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Abstract

This paper analyses the nature and extent of managerial knowledge spillovers from foreign direct investment through the diffusion of modern management practices and provides the first empirical evidence regarding their size and transmission mechanisms using establishment-level panel data from the UK. The paper finds that there are significant vertical and horizontal spillovers of management practices from foreign to local firms. The analysis suggests that vertical spillovers within supply chains are the most effective transmission channel. However, we have not find robust evidence suggesting the reverse spillovers of management practices from local to foreign firms.

Key words: FDI; managerial knowledge spillovers; management practices
JEL classification: F2; L2; M1

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I. Introduction

The impact of foreign direct investment (FDI) on host economies has long been of interest to academics and policy-makers. FDI is expected to bring a bundle of capital, technological and managerial skills to the host countries and to benefit their economies by enhancing productivity as well as creating more job opportunities. Given the nature of knowledge as a public good, positive externalities or "spillovers" from FDI are often expected to be the most important channels for the dissemination of advanced knowledge to local firms (eg. Blomström, 1989). Managerial knowledge transfer to local firms via FDI is widely regarded as one of the most important benefits of FDI for host economies (Dunning, 1958; Lall, 1992; Buckley et al., 2002). However, despite the importance of managerial knowledge spillovers and the huge volume of literature on various forms of spillovers from FDI[1], our understanding of managerial knowledge spillovers from FDI to local firms is limited. Empirical evidence in this respect is scarce except some case study evidence of intra-firm transfer of human resources management (HRM) practices within foreign subsidiaries. The empirical literature on knowledge spillovers from FDI has been focusing mainly on technological knowledge. Knowledge is often measured by number of patents, sales of new products, or expenditure on research and development (eg. Branstetter, 2006; Singh, 2007; Añón Higón, 2007; Driffield and Love, 2007; Girma and Görg, 2007; and Mancusi, 2008). Some studies attempt to infer knowledge spillovers indirectly by estimating the change in productivity of domestic firms as a result of increasing foreign share in total output, employment or assets in the industry or region (eg. Aitken and Harrison, 1999; Hejazi and Safarian, 1999; Buckley et al., 2002; Driffield and Girma, 2003; Javorcik, 2004). However, productivity effects of FDI can result from several possible sources, including technological and managerial knowledge transfer and spillovers as well as competition effects.

On the other hand, the research on managerial knowledge transfer from FDI is mostly based on case study evidence of intra-firm knowledge transfer. A seminal work by Dunning (1958) investigated intra-firm transfer of managerial techniques in the subsidiaries of US multinationals in the UK through 205 case

[1] There have been an increasing number of empirical studies regarding the spillover effects of FDI on host economies through various channels such as productivity, knowledge, technology, export, and wage spillovers. Empirical evidence on this subject is, however, mixed. For surveys of the literature on spillovers from FDI see Blomström and Kokko (1998) and Görg and Strobl (2001).

studies. Dunning examined managerial techniques in production planning and budgetary control, sales and distribution, labour selection and training, the wage system, and purchasing techniques in existing UK firms following investment by US capital. This research found that US direct investment had influenced managerial techniques in some of these firms to different degrees. The recent literature has been confined to human resource management in the subsidiaries of multinational enterprises (MNEs) (eg. Gamble, 2003; Beechler and Yang, 1994; Child et al., 2000). It is found that the country of origin, international strategy, method of foundation, dependence on local inputs, presence of expatriates, and the extent of communication with the parent have a significant impact on the selection of HRM practices in the subsidiaries (Björkman et al., 2007; Mabey, 2008; Rosenzweig and Nohria, 1994). These studies, again, focus on intra-firm transfer of HRM practices within the subsidiaries. Therefore, despite the huge volume of literature on various forms of spillovers from FDI and some case-study evidence of intra-firm transfer of HRM practices within foreign subsidiaries, our understanding of managerial knowledge spillovers from FDI to local firms is limited and empirical evidence is scarce. There is a significant gap in the literature regarding these issues.

