigenous Knowledge Spillovers in a Developing Country

As indicated earlier, most existing studies have dealt with spillovers from MNEs to local firms in a host country. As summarised in Blomström and Kokko (1998) and Saggi (2002), productivity spillovers occur by the following means. MNEs may break supply bottlenecks, demonstrate new technologies and train workers who later take employment in local firms, break down monopolistic industrial structure and stimulate competition and efficiency, transfer techniques for inventory and quality control and standardisation to their local suppliers and distribution channels, and force local firms to increase their managerial efforts, or to adopt marketing techniques used by MNEs. These activities may introduce new know-how and intensify competition and hence contribute to productivity gains. If productivity gains outweigh competition losses, there will be positive productivity spillovers. Otherwise, the impact of foreign presence on the host economy will be negative.

Empirical studies for both developed and developing countries as cited in the preceding section provide mixed results. Negative productivity spillovers are found in some countries, especially some developing countries. It is generally agreed that local firms can take advantage of the advanced technology possessed by MNEs if they have the technological competence to absorb it (Nunnenkamp, 2004). It is also found that spillover effects vary across regions within a country. (Wei and Liu, 2006).

While local firms may benefit from the very presence of MNEs, do MNEs learn from local firms? Recent literature suggests that MNEs can benefit from the knowledge possessed by local firms. Firstly, some studies such as Makino and Delios (1996) have discussed the importance of local knowledge in international joint venture (IJV) performance in developing countries. Secondly, Fosfuri and Motta (1999) and Driffield and Love (2003) among others have analysed MNEs' technology sourcing from local firms in developed countries. Building on these two lines of thoughts, we hypothesise that MNEs can learn from local firms even in a developing country.

2.1 Local Knowledge

FDI theory suggests that advanced technology, although very important, is not sufficient for the success of foreign subsidiaries in a host country. Knowledge needed for a foreign firm to be competitive in the host country includes the organisation of work, non-codifiable knowledge, marketing and finance know-how, and product innovations and modifications (Dunning, 1988). Firms investing abroad have the disadvantage of being foreign which stems from a lack of local knowledge. Local knowledge is the understanding of local market, cultural and environmental conditions (Inkpen and Beamish, 1997), including cultural traditions, norms, local business practices, values and institutional differences, operating conditions, laws, government policies and regulations and general knowledge of the economy. Local knowledge also includes a local firm's skills and capabilities to negotiate with the local government; its access to, and skills in negotiating with, the local elite; its ability to manage the local labour force and unions; and its competence with respect to local market access, product quality, branding, and market reputation. It is difficult for firms investing abroad to possess a whole set of knowledge which is required for a successful operation in the host country. A stock of local knowledge can complement a firm’s ownership advantages and can mitigate the disadvantages of being foreign, hence can improve the performance of foreign subsidiaries (Makino and Delios, 1996). Thus, to establish an operational success in a host country, a firm must access local knowledge as a means of overcoming market risks and uncertainties (Stopford and Wells, 1972).

Makino and Delios (1996) provide a detailed discussion of three channels for local knowledge acquisition: by formation of a JV with a local firm, by transference from the foreign parent's stock of host country experience, and by the accumulation of operational experience in the host country. The first channel is seen as a between-firm channel in which local knowledge is transferred from a local JV partner to the JV. The local partner is the immediate source of local knowledge, which can complement the investing firm's ownership advantages. The second channel is a within-firm transfer of local knowledge from the foreign parent to the JV. Transaction cost economics suggests that a firm has an incentive to internalise the market for such intangible assets. The third channel is also regarded as a within-firm acquisition of knowledge because local knowledge is accumulated by a JV in its learning-by-doing process.

The three channels identified above are important for a foreign firm to obtain local knowledge. However, this strand of analysis neglects one significant channel, local knowledge diffusion. Given the nature of local knowledge being non-rival and only partially excludable, it can exert an externality effect on foreign firms. Foreign firms can simply acquire knowledge via learning by watching and benefit from the very presence of local firms. Local firms can have demonstration and competition effects on foreign-invested firms and therefore affect their productivity.

2.2 Technology Sourcing

In a theoretical model, Fosfuri and Motta (1999) question the traditional argument that firms must possess some specific advantages in order to invest abroad. They argue that laggard firms might benefit from technological spillovers when they locate close to market leaders. Given the possible existence of this reverse spillover phenomenon, FDI might be a channel for acquiring knowledge. The reverse productivity spillover hypothesis has gathered support from empirical studies. Kogut and Chang (1991) find that Japanese MNEs in the US benefited from US R&D intensity during the period 1976-1987. Cantwell (1995) indicates that technology leaders develop international networks to exploit the locationally differentiated potential of foreign centres of excellence. Similarly, Braunerhjelm and Svensson (1996) demonstrate that Swedish MNEs in high-tech industries tend to locate their production facilities in foreign "centres of excellence". Neven and Siotis (1996) show that technology sourcing by US MNEs may undermine the technological base in the EC. Recently, Driffield and Love (2003) find that technology generated by the indigenous sector in the UK spills over to foreign MNEs although this effect is restricted to relatively R&D inventive sectors only.

The recognition of the possible existence of reverse spillovers from indigenous to foreign firms represents a very important contribution to the research of productivity spillovers. However, one important problem with this analysis is that it treats advanced technology as the only source of productivity spillovers. As developed countries are world leaders in technology, this line of thoughts naturally implies that reverse spillovers can only happen in the developed world.

2.3 Indigenous Knowledge Spillovers in a Developing Country

There can be mutual productivity spillovers between foreign and indigenous firms in a developing country. Just as foreign knowledge can spill over to local firms because of the presence of foreign firms, indigenous knowledge may spill over to foreign-invested firms in a host developing country. As mentioned earlier, for a foreign firm to be competitive or efficient in a host country, indigenous knowledge is essential. The two main elements of *indigenous knowledge* are *indigenous technology* and *local knowledge*.

Indigenous technologies in developing countries are generally not as advanced as technologies possessed by MNEs from developed countries. However, they may be more appropriate for the local market than those from MNEs, may play an important role when advanced foreign technologies from MNEs are adapted to the local conditions, or may be complementary to foreign technologies (Lall, 1983). It is noted in recent FDI literature that spillovers should be more easily captured when there is a high degree of complementarity between the host and the foreign firm (Harris and Robinson, 2004).

Local knowledge is crucial for overcoming local market uncertainties. Its role is more important in a developing country than in a developed country, as market uncertainty in the former is much higher than in the latter. If MNEs' benefits from locating in a developed country are reversed technology spillovers, theirs from locating in a developing country are knowledge diffusion from indigenous firms. Both kinds of knowledge diffusion contribute to productivity enhancement in MNEs.

If the direction of the channels of productivity diffusion summarised in Blomström and Kokko (1998) and Saggi (2002) is reversed, the means of indigenous knowledge spillovers from local to foreign firms can be readily identified. For instance, they can occur when local firms demonstrate new or appropriate technologies for the local market, when local firms train workers who later take employment in foreign firms and when local firms force foreign firms to increase their managerial efforts. Similarly, the impact of indigenous knowledge spillovers can be either positive or negative.