This paper aims to contribute to the literature by making the first attempt to analyse the nature and extent of managerial knowledge spillovers from FDI and empirically test their existence, size and transmission mechanisms through the diffusion and adoption of management practices. The empirical analysis is based on data from a national UK survey at the establishment-level in 1998 and 2004. Focusing on a developed country is an appropriate starting point for the study of managerial knowledge spillovers because the endowment of human capital, the developed corporate management system and relatively small cultural distance make it easier for foreign management practices to be accepted and absorbed by local firms. The UK provides a worthwhile case study given the high degree of openness of its economy. Empirical evidence from this study suggests that there are significant vertical and horizontal spillovers of managerial knowledge from foreign to local firms. Vertical spillovers through supply chains are found to be the most effective channel. However, we have not found evidence suggestion significant reverse spillovers of practices from local to foreign firms.

The paper is structured as follows: Section II sets up the theoretical framework of managerial knowledge spillovers. Section III discusses the data, measurement and model of the present study. Section IV presents the empirical results on practices spillovers. Section VI concludes.

II. Theoretical framework

Knowledge spillovers take place when the multinational firm 'cannot capture all quasi-rents due to its productive activities or to the removal of distortions by the subsidiary's competitive pressure' (Caves, 1974). They may affect the production performance of local firms in the same industry as well as of those which are located in the same region as the MNEs. Technological and managerial knowledge are the two major types of knowledge embedded in foreign direct investment. Managerial knowledge, including the current endowment of managerial intellectual property of a firm and its managerial and organisational practices, plays an important role in determining the productive efficiency of a firm and hence its competitive advantage (Teece and Pisano, 1994). It covers all aspects of the management of the firm, ranging from strategic planning and decision making to human-, financial- and information-resource management as well as operations and marketing management. Some managerial knowledge is tacit and imperfectly imitable; other forms of managerial knowledge such as the majority of management practices can be codified and are hence transferable.

Management practices are routines for the various practical management operations that a firm or organisation adopts. Examples of management practices include just-in-time, total quality management, *kanban* management and lean production as well as stock-option schemes and performance-related pay. There is a substantial literature in management studies and economics which suggests a significant positive association between various advanced management practices and business performance[2]. Differences in the adoption of targeting, monitoring, incentive and operational management practices are found to be a significant factor explaining cross-country productivity differences (Bloom and Van Reenan, 2007). More importantly, success in the adoption of one set of practices can heavily depend on whether other

[2] See Fu, et al. (2007a) for a survey.

(complementary) practices are in place (Whittington et al., 1999; Fu, et al., 2007a). A cluster of complementary HRM practices is found to have greater effects on productivity than that of any individual practice (Ichniowski et al., 1997). These clusters are identified in the literature as high performance HRM practices (Huselid, 1995), high involvement practices (Bryson et al., 2005) and just-in-time practices (Callen et al., 2000; Brox and Fader, 2002; Kaynak and Pagan, 2003). These clusters are all found to contribute positively to the productivity and business performance of firms. Moreover, these clusters of practices can be complementary to each other and can enhance a firm's performance more than if used in isolation (Fu et al., 2007). The introduction (absence) of any one set of management practices may reinforce (weaken) the effects of the others. For example, the effectiveness of incentives is subject to the introduction of other human resource management practices such as effective target, monitoring and appraisal management practices. The strength of the impact of operations management practices on productivity is also moderated by the introduction of complementary practices such as targeting, monitoring and skills management practices. The resulting "systems" of management practices, when successfully implemented, create a unique source of competitive advantage for a firm. In this study, following existing literature discussed earlier, we define these productivity enhancing management practices as high performance management practices (HPMP). Since advanced managerial techniques are often regarded as a major source of the 'ownership' advantage of MNEs (Dunning, 1980; Cantwell, 1991; Ngo et al., 1998; Bartlett et al., 2002), those MNEs are therefore likely to have adopted more high performance management practices than local firms.

Most management practices can be codified and are more transferrable than tacit knowledge. Unlike tacit managerial knowledge (which has to be developed over time) most codified management practices can be learned through management education and training or imitation, although the degrees of adoption and effectiveness of implementation depends on each firm's capability in assimilation and adaptation. As the relative transferable component of managerial knowledge, management practices are likely to spill over from MNEs to indigenous firms. Such spillovers are widely regarded as one of the most important benefits of FDI for host economies (Dunning, 1958; UNCTAD, 1995). Management knowledge may spill over from foreign to indigenous firms through several channels. One of the mechanisms is the demonstration effect. The advanced management practices used by MNEs in their management can be known to their competitors,

suppliers and clients through demonstration-by-implementation and word-of-mouth, and can then be imitated by these competitors, suppliers and clients. The Chinese banking sector is one such example. When multinational banks entered the Chinese market, their modern management practices in human resource and marketing management had strong demonstration effects for local banks (Fu, 1999). A collection of studies on the Americanisation of European business also suggests that MNEs played significant roles in disseminating management know-how across national borders by acting as successful examples in Europe (Kipping and Bjarnar, 1998).

The second channel for managerial knowledge spillover is the movement of labour from foreign to local firms. Most MNEs invest in labour through training to implement their management practices effectively and improve their own productivity. Although the volume and quality of training by MNEs is uneven and depends greatly on factors such as economic sector, qualifications of the available indigenous manpower and local training policies, with the increasing indigenisation of the workforce in MNEs, there is an increase in the number of local employees who receive managerial training (ILO, 1981; Gershenberg, 1994). When the trained employees move from foreign to indigenous firms for various reasons (eg. higher payment or senior management position offered by indigenous firms), they carry with them new management practices which they acquired in foreign firms. This could be the most important channel for spillovers (ILO, 1981; Almeida and Kogut, 1999; Djanko and Hoekman, 2000; Fosfuri et al., 2001). The movement of labour not only provides a one-time transfer of information but may also facilitate the transfer of capabilities, allowing further knowledge-building (Kim, 1997). All this suggests the possible existence of horizontal knowledge spillovers within the same industry. Of course, competitive pressure from foreign firms may also induce local firms to adopt HPMP to increase competitiveness. Therefore we have the following:

Hypothesis 1 (Horizontal spillovers): The greater the adoption of HPMP in MNEs, the greater the adoption of HPMP by local firms in the same industry.

Moreover, the linkages discussed above also suggest that possible vertical knowledge spillovers may take place within the supply chain. In addition to unintended leakage of knowledge through demonstration effects

and labour movement, MNEs may purposely transfer relevant knowledge to their suppliers or customers. On the one hand, they may transfer relevant knowledge to their suppliers in order to improve product quality and reduce production costs. On the other hand, they may also be asked to provide management training as a contractual requirement attached to the sales contract or demonstrate their advanced management practices to assure customers of the quality of their products and services. Such inter-firm linkages within the supply chain are found to be a critical mechanism for the exchange of tacit knowledge (Saxenian, 1991). It provides an effective channel for spillovers of management practices, especially for supply chain management, quality management and marketing management. All this gives rise to vertical spillovers of management practices through forward and backward linkages. Based on the above discussion, we have the following:

Hypothesis 2 (Vertical spillovers): The greater the adoption of HPMP in the MNEs in the upstream or downstream industries, the greater the adoption of HPMP by local firms through forward and backward linkages.

On the other hand, recent studies find an asymmetry of knowledge spillovers between MNEs and host country firms. Using patent citation data, Singh (2007) discovers significant knowledge outflows back from the host country to foreign MNEs in addition to the knowledge inflows from foreign MNEs to local firms. This is particularly the case in technologically advanced countries where knowledge outflows to foreign MNEs greatly outweight knowledge inflows. Reverse technology spillovers from domestic to foreign firms are found in the R&D intensive sectors in the UK (Driffield and Love, 2003). Kafouros and Buckley (2008) find that net R&D spillovers from MNEs vary depending on the technology opportunities, firm size and competitive pressure a firm faces. Since local firms have the best knowledge of local culture, and foreign firms are likely to adapt to local culture and conditions in order to create the best practice for the specific location, the actual usage of management practices of foreign firms will be informed or affected by the management practices adopted by local firms. Therefore, reverse spillovers from local firms to MNEs is also likely to occur with regard to managerial knowledge. We hence suggest

Hypothesis 3 (Reverse spillovers): The adoption intensity of a cluster of management practices by the foreign firms will be positively associated with the adoption intensity of these practices in the local firms in the same region, the same industry or their up- and down-stream industries.