Of course, indigenous knowledge can also be acquired directly via strategic alliances such as forming JVs as discussed by Makino and Delios (1996). A recent example was that Alcatel, a French multinational, and Chinese SDG Information Co Ltd invested a total of US$ 28 million in an optical fibre JV in Shenzhen, China. These two parent companies combine their complementary resources in the following way: "Alcatel will mainly provide the process technology for the venture while SDG Information will offer its local knowledge and industry expertise" (Telecomworldwire 2000). It must be noted that Alcatel via the establishment of the JV is able to acquire not only local knowledge but also indigenous technical expertise.

In sum, the existing literature suggests that knowledge flows run in both directions in industrial countries because both foreign and local firms are technologically strong and capable. In most developing countries, local firms are relatively weak in technological terms, and hence knowledge flows are likely to be more one-way traffic, from foreign affiliates to local firms (UNCTAD, 2001). This traditional wisdom is generally valid if advanced technology sourcing is regarded as the only cause for productivity spillovers. However, advanced technology is not the only important determinant of productivity. Indigenous knowledge, which includes both indigenous technology and local knowledge, is also important for the productivity enhancement in MNEs in a developing country. This paper argues that there can be mutual productivity spillovers between foreign and local firms in a host developing country if the role of indigenous knowledge in productivity enhancement is properly acknowledged. If productivity spillovers from foreign to indigenous firms are mainly caused by advanced technological knowledge spillovers, then those from local to foreign firms may result chiefly from indigenous technology and local knowledge spillovers.

3. Case Studies

Methodologically, we first conduct a comparative case study to identify the mechanisms of mutual spillovers. Seven local and foreign-invested firms located in Chong Qing, China were interviewed during August and September 2005. The basic characteristics of these companies are presented in table 1 with their identities being disguised for the sake of confidentiality[1]. These companies were chosen because of their representative ownership profiles and industrial nature. There are a large number of local private companies in Chong Qing and inward FDI is mainly from East Asian

[1] A detailed description of the companies is available upon request.

economies such as Japan, South Korea, Hong Kong and Taiwan. The seven selected companies are representatives of different groups. As for the industrial sectors, the selected companies consist of five motor-cycle companies (Motor1 to Motor5) and two medical product and equipment firms (Med1 and Med2).

Chong Qing is China's most important motor-cycle manufacturing base where hundreds of firms, large or small, operate in the industry. Lever (1974), Reid (1995) and UNCTAD (2001) suggest that it is easier to source externally when the technology is divisible into separate stages and services than when it is a continuous process. Like the electronic and automotive sectors, technology in the motor-cycle industry is divisible. Hence a broad range of knowledge diffusion was expected. Compared with the motor-cycle industry which is widely seen as a medium-tech sector, the medical product and equipment industries are generally regarded as high-tech sectors.

<Table 1 about here>

In these case studies we first explored whether foreign firms were technologically superior to local firms. Within the five motor-cycle firms, the technology of only one local Chinese firm (Motor3) was regarded as internationally advanced while the other two local Chinese firms (Motor1 and Motor2) possessed domestically advanced technologies. The technology of the Taiwanese firm (Motor4) was also regarded as domestically advanced but that of the Korean firm (Motor5) was internationally advanced. In the medical product and equipment industries, the technology of the HK-mainland China joint venture (Med1) was only domestically advanced, while that of the Japan-mainland China (Med2) was the world's leading one.

The above results are consistent with the existing literature. Japan as a developed county is one of world leaders in technology, while South Korea as one of the newly industrialised countries also has technological advantages in a number of industrial sections over mainland China. The technological levels of the Taiwanese firm and HK-mainland China joint venture seemed to be similar to those of many local Chinese firms, while individual local Chinese firms (e.g. Motor3) could also be internationally advanced in terms of technology. As quoted from the CEO of Motor3, "we own as many as 2,700 intellectual property rights for motor-cycles, and no foreign firm in the industry in Chong Qing is comparable to us", In addition, Motor2 indicated that the company has advantages in some overseas marketing networks, especially in the US, Canada and some Southeast Asian countries. It can correctly identify export markets, and is able to take up orders that other companies do not dare to. These evidences show that different firms have different advantages, and advanced technologies are not the only determinant of a firm's successful operations. Foreign and local firms have their own firm-specific advantages and they could learn and benefit from the presence of each other.

We then looked at *how* local and foreign firms may learn from each other. All three local Chinese firms agreed that they learnt from their foreign counterparts in China. Motor1 explained that the use of more advanced technology and equipment by foreign firms such as Honda and Yamaha to produce motor-cycles set an example for local Chinese firms. As a supplier of components and parts to these foreign firms, Motor1 learnt much from vertical linkages. The main way of Motor2 learning from foreign firms was by reverse engineering. Whenever foreign firms (from Japan, Canada, United States and Italy) developed a new model, Motor2 would buy, study, and modify it according to local market conditions. In addition, Motor2 attended industrial and trade exhibitions in Milan, Manila and Guangzhou to see new models and to learn new technology applications and new material utilisation. Motor3 learnt technologies from foreign firms in three ways. First, similar to Motor2, it purchased and studied new models of motor-cycles from foreign firms for the purpose of developing its own products. Second, it bought two assembly lines from Yamaha and this substantially improved the efficiency and quality of motor-cycle assembly. Third, it jointly developed a new model with Yamaha which turned out to be the most popular motor-cycle in southwest China in 2004.

As for managerial skills, Motor1 and Motor2 did not learn from foreign firms, but Motor3 did. When advanced machinery and equipment were introduced from Yamaha, its technical and managerial personnel came to provide guidance and assistance. Motor3 learnt advanced management gradually via such co-operations. The key aspect that Motor3 learnt is Yamaha’s responsibility and incentive/punishment system. In addition, Motor3 has recruited personnel who used to work for foreign firms (e.g. Yamaha).

The above evidence further confirms that local Chinese firms do learn from foreign firms. The mechanisms include demonstration, imitation, contagion, collaboration, labour turnovers and technical assistance.

Having identified mechanisms through which local Chinese firms learnt from foreign invested firms, we sought both local Chinese firms' and foreign firms' views on whether indigenous knowledge is important for foreign invested firms and whether foreign firms learn from local Chinese firms.

All the three local Chinese firms felt that indigenous knowledge is very important for foreign firms operating in China. As reported by Motor1, foreign firms obtain local knowledge via recruiting local people and collaborating with local Chinese firms. Both Motor2 and Motor3 said that foreign and local firms do learn and imitate from each other. As the CEO of Motor2 put it: "There are more than 3000 firms producing components and parts for the motor-cycle industry in Chong Qing. While supplying my company, such a firm may supply my foreign and local competitors at the same time. Competitors may well obtain my company's most advanced technology or method via the supplier. For instance, in 2003, my company invented a new technology for motor-cycle shock absorption. Within 2 months foreign and local competitors produced a very similar or almost the identical product".

All four foreign invested firms also agreed that indigenous knowledge is important to their success in China, and they obtained such knowledge in various ways. Motor4 and Med2 indicated that they obtained local knowledge via communications with the local government, collaborations with relevant local firms, and recruitment of technical and management personnel from local firms. In addition to the mechanisms mentioned by Motor4 and Med2, Motor5 invited various experts as the firm's advisers and Med1 said they collaborated with local universities. Med2 also indicated that they obtained indigenous knowledge via employment of large and experienced market investigation companies. This helped the firm to better understand market situations and changes.

With regard to local Chinese firms' demonstration effects, the financial director of Motor5 said: "When we just entered the Chong Qing market, we really felt that motor-cycles produced by local Chinese firms were more appropriate. Initially our main products were the mid- and large-sized engine motor-cycles. However, income levels of Chong Qing consumers were not relatively high, and they used motor-cycles mainly as basic transport tools in this hilly city. Therefore, small-engine motor-cycles, e.g. 80-120cc, better meet Chong Qing consumers' needs. It followed that from last year we gradually switched to producing small-engine motor-cycles".

In terms of recruitment of key technical and managerial personnel from local Chinese competitors, three out of the four foreign invested firms admitted that they did so to obtain indigenous knowledge. Given that three out of these four foreign invested firms also lost some key personnel to local Chinese competitors, it is clear that key personnel turnover is running in both directions. On the other hand, none of these foreign invested firms interviewed had any formal technical or managerial collaboration with local firms. This is different from the three Chinese firms interviewed of which two had such formal co-operations with foreign invested firms.

The findings from our comparative case study support our hypothesis that indigenous knowledge is important for foreign firms operating in China and that foreign firms learn and benefit from local firms even in a developing country.

4. Econometric Model and Estimation Strategy

While case studies are useful for obtaining direct evidence of how knowledge spills over between firms on an individual basis, a large-sample econometric analysis is able to provide statistical generalisation. Koo (2005) categorises spillover studies into four groups according to methodological approaches: technology flow approach, cost function approach, production function approach and the paper trail approach. We adopt the production function approach to measure the effects of spillovers on productivity. First, arguably, the paper trail approach using patent and patent citation data provides the most direct measure of spillover effects while the others employ indirect and suggestive measures. Unfortunately, patent and patent citation data are not readily available in China at the firm level. Second, in FDI research, productivity spillovers have long been the focus of almost all authors, from early studies such as Caves (1974) and Globerman (1979) to recent studies such as Javorcik (2004) and Kohpaiboon (2006). Given the theme of this paper, we take the same approach to modeling the productivity of a foreign (local) firm as a function of the presence of local (foreign) firms in Chinese manufacturing as well as other relevant variables. The findings from our study can be compared and contrasted with findings in the existing literature.

In line with the discussions so far, the following extended production function at the firm level, which is commonly used in the FDI spillover literature, is employed to examine the hypothesis of mutual productivity spillovers:

$$Log(Y_{ijt}) = \alpha_0 + \alpha_1 Log(K_{ijt}) + \alpha_2 Log(L_{ijt}) + \alpha_3 (IAR_{ijt}) + \alpha_4 (MS_{ijt}) + \alpha_5 (SP_{jt}) + \alpha_6 (SP_{jt})^2 + \alpha_7 (IDs) + \alpha_8 (RDs) + u_{ijt} \quad (1)$$

where subscripts i, j and t indicate the firm i in sector j in year t. *Y*, *K*, and *L* are value added, capital stock, and employment, respectively. *IAR* is the ratio of intangible assets to total assets of a firm and *MS* is a firm's sales as a proportion of sales of four-digit industry to which the firm belongs. SP_j is the spillover variable which captures the effects of the presence of Chinese or foreign firms. A positive (negative) coefficient indicates a positive (negative) productivity spillover effect. Given that productivity spillovers may be nonlinear, the squared *SP* is introduced. *ID*s are the industry dummies for manufacturing industries. They are used to control for differences in productivity across sectors. *RD*s are the region dummies and are introduced to control for region-specific effects such as infrastructure. China consists of 31 provinces. Tibet is left out because reliable data are not available for the whole period. Chongqing was not separated from Sichuan until 1996 and thus Chongqing and Sichuan have been treated as one combined province. Finally, *u* is the usual error term. *IAR*, *MS*, *IDs* and *RDs* are introduced as control variables.

Equation (1) shows that a foreign (local) firm's productivity is influenced by its own knowledge stock proxied by its intangible assets and its market size as well as the presence of local (foreign) firms (the spillover term *SP*). We are particularly interested in the sign and magnitude of the spillover term. In the case of productivity of a foreign firm, for instance, the basic idea of Equation (1) is that the spillover term should be large if there are Chinese firms operating in any industry alongside foreign firms, whereas the spillover term should be low if the industry is made up exclusively of foreign firms[2]. A similar interpretation applies in the case of productivity of a local firm.

Our econometric study is based on a panel data set covering 7763 domestically-owned firms and 5487 foreign-invested firms in 193 four-digit manufacturing industries over the period of 1998-2001. The appendix provides a detailed description of the data sources and variable definitions. Foreign investors in China can be divided into two groups according to their country-of-origin: overseas Chinese from Hong Kong, Macao and Taiwan (HMT), and other foreign investors mainly from OECD countries (OECD). There are 2598 HMT-invested and 2689 OECD-invested firms in the sample. Their roles in mutual productivity spillovers are compared in this study.

One important econometric issue is the possibility of endogeneity. The Chinese and foreign presence might well be influenced by productivity. Foreign/domestic firms may be attracted to high productivity sectors without generating spillovers. As is well known, it is very difficult to create an effective set of instruments. Among the list of candidates, few are likely to be truly exogenous. To keep the possible endogeneity problem to a minimum, two estimation techniques are employed in the paper. One is to use spillover variables with a lag of one year in the estimation. This also takes into account the lag between knowledge spillovers and productivity gains. The other is to use three stage least squares (3SLS) estimation techniques, and the instruments used include all lagged explanatory variables and all region and industry dummy variables. These instruments are not perfect and therefore caution must be exercised when interpreting the results.

[2] We thank one referee for suggesting this clarification of the econometric model.

Spillover effects are normally received first by the neighbouring firms. The benefits may then gradually spread to other, more distant firms. Thus, inter-firm knowledge spillovers are increased when firms collocate, that is geographically proximate[3]. A study of geographical scale of productivity spillovers is particularly important when we measure the impact of FDI in all regions if the "local" benefits are too small to offset the overall negative impact across all regions (Aitken and Harrison, 1999). In this study, we also examine whether the spillover effects are local in scale.

5. Regression Results

Table 2 provides summary statistics and correlation coefficients of the variables used in the estimations. There is substantial variation in variables. Three sets of measurements for spillovers variables are used in the paper, R&D (RDSP), capital investment (DISP) and employment (EMSP) for two reasons. Firstly, they can be used to test the robustness of the empirical model. Secondly and more importantly, we feel that a single proxy may capture one aspect of spillovers only. In our case, R&D spillovers are the leakage of R&D activities from other firms. Capital investment spillovers are related to the demonstration effect of the suitability of the project, or the superiority of machinery or equipment embodying updated technologies. Employment spillovers are associated with employee turnovers or contagion between employees in foreign and local firms. By so doing, we can find out the means by which productivity spillovers occur between foreign and local firms in Chinese manufacturing. *DRDSP*/*DDISP*/*DEMSP* are measured by the share of domestically owned firms'

[3] We thank one referee for pointing out this.

intangible assets/*direct investment*/*employment* in total *intangible assets*/*direct investment*/*employment* in the four-digit industry. HRDSP, HDISP, HEMSP, ORDSP, ODISP, OEMSP are defined and measured in a similar way. Details of measures of variables can be found in the Appendix. Different measures of spillover variables are relatively highly correlated. The correlation coefficients between DRDSP, DDISP and DEMSP range from 0.67 to 0.81, those between HRDSP, HDISP and HEMSP range from 0.56 to 0.76 and those between ORDSP, ODISP and OEMSP range from 0.68 to 0.75. The correlation coefficients between other explanatory variables are low except those between LK (=log(K)) and LL (=log(L)), suggesting that multicollinearity doesn’t seem to be a severe problem in our estimations.