III. Model, Data and methodology

Model

We start from the following basic adoption model for management practices:

$$MPD = \alpha_0 + \alpha X + \varepsilon \quad (1)$$

where *MPD* is adoption intensity of management practices measured by the weighted index of HPMP adoption. *X* is a vector of variables that affects a firm's decision on the adoption of management practices. The control variables *(X)* include firm size, size of company group, human capital, market competition, and a vector of industry dummies.

The intra-firm managerial knowledge diffusion is examined using equation (2) by testing whether foreign ownership has a significant impact on a firm's adoption intensity of management practices. A dummy variable for foreign ownership (*FDI*), which equals 1 for firms with 50-100% foreign ownership, is then introduced as one of the explanatory variables to determine whether foreign firms adopt more management practices when firm specific characteristics are controlled:

$$MPD = \alpha_0 + \alpha X + \beta FDI + \varepsilon \quad (2)$$

Managerial knowledge spillovers are modelled following the standard approach used to test R&D or technology spillovers from FDI by including a foreign managerial knowledge variable into the model of management practices adoption (Caves, 1974; Jaffe, 1989; Coe and Helpman, 1995). Specifically, we test for managerial knowledge spillovers from foreign to indigenous firms by examining whether the intensity of HPMP adoption in indigenous firms is affected by the adoption intensity in foreign firms in the same industry and region and in their upstream and downstream industries. Therefore, in a similar manner to Javorcik (2004), we test for spillover effects using:

$$MPD_d = \alpha_0 + \alpha_1 X + \beta_1 MP_{horizontal} + \beta_2 MP_{forward} + \beta_3 MP_{backward} + \varepsilon \quad (3)$$

where MPD_d *is MPD* of local firms and $MP_{Horizontal}$ represents the horizontal HPMP spillovers variable measured by industry average of *MPD* of foreign firms in each of the 15 SIC (UK92) 2-digit industries[3]. Intra-regional spillovers are measured by the average of *MPD* of foreign firms in the same region in which the firm is located. Following Javorcik (2004), $MP_{Backward}$ is used to proxy the foreign managerial knowledge spilled over from foreign firms in downstream industries to domestic firms in sector j through backward linkage. This variable is intended to capture the extent of potential contacts between domestic supplier and MNE customers. It is defined as:

$$MP_{backward} = \sum_{ifk \neq j} \alpha_{jk} MP_{Horizontal} \quad (4)$$

where α_{jk} is the proportion of industry j's output supplied to sector k for intermediate consumption taken from the UK Input-Output matrix at the two-digit SIC level for the years 1998 and 2003.

$MP_{Forward}$ is used to proxy the foreign managerial knowledge spilled over from foreign firms in upstream industries to domestic firms in sector j through forward linkage. It is defined as the weighted average of management practices adoption in upstream (or supplying) industries as:

$$MP_{forward} = \sum_{ifp \neq j} \sigma_{jp} MP_{Horizontal} \quad (5)$$

where σ_{jk} is the share of inputs purchased by industry j from industry p in total inputs sourced by industry j taken from the corresponding UK Input-Output matrix. This variable intends to capture the extent of potential contacts between domestic buyer and MNE supplier.

[3] Industries are classified at SIC (UK92) 2-digit level. To avoid a large number of industry dummies, some manufacturing industries are grouped into one sector: for example, industries in the food, textile, apparel, paper and printing sectors are collated into the 'light industries sector'. In total, there are 15 industry dummies, including food products, textile, wood & printing, chemical, plastic and fuel, metals & machinery, office and ICT equipment, transportation, other manufacturing, electricity & gas, construction, wholesale & retail, hotels & restaurant, transport & communication, financial services, business services, and other services.

Turning to the firm specific control variables, firm size (*FS*), measured by the total number of full-time equivalent employees, is expected to have a positive impact on the intensity with which modern management practices are used. This is because larger firms have greater demand for management with respect to both scope and intensity. They also have greater capacity to introduce and implement new management practices (Battisti and Iona, 2007). The size of the company group (*GS*) may also affect the adoption of management practices in a workplace as recent research suggests that the adoption decision of a certain management practice is usually made at the top management level in the headquarters of the firm. Workplaces that belong to a larger company group are likely to introduce more management practices. Human and technological capital (*HC*) of the firm, proxied by percentage of technical staff, is expected to show a positive impact on the intensity of adoption of management practices. This is because a better educated workforce can be expected to be more open to advanced management practices. Competition pressure *(COMP),* proxied by a dummy equalling 1 for firms that report "many competitors" for their products and services and 0 for the others, is another important driver of adoption of new management practices. Intensive competition in the market may put strong pressure on a firm to adopt effective management practices to reduce production costs, motivate employees and therefore enhance its competitiveness (Bloom and Van Reenen, 2007).

There is a methodological issue here regarding the possible industry-level co-occurrence of managerial practices. In other words, the linkage between adoption intensity of HPMP in local firms and that in foreign firms in the same industry may arise from the fact that usage of HPMP is more common in some industries than in others. In order to ensure that the estimated coefficients indicate real spillover effects and not simply the presence of common industry drivers, a vector of 14 industry dummies at SIC 2-digit level (*SEC*) are included in the model to control for industry specific effects. This measure serves as a double filter as industry effects have already been reduced in the synergetic adoption index. The empirical model for managerial knowledge spillovers is, therefore:

$$MPD_d = \varphi + \beta_1 MP_{horizontal} + \beta_2 MP_{forward} + \beta_3 MP_{backward} + \delta_1 SIZE + \delta_2 GroupSIZE + \delta_3 HC + \delta_4 COMP + \delta_5 SEC + \varepsilon \quad (6)$$

In view of the high correlation between the various spillover variables, especially between forward and backward spillover variables[4], we enter them into the regression alternatively to avoid the multi-colinearity problem.

Data

The data used for this study is collected from the 1998 and 2004 Workplace Employment Relations Survey (WERS), a national survey of workplaces in Britain with five or more employees and which covers most industries in both the manufacturing and services sectors in the economy. The sampling frame used for WERS was the Inter-Departmental Business Register (IDBR) which is maintained by the Office for National Statistics (ONS). It covers firms in all manufacturing and services industries in all eleven administrative regions in England, Scotland and Wales. A detailed description of the survey and sampling framework for WERS is reported in Forth and McNabb (2007). The survey contained both a 2004 cross-section and a 1998-2004 panel element. The 1998 to 2004 Panel Survey was conducted in a random sub-sample of these workplaces which had participated in the 1998 survey, had continued to be in operation throughout the six-year period, and had employed at least 10 employees. The achieved sample of the panel survey consists of 956 workplaces (1,912 observations), representing a response rate of 77 percent. After deletion of observations with itemised missing values, the cleansed panel sample consists of 1,079 observations, including 853 observations of local firms and 226 observations of wholly foreign-owned or foreign-controlled joint ventures. Since panel data has the advantage of capturing dynamics over time and is regarded as most appropriate to the determination of the true extent of productivity spillovers (Görg and Strobl, 2001), we use the panel data as the main dataset for the tests of knowledge spillovers and their productivity effects. The 2004 cross section is used to provide supplementary information on the gap between foreign and local firms[5].

[4] The correlation coefficients between forward and backward spillover variables are 0.784 and 0.813 for the factor weighted index and the synthetic weighted index, respectively.

[5] The final sample with respect to the management interview in the cross section consists of 2,295 workplaces, representing a response rate of 64 percent. The cleansed sample of the cross section consists of 1,690 workplaces including 210 wholly foreign owned and 166 foreign controlled joint ventures with 50-100% of equity share owned by foreign investors, accounting for 12.4% and 9.8% of the sample population, respectively.

Measurement

One challenge for this study is the measurement of the managerial knowledge. Managerial knowledge is multi-faceted and cannot easily be quantified. There is little prior work on the quantitative measurement of this type of knowledge. In the literature on multinational enterprises, management skills are often proxied by the ratio of managerial staff to total number of employees (Caves, 1974; Dunning, 1980; Saunders, 1982). However, this method suffers from the problem that the richness of managerial knowledge and skills varies between individuals and different management skills have different effects. In this study, we focus on management practices, an important and transferable component of managerial knowledge.