<Table 2 is about here>

Table 3 presents the estimation results using generalised least squares. This is because White tests indicate the existence of heteroskedasticity. Consequently, all variance-covariance matrices are estimated according to the White method for heteroskedasticity adjustment. Columns (3.1) to (3.4) report the reverse productivity spillover from local Chinese firms to overseas Chinese (HMT) firms as well as OECD invested firms, and columns (3.5) to (3.8) show the spillovers from HMT and OECD invested firms to local Chinese firms. In each column, we use three measures of spillovers, R&D (RDSP), capital investment (DISP) and employment (EMSP). In addition, given that productivity spillovers may not be necessarily linearly associated with the presence of indigenous or foreign-invested firms, we introduce the squared spillover variables in our estimations to avoid possible model mis-specifications. But the results for models without squared spillover variables are also reported for comparison.

As can be seen in table 3, in some cases such as the bottom panel of columns (3.1) and (3.2), when only the level spillover variable is included in the estimation, it is insignificant. However, when both the level and the squared variables are introduced, both become significant. This suggests that simply including one level variable is not sufficient to capture the spillover effects. The fact that some previous studies fail to find spillovers may partly be caused by their adoption of the incorrect functional form for estimations. The following discussion will concentrate on the results when both SP and SP^2 variables are included in the empirical models.

<Table 3 is about here>

As shown in table 3, the coefficients on capital (LK), labour (LL), and market share (MS) in any column are all highly significant and have the expected positive sign. A firm's own R&D (IAR) is positive and statistically significant in regressions (3.5) to (3.8), but insignificant in other regressions. This shows that there is also a need to control for both market share and R& D variables.

We now turn to the impacts of Chinese and foreign presence in which we are most interested. The upper panel of columns (3.1) to (3.4) shows the results of productivity spillovers to foreign-invested firms via R&D activities of local Chinese firms. The coefficients on DRDSP in columns (3.1) and (3.2) are positive and significant at the 10% level, but the coefficient on $DRDSP^2$ in (3.1) is insignificant, indicating a positive and linear relationship between R&D activities in local Chinese firms and the productivity in HMT-invested firms. By comparison, the coefficients on DRSP in columns (3.3) and (3.4) are positive and highly significant, and the coefficient on $DRSP^2$ in column (3.3) is negative and highly significant, showing a non-linear relationship between R&D activities in local Chinese firms and the productivity in OECD-invested firms. Put another way, with an increase of R&D activities by local Chinese firms, their positive impact on the productivity of OECD-invested firms increases initially, but after a threshold level, it decreases.

The middle panel of columns (3.1) to (3.4) reports the results of productivity spillovers to foreign-invested firms via possible demonstration effects of capital investment made by local Chinese firms. In (3.1), the coefficients on DDISP and $DDISP^2$ are positive and negative, respectively and both are highly significant, suggesting a non-linear relationship between capital investment by local Chinese firms and the productivity of HMT-invested firms. Similarly, by checking the coefficients on DDISP and $DDISP^2$ in (3.3), we also find a non-linear relationship between capital investment by local Chinese firms and the productivity of OECD-invested firms. These results suggest that local Chinese firms seem to exert positive effects on foreign (i.e. both HMT and OECD) invested firms though at a diminishing rate. The technological capabilities in Chinese indigenous firms are lower than those in foreign-invested firms. To compete with foreign-invested firms, local Chinese firms may invest in machinery and equipments which are most suitable for the production of goods for the Chinese market. Local Chinese firms may do so in order to compensate for their inferiority in technologies, but these activities may in fact produce strong demonstration effects on foreign-invested firms and force them to choose appropriate ways of production and improve efficiency in the Chinese market.

In the bottom panel of columns (3.1) to (3.4) we present the results of productivity spillovers from local Chinese firms to foreign-invested firms via employee turnover or contagion effects. The coefficients on DEMSP in (3.1) and (3.3) are positive and highly significant, and the coefficients on $DEMSP^2$ are negative and highly significant in (3.1) and (3.3). This indicates a positive and non-linear relationship between employment in local Chinese firms on one hand, and the productivities of HMT and OECD invested firms respectively on the other. This type of reverse productivity spillovers is not difficult to understand. When MNEs enter China, the overwhelming majority of their employees are local Chinese. They can be well trained by local Chinese firms but attracted to foreign-invested firms by higher salaries. They also have close relations with the employees in the local Chinese sector. Thus, indigenous technologies and local knowledge spill over to foreign-invested firms in this way.

Having examined reverse spillovers, we now need to look at productivity spillovers from HMT and OECD invested firms to local Chinese firms to see whether the spillover effects are mutual. Though there are a number of studies investigating this issue including Li et al. (2001), Wei and Liu (2001, 2006), Buckley et al. (2002), Hu and Jefferson (2002) and Liu (2002), none of these studies take into account the possibility that spillovers may be non-linear. The results are reported in columns (3.5) to (3.8) of table 3. The coefficients on HRDSP and $HRDSP^2$ are positive and negative, respectively and both are highly significant in the upper panel of (3.5). This shows that R&D activities in HMT-invested firms have a positive but non-linear impact on the productivity of local Chinese firms. Similarly, the information on the coefficients of ORDSP and $ORDSP^2$ in the upper panel of (3.7) indicates a positive but non-linear impact of R&D activities in OECD-invested firms on the productivity of local Chinese firms. It is generally held that MNEs from OECD countries are superior to those from HMT in product and process innovation and in technological development, while the latter have good ability to adapt mature technologies to more labour-intensive contexts and to local raw materials (Buckley et al. 2002). Our results confirm that these two types of activities in foreign-invested firms are both important to the productivity enhancement in local firms in Chinese manufacturing.

The middle panel of columns (3.5) to (3.8) of table 3 is concerned with the productivity impact of capital investment by HMT and OECD invested firms on local Chinese firms. The coefficients on HDISP and $HDISP^2$ in (3.5) and (3.6) and these on ODISP and $ODISP^2$ in (3.7) and (3.8) indicate that the capital investment by HMT-invested firms has a positive and linear impact, and that by OECD-invested firms has a positive and non-linear impact, on the productivity of local Chinese firms. Our tentative explanation of the results is that, HMT-invested firms may be engaged more in labour intensive products, which may be more consistent with the current resource endowments in China, so that this positive productivity impact turns to be linear. On the other hand, OECD-invested firms may be involved in more technologically advanced projects. Although they are extremely important to China’s technological upgrade and future development, the investment projects by OECD firms may be less compatible with the current resource endowments in China than those by HMT firms, and hence the positive impact reduces with an increase in these projects. Of course, this difference may be caused by the use of a specific estimation method. As can be seen in table 4, when 3SLS is used, the productivity impacts of capital investment from both HMT and OECD invested firms are positive and non-linear.