Most of the literature measures management practices using indicators for each individual practice. This method has a serious limitation in its failure to capture the importance of joint adoption and the synergetic effects of complementary practices. As discussed earlier, management practices have a distinctive feature given the strong synergetic effects between complementary practices. Joint adoption of a cluster of complementary practices may generate greater effects than the adoption of individual practices. Accurate measurement of the adoption of management practices should capture this important aspect. An alternative method of measurement is the scoreboard approach which gives a score to each managerial practice and sums them up to provide an overall score. However, this method assumes that the productivity enhancing effects (weights) of each practice are the same, which is over-simplistic.

A widely used method in the management literature is a weighted index estimated directly using factor analysis of all the identified high performance management practices. This method summarises the variations in a set of practices into a few factors. Each factor is a linear combination of the variables under study with different factor loadings (weights) attached to these variables. This approach reflects, to a certain extent, clusters of complementary management practices. It lets the data speak for itself: the weights assigned to each of the practices are determined by the prevailing pattern of practice adoption in the sample rather than that of the high performance practices.

In this paper we use a synthetic weighted index of HPMP adoption intensity following the theory and methods developed by Arora and Gambardella (1990) and Battisti and Iona (2009). This method has the advantage that synergetic effects of complementary practices are purposely estimated and incorporated into the index. The theoretical consideration underlying this method is that firms take into account the synergetic effects from joint adoption of complementary practices in their adoption decision. This synergetic effect of joint adoption of complementary practices within one practice cluster is reflected in the residuals of the adoption model having controlled for some of the specific characteristics of firms. This information is then used to construct a weighted index as a synthetic indicator of joint adoption of different clusters of practices for each firm. In practice, standardised residuals are obtained for each adoption equation of different practice clusters. The residual variance covariance matrix is used to capture the synergies in joint adoption of different clusters of practices. Then, we linearly transform the matrix to obtain a reduced form representation that accounts for the largest part of the heterogeneity of the joint use. Factor Analysis of the residual variance covariance matrix is used to estimate the weights for the linear combination. As a final step, a weighted synergic index is therefore of the form:

$$WI = \sum \lambda_k MP_k \qquad (7)$$

where λ is the weight of each cluster of management practices, estimated as the factor loading of the first factor that captures the largest variation in the residual variance covariance matrix. *MP* is the adoption intensity of each practice cluster measured by the number of individual practices adopted in each cluster. It is argued that such an index reflects the three dimensions of the adoption status, namely: whether adopted, the intensity of adoption (the intensity of use of each set of practices) and the extent of the synergistic effects derived from joint adoption (Battisti and Iona, 2009). By including industry dummies and firm size as explanatory variables in the basic adoption regression, industry specific effects and firm size effect are removed from the residuals. Therefore, the possibility of industry-level co-concurrence of HPMP adoption is greatly reduced in the estimated weighted synthetic index. The possible effect of size is reduced in the same manner.

In this research, we focus on 17 high performance management practices. Following Bloom and Van Reenen (2007), these practices are classified into three categories, namely targeting and monitoring practices (TMP), incentives and skills management (ISMP), and operations and communications practices (OCMP). Details of these practices are given in Table 1. Such a classification is chosen on the grounds that these three sets of management practices are crucial to the organizational architecture of a firm. Evidence from the literature has demonstrated that these clusters of practices can be complementary and that joint adoption has greater productivity effects than single adoption (Fu et al., 2007). For example, monitoring performance via appraisals, setting clear targets in line with the establishment's strategy, providing rewards and incentives, are all expected to increase employees' motivation and productivity. We regress the adoption intensity of each practice cluster, measured by number of practices adopted, on a vector of basic firm characteristics including the size of firms and industry sector. The estimated residual variance covariance matrix is given in Appendix 1. The factor loadings of the largest factor from the factor analysis are taken as the weights for the corresponding clusters of management practices. The formula for the weighted index takes the following form:

$$WI = 0.6443TMP + 0.3250ISMP + 0.6516OCMP \quad (8)$$

As a robustness check, we also use the principal factors estimated directly from factor analysis as an alternative measure of HPMP adoption. For the 17 key management practices identified, factor analysis generated one factor that explains 98% of the total variance in the data. Details of the factor loadings are given in Appendix 2.