Finally, the bottom panel of columns (3.5) to (3.8) reports the results on productivity spillovers from foreign-invested firms via employment turnover and contagion effects. The coefficients on HEMSP and $HEMSP^2$ in (3.5) and (3.6) are positive and highly significant, indicating a linear relationship between the employment in HMT-invested firms and the productivity of local Chinese firms. On the other hand, the positive and significant coefficient on OEMSP and the negative and significant coefficient on $OEMSP^2$ in (3.7), show a positive but non-linear relationship between the employment in OECD-invested firms and the productivity of local Chinese firms. The fact that HMT-invested firms seem to have a linear, and OECD-invested firms have a non-linear, productivity impact may well be due to the use of a particular estimation method. From table 4, this difference is reversed. But the main finding in this aspect is that the employment in both HMT and OECD invested firms has a positive impact on the productivity of local Chinese firms.

Table 4 shows the results of mutual productivity spillovers using 3SLS. As mentioned in the previous section, because the instrumental variables used may be imperfect, the results from 3SLS need to be interpreted with caution. However, by comparing tables 3 and 4, we can find that the main results from the two alternative estimation methods are quite consistent. The central messages are: the presence of both HMT and OECD invested firms has consistently positive impacts on the productivity of local Chinese firms, while significantly positive reverse spillovers are identified from local Chinese firms to both HMT and OECD invested firms in Chinese manufacturing. These mutual productivity spillovers occur via the means of R&D activities, investment demonstrations and employment turnover and contagion effects. Put another way, no matter which measure of foreign or Chinese presence is used and which estimation method is applied, the clear evidence is that there are mutual productivity spillovers between foreign and local firms in Chinese manufacturing. The only slight differences between the two tables lie in whether the positive spillovers are linear or non-linear in several limited cases. But overall, the results are quite robust.

<Table 4 is about here>

Tables 3 and 4 report the spillover effects on the national scale. Following the discussion in the final paragraph of section 4, we now examine whether inter-firm knowledge spillovers are increased when firms co-locate. There can be different ways to test this “geographic proximity” hypothesis. In this study we follow the common practice in the FDI spillover literature and examine whether the externalities are local in scale.

In table 5 we report the results when the regional rather than national spillover term is employed. Mainland China is divided into 29 regions. Consistent with the existing FDI literature such as Sjöholm (1999), we examine the productivity spillovers impact of foreign presence/domestic presence within regions by employing measures of localisation which takes the form of the shared foreign or domestic presence in the sector within a region. Put another way, the degree of domestic presence at four-digit industry level for each region is constructed as the proportion of intangible assets/capital investment/employment within the particular manufacturing sector accounted for by domestic firms. Overseas Chinese firms' presence and OECD firms' presence are defined and measured in a similar way. In this table, variables with a postfix _REG capture the effects of the presence of foreign or domestic firms within a region.

The central message from this table is that, in each region on average, there is clear evidence of mutual productivity spillovers. Combining the information in tables 3-5, we can conclude that mutual productivity spillovers between foreign and local firms are both national and regional in scale. Although there are some differences in the magnitude and level of significance of the spillover term in tables 3-5, qualitatively, these tables provide the consistent statistical evidence: both foreign and local firms learn and benefit from each other in Chinese manufacturing.

6. Conclusions

This research is motivated by our puzzling observation that no attempt has been made to assess the possibility of reverse productivity spillovers in a developing country. We argue that advanced technology is not the only important factor influencing productivity. For a firm to be competitive or efficient in a host country, especially in a host developing economy, indigenous knowledge is essential. The success of MNEs in a developing country depends on a successful combination of the firm-specific advantages (e.g. advanced technology and managerial skills) with indigenous knowledge. Indigenous knowledge can spill over to foreign-invested firms and can have positive effects on productivity in foreign-invested firms.

Methodologically, we use both case studies and econometric analysis to test our new hypothesis. The comparative case study has provided direct evidence that foreign and local firms do learn and benefit from each other. Such productivity spillover channels as demonstration, imitation, contagion or labour turnover, and technical and managerial assistance to suppliers are confirmed by the seven foreign and local Chinese companies. Econometrically, the large-sample though indirect evidence from Chinese manufacturing also supports this new argument. On one hand, both OECD and overseas Chinese invested firms have positive, though sometimes diminishing, effects on the productivity of local Chinese firms. On the other hand, the very presence of local Chinese firms exerts positive but sometimes diminishing productivity impacts on both OECD and overseas Chinese invested firms. The empirical models for mutual spillovers between local Chinese and foreign-invested firms are robust as the use of the different measures of presence (R&D, capital investment and employment) and the adoption of the different estimation methods produce quite consistent results.

The main limitations of this paper are as follows. Firstly, although there are a very large number of firms included in the sample, the time frame (1998-2001) is relatively short. Secondly, like all existing econometric analyses, the statistical evidence of productivity spillvoers provided in this paper is only indirect. Thirdly, although we have used the case studies to provide direct evidence of mutual productivity spillovers in the motor-cycle and medical product and equipment sectors, probably it would be more interesting to have more companies interviewed and to compare an industry where spillovers are large with an industry where they are much less.

Despite the limitations, we believe that the findings of this study have important theoretical, policy and managerial implications. In terms of theory, this paper only provides a preliminary framework for reverse spillovers from local to foreign firms in a host developing country. Further studies need to be carried out to examine and elaborate this new hypothesis. For home-country governments and businesses, the findings of this paper indicate that outward FDI into a developing country may enable investing firms to obtain an access to not only relatively cheap labour and other factors of production, but also indigenous knowledge which plays a complementary role in productivity enhancement. For host developing countries, inward FDI needs to be promoted as it can have a positive impact on productivity in indigenous firms, and therefore on economic growth.

APPENDEX: Data Sources and Variable Definitions

The data used for the current study are mainly from the *Annual Report of Industrial Enterprise Statistics* compiled by the State Statistical Bureau of China during the period 1998-2001. The data set covers nine two-digit industries, including food processing, food manufacturing, beverage production, garments and other fibre products, medical and pharmaceutical products, ordinary machinery manufacturing, transport equipment manufacturing, electric machines and apparatuses, and electronic and telecommunications equipment. Due to entry and exit and ownership restructuring, the number of firms in operation is changing over time. In this study, the same firms have been identified based on their identifiers to produce a balanced set of 15,761 firms for each year. The data are then cleaned via extensive checks for nonsense observations, outliers, coding mistakes, and the like. In addition, only firms with at least three years of data for value added, output, capital stock, intangible assets, exports and total sales are kept. These finally leave us with a balanced panel of 13,250 firms.

The data are broken down by ownership. A firm has been defined to be domestically-owned, if its foreign equity participation, if any, is below 25%. All foreign investors in China based on their country-of-origin can be divided into two groups: overseas Chinese from Hong Kong, Macao and Taiwan (HMT), and other foreign investors mainly from OECD countries (OECD). In the data set, 7763 are domestically-owned firms, 2598 are HMT-owned firms and 2689 are OECD-owned firms. In terms of employment, these firms altogether accounted for nearly 78% over the sample period. Thus the sample is fairly representative of the 9 Chinese manufacturing industries.

In our model, *Y*, *K*, and *L* are value added, physical assets, and the number of employees of firm *i*, respectively. *IAR* is the ratio of intangible assets to total assets of a firm. Intangible assets are used as a proxy for the stock of knowledge and can include patents, trademarks, goodwill, development costs where capitalised and the value of publication rights and brands where capitalised. *MS* is firm *i*'s sales as a proportion of sales of the four-digit industry in which the firm belongs to. *SP* is the spillover variable. DRDSP/DDISP/DEMSP are measured by the share of domestically owned firms' intangible assets/direct investment/employment in total intangible assets/direct investment/employment in the four-digit industry. HRDSP, HDISP, HEMSP, ORDSP, ODISP, OEMSP are defined and measured in a similar way. HRDSP/HDISP/HEMSP are measured by the share of HMT-invested firms' intangible assets/direct investment/employment in total intangible assets/direct investment/employment in the four-digit industry and ORDSP/ODISP/OEMSP are measured by the share of OECD-invested firms' intangible assets/direct investment/ employment in total intangible assets/direct investment/employment in the four-digit industry.

To remove the influence of inflation, all relevant variables have been adjusted by deflators. Price indices for total manufacturing fixed assets and industrial output are obtained from *China Statistical Yearbook* 2002.

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Table 1: Summary of Main Characteristics of Firms Interviewed

Company	Ownership	Main product	Export share	Interviewee
Motor1	Chinese limited	Motor-cycles parts	0%	Chairman
Motor2	Chinese private	Motor-cycles & parts	50%	CEO
Motor3	Chinese stock Co	Motor cars & motor-cycles	30%	CEO
Motor4	Taiwanese owned	Motor-cycle engines & parts	70%	Chairman
Motor5	Korean owned	Motor-cycle parts	100%	Finance director
Med1	IJV with HK	Biotech products	22%	Chairman
Med2	IJV with Japan	Medical equipment	80%	Finance manager

Table 2 Summary Statistics and Correlations

Panel A

	HMT Sector			OECD Sector				Domestic Sector		
	Mean	Med.	s.d.	Mean	Med.	s.d.		Mean	Med.	s.d.
LY	8.97	8.82	1.37	9.41	9.23	1.54	LVA	8.01	8.13	1.98
LK	8.85	8.77	1.60	9.50	9.40	1.71	LK	8.82	8.89	1.92
LL	5.35	5.31	1.06	5.40	5.33	1.15	LL	5.28	5.27	1.43
IAR	0.26	0.00	11.09	0.15	0.01	2.31	IAR	0.11	0.00	0.84
MS	0.01	0.00	0.04	0.02	0.00	0.05	MS	0.01	0.00	0.04
DRDSP	0.30	0.23	0.22	0.32	0.26	0.24	HRDSP	0.14	0.08	0.16
DDISP	0.43	0.36	0.18	0.46	0.41	0.19	ORDSP	0.31	0.27	0.23
DEMSP	0.42	0.31	0.25	0.48	0.46	0.25	HDISP	0.12	0.09	0.11
							ODISP	0.24	0.24	0.17
							HEMSP	0.11	0.07	0.13
							OEMSP	0.15	0.11	0.13

Notes: Med. = Median; s.d. = Standard Deviation. LY = log(Y); LK = log(K); LL = log(L). Variable definitions are provided in appendix.

Panel B: Correlation Coefficient Matrix for the HMT Sector and OECD Sector

OECD Sector / HMT Sector	LK	LL	IAR	MS	DRDSP	DDISP	DEMSP
LK	1	*0.62*	*-0.04*	*0.32*	*0.01*	*0.11*	*0.17*
LL	0.51	1	*0.00*	*0.28*	*-0.06*	*-0.07*	*-0.11*
IAR	-0.06	0.00	1	*0.00*	*0.02*	*0.05*	*0.04*
MS	0.24	0.19	0.00	1	*-0.17*	*0.05*	*0.04*
DRDSP	0.04	-0.13	-0.01	-0.09	1	*0.63*	*0.62*
DDISP	0.06	-0.18	0.00	0.02	0.67	1	*0.81*
DEMSP	0.13	-0.23	-0.01	0.08	0.67	0.81	1

Note: The part of Panel B below the diagonal displays the correlation coefficients for the sample of HMT sector, and the correlation coefficients for the sample of OECD sector are shown above the diagonal.

Panel C: Correlation Coefficient Matrix for the Domestic Sector

Domestic Sector	LK	LL	IAR	MS	HRDSP	ORDSP	HDISP	ODISP	HEMSP	OEMSP
LK	1									
LL	0.81	1								
IAR	-0.04	0.00	1							
MS	0.26	0.27	0.00	1						
HRDSP	-0.12	-0.14	-0.01	-0.07	1					
ORDSP	-0.05	-0.04	-0.02	-0.09	-0.04	1				
HDISP	-0.13	-0.16	-0.01	-0.09	0.71	0.11	1			
ODISP	-0.07	-0.08	-0.01	-0.11	0.10	0.75	0.17	1		
HEMSP	-0.08	-0.06	0.00	-0.08	0.56	0.30	0.76	0.41	1	
OEMSP	-0.04	-0.05	-0.01	-0.09	0.14	0.68	0.27	0.70	0.50	1

Table 3 Production Function Regressions (GLS)

	(3.1)	(3.2)	(3.3)	(3.4)		(3.5)	(3.6)		(3.7)	(3.8)
	HMT Sector	HMT Sector	OECD Sector	OECD Sector		Local Sector	Local Sector		Local Sector	Local Sector
LK	0.301	0.301	0.381	0.384	LK	0.253	0.255	LK	0.253	0.254
	(0.009)***	(0.009)***	(0.010)***	(0.009)***		(0.007)***	(0.007)***		(0.007)***	(0.007)***
LL	0.534	0.535	0.455	0.459	LL	0.750	0.749	LL	0.748	0.749
	(0.013)***	(0.013)***	(0.014)***	(0.013)***		(0.010)***	(0.010)***		(0.010)***	(0.010)***
IAR	0.001	0.001	-0.002	-0.002	IAR	0.019	0.019	IAR	0.019	0.019
	(0.001)	(0.001)	(0.003)	(0.004)		(0.009)**	(0.009)**		(0.009)**	(0.009)**
MS	3.499	3.345	4.643	4.056	MS	3.999	3.915	MS	4.046	3.923
	(0.273)***	(0.255)***	(0.360)***	(0.221)***		(0.212)***	(0.211)***		(0.214)***	(0.212)***
DRDSP	0.250	0.099	0.651	0.176	HRDSP	0.388	-0.030	ORDSP	0.422	0.007
	(0.114)*	(0.059)*	(0.113)***	(0.052)***		(0.138)***	(0.054)		(0.120)***	(0.037)
$DRDSP^2$	-0.211		-0.714		$HRDSP^2$	-0.709		$ORDSP^2$	-0.529	
	(0.137)		(0.138)***			(0.215)***			(0.145)***	
R^2	0.516	0.516	0.634	0.633		0.637	0.637		0.637	0.637
No. of Obs.	7794	7794	8067	8067		23178	23178		23178	23178
LK	0.297	0.300	0.377	0.382	LK	0.255	0.255	LK	0.254	0.256
	(0.009)***	(0.009)***	(0.009)***	(0.009)***		(0.007)***	(0.007)***		(0.007)***	(0.007)***
LL	0.540	0.539	0.468	0.464	LL	0.758	0.757	LL	0.755	0.755
	(0.013)***	(0.013)***	(0.013)***	(0.013)***		(0.010)***	(0.010)***		(0.010)***	(0.010)***
IAR	0.001	0.001	-0.002	-0.003	IAR	0.019	0.019	IAR	0.020	0.020
	(0.001)	(0.001)	(0.004)	(0.004)		(0.009)**	(0.009)***		(0.009)**	(0.009)**
MS	3.534	3.304	3.923	3.862	MS	3.179	3.164	MS	3.245	3.140
	(0.253)***	(0.251)***	(0.215)***	(0.215)***		(0.184)***	(0.183)***		(0.185)***	(0.184)***
DDISP	2.240	0.329	1.650	0.376	HDISP	0.361	0.238	ODISP	0.706	0.014
	(0.314)***	(0.081)***	(0.313)***	(0.075)***		(0.182)**	(0.085)***		(0.148)***	(0.055)
$DDISP^2$	-1.952		-1.249		$HDISP^2$	-0.278		$ODISP^2$	-1.203	
	(0.310)***		(0.298)***			(0.365)			(0.239)***	
R^2	0.519	0.517	0.634	0.633		0.638	0.638		0.638	0.638
No. of Obs.	7794	7794	8067	8067		23289	23289		23289	23289

	(3.1)	(3.2)	(3.3)	(3.4)		(3.5)	(3.6)		(3.7)	(3.8)
LK	0.299 (0.009)***	0.300 (0.009)***	0.378 (0.009)***	0.381 (0.009)***	LK	0.255 (0.007)***	0.255 (0.007)***	LK	0.254 (0.007)***	0.254 (0.007)***
LL	0.538 (0.014)***	0.537 (0.014)***	0.465 (0.013)***	0.464 (0.013)***	LL	0.757 (0.010)***	0.757 (0.010)***	LL	0.757 (0.010)***	0.757 (0.010)***
IAR	0.001 (0.001)	0.001 (0.001)	-0.002 (0.004	-0.003 (0.004)	IAR	0.019 (0.009)***	0.019 (0.009)***	IAR	0.020 (0.009)**	0.020 (0.009)***
MS	3.340 (0.252)***	3.284 (0.252)***	3.954 (0.216)***	3.923 (0.216)***	MS	3.181 (0.184)***	3.186 (0.183)***	MS	3.239 (0.184)***	3.198 (0.183)***
DEMSP	0.983 (0.247)***	0.065 (0.064)	0.770 (0.252)***	0.136 (0.061)**	HEMSP	0.244 (0.204)***	0.295 (0.084)***	OEMSP	0.526 (0.169)***	0.259 (0.071)***
$DEMSP^2$	-0.923 (0.239)***		-0.605 (0.233)***		$HEMSP^2$	0.102 (0.370)***		$OEMSP^2$	-0.579 (0.331)*	
R^2	0.517	0.516	0.633	0.632		0.638	0.638		0.638	0.638
No. of Obs.	7794	7794	8067	8067		23289	23289		23289	23289

Notes:

1. Region and industry dummies are included in all regressions. Their coefficients are not reported, but available upon request.
2. Standard errors are in parentheses.
3. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.

Table 4 Production Function Regressions (3SLS)

	(4.1)	(4.2)	(4.3)	(4.4)		(4.5)	(4.6)		(4.7)	(4.8)
	HMT Sector	HMT Sector	OECD Sector	OECD Sector		Local Sector	Local Sector		Local Sector	Local Sector
LK	0.355	0.355	0.420	0.420	LK	0.278	0.281	LK	0.281	0.281
	(0.013)***	(0.013)***	(0.013)***	(0.013)***		(0.013)***	(0.013)***		(0.013)***	(0.013)***
LL	0.465	0.465	0.433	0.447	LL	0.723	0.719	LL	0.708	0.715
	(0.020)***	(0.020)***	(0.019)***	(0.019)***		(0.018)***	(0.018)***		(0.018)***	(0.018)***
IAR	0.012	0.012	0.009	0.008	IAR	0.034	0.034	IAR	0.032	0.033
	(0.007)*	(0.007)	(0.012)	(0.012)		(0.012)***	(0.012)***		(0.012)***	(0.012)***
MS	3.841	3.819	5.122	4.224	MS	3.960	3.760	MS	3.916	3.675
	(0.405)***	(0.366)***	(0.356)***	(0.316)***		(0.336)***	(0.334)***		(0.340)***	(0.335)***
DRDSP	0.404	0.381	1.151	0.410	HRDSP	1.114	0.187	ORDSP	0.531	-0.181
	(0.182)**	(0.075)***	(0.156)***	(0.068)***		(0.210)***	(0.082)**		(0.177)***	(0.056)***
$DRDSP^2$	-0.030		-0.990		$HRDSP^2$	-1.620		$ORDSP^2$	-0.910	
	(0.215)		(0.185)***			(0.338)***			(0.214)***	
No. of Obs.	7794	7794	8067	8067		23178	23178		23178	23178
LK	0.353	0.353	0.413	0.415	LK	0.279	0.283	LK	0.282	0.283
	(0.013)***	(0.013)***	(0.013)***	(0.013)***		(0.013)***	(0.013)***		(0.013)***	(0.013)***
LL	0.471	0.475	0.456	0.455	LL	0.735	0.725	LL	0.712	0.718
	(0.020)***	(0.020)***	(0.019)***	(0.019)***		(0.018)***	(0.018)***		(0.017)***	(0.018)***
IAR	0.010	0.007	0.012	0.012	IAR	0.035	0.034	IAR	0.033	0.034
	(0.007)	(0.007)	(0.012)	(0.012)		(0.012)***	(0.012)***		(0.012)***	(0.012)***
MS	3.826	3.628	3.926	3.866	MS	3.209	3.042	MS	3.219	2.888
	(0.369)***	(0.364)***	(0.313)***	(0.312)***		(0.291)***	(0.289)***		(0.292)***	(0.291)***
DDISP	1.976	0.554	1.410	0.419	HDISP	1.878	0.512	ODISP	1.487	-0.193
	(0.432)***	(0.092)***	(0.446)***	(0.089)***		(0.271)***	(0.120)***		(0.221)***	(0.075)***
$DDISP^2$	-1.443		-0.974		$HDISP^2$	-3.177		$ODISP^2$	-2.893	
	(0.428)***		(0.429)**			(0.565)***			(0.357)***	
No. of Obs.	7794	7794	8067	8067		23289	23289		23289	23289

	(4.1)	(4.2)	(4.3)	(4.4)		(4.5)	(4.6)		(4.7)	(4.8)
LK	0.343 (0.014)***	0.347 (0.014)***	0.409 (0.014)***	0.417 (0.014)***	LK	0.285 (0.013)***	0.287 (0.013)***	LK	0.283 (0.013)***	0.283 (0.013)***
LL	0.485 (0.021)***	0.481 (0.021)***	0.459 (0.020)***	0.452 (0.020)***	LL	0.722 (0.018)***	0.718 (0.017)***	LL	0.720 (0.018)***	0.721 (0.017)***
IAR	0.013 (0.007)*	0.011 (0.007)*	0.015 (0.012)	0.013 (0.012)	IAR	0.035 (0.012)***	0.035 (0.012)***	IAR	0.034 (0.012)***	0.034 (0.012)***
MS	3.597 (0.368)***	3.553 (0.367)***	3.927 (0.313)***	3.895 (0.313)***	MS	3.129 (0.290)***	3.079 (0.290)***	MS	3.115 (0.292)***	3.087 (0.290)***
DEMSP	1.353 (0.341)***	0.331 (0.072)***	1.283 (0.348)***	0.177 (0.068)***	HEMSP	1.084 (0.282)***	0.505 (0.097)***	OEMSP	0.588 (0.242)**	0.396 (0.096)***
$DEMSP^2$	-1.028 (0.335)***		-1.070 (0.329)***		$HEMSP^2$	-1.201 (0.550)**		$OEMSP^2$	-0.418 (0.484)	
No. of Obs.	7794	7794	8067	8067		23289	23289		23289	23289

Notes:

1. Standard errors are in parentheses.
2. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively. # indicates that the coefficient is marginal insignificant at 12%.
3. Instrumental variables used are all lagged explanatory variables, region and industry dummies.

Table 5 Production Function Regressions (GLS)

	(5.1)	(5.2)	(5.3)	(5.4)		(5.5)	(5.6)		(5.7)	(5.8)
	HMT Sector	HMT Sector	OECD Sector	OECD Sector		Local Sector	Local Sector		Local Sector	Local Sector
LK	0.302	0.301	0.391	0.388	LK	0.256	0.256	LK	0.252	0.256
	(0.009)***	(0.009)***	(0.009)***	(0.009)***		(0.007)***	(0.007)***		(0.007)***	(0.007)***
LL	0.534	0.535	0.457	0.459	LL	0.754	0.754	LL	0.755	0.755
	(0.013)***	(0.013)***	(0.013)***	(0.013)***		(0.010)***	(0.010)***		(0.010)***	(0.010)***
IAR	0.001	0.001	-0.002	-0.002	IAR	0.019	0.020	IAR	0.020	0.021
	(0.001)	(0.001)	(0.004)	(0.004)		(0.009)**	(0.009)**		(0.009)**	(0.009)**
MS	3.338	3.289	4.186	4.036	MS	3.161	3.133	MS	3.314	3.210
	(0.256)***	(0.255)***	(0.221)***	(0.219)***		(0.183)***	(0.182)***		(0.183)***	(0.183)***
DRDSP_REG	0.011	0.008	0.076	0.086	HRDSP_REG	0.408	-0.001	ORDSP_REG	0.963	0.140
	(0.031)	(0.031)	(0.026)***	(0.026)***		(0.136)***	(0.036)		(0.108)***	(0.027)***
$DRDSP\_REG^2$	-0.076		-0.181		$HRDSP\_REG^2$	-0.468		$ORDSP\_REG^2$	-0.934	
	(0.041)*		(0.035)***			(0.150)***			(0.119)***	
R^2	0.517	0.516	0.634	0.632		0.638	0.638		0.640	0.639
No. of Obs.	7794	7794	8067	8067		23178	23178		23178	23178
LK	0.298	0.301	0.380	0.384	LK	0.255	0.256	LK	0.253	0.256
	(0.009)***	(0.009)***	(0.009)***	(0.009)***		(0.007)***	(0.007)***		(0.007)***	(0.007)***
LL	0.537	0.537	0.462	0.462	LL	0.756	0.756	LL	0.755	0.755
	(0.013)***	(0.013)***	(0.013)***	(0.013)***		(0.010)***	(0.010)***		(0.010)***	(0.010)***
IAR	0.001	0.001	-0.002	-0.002	IAR	0.019	0.019	IAR	0.019	0.020
	(0.001)	(0.001)	(0.004)	(0.004)		(0.009)**	(0.009)**		(0.009)**	(0.009)**
MS	3.468	3.331	3.990	3.925	MS	3.177	3.166	MS	3.298	3.182
	(0.252)***	(0.252)***	(0.215)***	(0.215)***		(0.182)***	(0.182)***		(0.183)***	(0.183)***
DDISP_REG	1.157	0.233	0.938	0.229	HDISP_REG	0.513	0.316	ODISP_REG	1.233	0.113
	(0.177)***	(0.060)***	(0.171)***	(0.054)***		(0.158)***	(0.069)***		(0.115)***	(0.042)***
$DDISP\_REG^2$	-1.056		-0.777		$HDISP\_REG^2$	-0.341		$ODISP\_REG^2$	-1.693	
	(0.190)***		(0.178)***			(0.247)			(0.162)***	
R^2	0.519	0.517	0.633	0.632		0.639	0.639		0.640	0.638
No. of Obs.	7794	7794	8067	8067		23289	23289		23289	23289

	(5.1)	(5.2)	(5.3)	(5.4)		(5.5)	(5.6)		(5.7)	(5.8)
LK	0.299 (0.009)***	0.300 (0.009)***	0.380 (0.009)***	0.380 (0.009)***	LK	0.255 (0.007)***	0.255 (0.007)***	LK	0.255 (0.007)***	0.256 (0.007)***
LL	0.537 (0.014)***	0.537 (0.014)***	0.468 (0.013)***	0.469 (0.013)***	LL	0.757 (0.010)***	0.757 (0.010)***	LL	0.756 (0.010)***	0.757 (0.010)***
IAR	0.001 (0.001)	0.001 (0.001)	-0.003 (0.004)	-0.003 (0.004)	IAR	0.019 (0.009)**	0.019 (0.009)**	IAR	0.019 (0.009)**	0.020 (0.009)**
MS	3.358 (0.253)***	3.304 (0.253)***	4.072 (0.219)***	4.060 (0.218)***	MS	3.183 (0.183)***	3.200 (0.182)***	MS	3.258 (0.183)***	3.196 (0.183)***
DEMSP_REG	0.578 (0.151)***	0.050 (0.053)	0.259 (0.132)**	0.199 (0.044)***	HEMSP_REG	0.176 (0.162)	0.451 (0.066)***	OEMSP_REG	0.907 (0.131)***	0.224 (0.049)***
$DEMSP\_REG^2$	-0.633 (0.170)***		-0.070 (0.146)		$HEMSP\_REG^2$	0.443 (0.238)*		$OEMSP\_REG^2$	-1.113 (0.199)***	
R^2	0.517	0.516	0.632	0.632		0.639	0.639		0.639	0.639
No. of Obs.	7794	7794	8067	8067		23289	23289		23289	23289

Notes:

1. Region and industry dummies are included in all regressions. Their coefficients are not reported, but available upon request.
2. Standard errors are in parentheses.
3. ***, ** and * indicate that the coefficient is significantly different from zero at the 1%, 5% and 10% levels respectively.