IV. Results

Do foreign subsidiaries adopt more management practices than indigenous firms?

Figure 1 reports the proportion of indigenous and foreign firms that have adopted various individual HPMP in 2004. Foreign firms are defined as firms with foreign equity ownership of at least 50%. The evidence presented in Figure 1 shows that foreign firms in the UK have adopted a greater number and wider scope of HPMP than indigenous UK firms. Of all the HPMPs reported in the survey, the extent of adoption by indigenous British firms only exceeds that of the foreign firms in respect of empowerment-related non-

pecuniary incentive practices. The gaps between the UK and foreign firms are considerable and statistically significant in most areas, even after controlling for firm size, group size and other firm specific characteristics[6]. The gap is larger between small and medium-sized local enterprises and their MNE counterparts than the gap between large firms. The gap is also larger between local and foreign dominated joint ventures than between joint ventures and wholly foreign-owned subsidiaries, which suggests the existence of intra-firm diffusion of HPMP within the joint ventures[7]. Comparing the establishments according to the location of their Head Office, the pattern of management practices in UK firms most resembles that of the MNEs headquartered in continental Europe. MNEs with US or Japanese headquarters have the highest intensity and widest scope in adoption of HPMP, but Japanese MNEs have a unique practice pattern: while they demonstrate greater adoption of operations HPMP such as just-in-time and computer usage, they adopt fewer practices with respect to flexible work time arrangements, empowerment and communication management. Details of the 17 practices that are surveyed in the WERS panel are reported in Table 1[8].

Managerial knowledge spillovers: evidence from panel data

Table 2 reports the industry average of the estimated HPMP spillovers and the synergetic HPMP adoption index for the year 2004. ICT equipment, construction and financial services have the highest horizontal spillovers in HPMP. Other manufacturing and retail/wholesale have the highest forward spillovers of HPMP. On average, services industries enjoyed higher backward spillovers than manufacturing firms. The patterns of industry strength of the three types of spillovers are significantly different from each other. They are also different from that of general FDI spillovers disentangled on the basis of these three channels.

[6] Test results are available from the author on request.
[7] Details of comparisons by group size and between joint venture and subsidiaries are available from the author on request. Another comparison that can be made is between UK MNEs and MNEs from other countries. However, information from existing datasets does not allow for a precise identification of UK MNEs.
[8] Details of the comparison of further practices are available from the author on request.

Table 3 reports the estimated results of managerial knowledge spillovers using the WERS 1998-2004 panel dataset[9]. Results from models (1) to (5) indicate significant horizontal and vertical managerial knowledge spillovers. The estimated coefficient of the horizontal spillover variable is 0.336 and is statistically significant at the 1% level, suggesting the existence of horizontal spillovers of managerial knowledge as stated in Hypothesis 1. The vertical spillovers take place through both the forward and backward linkages. The estimated coefficient of the forward and backward spillover variables are both positive and statistically significant at the 1% level, which demonstrates the existence of substantial vertical managerial knowledge spillovers as proposed in Hypothesis 2. The magnitude of the forward spillover coefficient is as high as 0.931, which is much larger than the horizontal spillover coefficient, suggesting the effectiveness of knowledge transfer through the supply chain in comparison to unintended knowledge leakage via demonstration effects. The magnitude of the backward spillover coefficient is, however, 0.570, which is greater than that of horizontal spillovers but smaller than forward spillovers. Taking both the horizontal and vertical spillovers into the regression at the same time[10], the results are robust. The estimated coefficient remains positive and statistically significant. The magnitudes of the estimated coefficients become smaller but are still of a substantial level, eg. 0.667 for the forward spillover variable.

Reverse spillovers

Table 4 reports the estimated results of the reverse spillovers from local to foreign firms. The estimated coefficient of the horizontal spillovers though bear the expected positive sign, it is statistically significant only in one model when backward linkages are controlled for. This provides some weak evidence suggesting that foreign firms are imitating their local rivals in adaptation of their management practices. The estimated coefficient of forward spillovers also bears the expected positive sign. None of them are statistically significant suggesting local suppliers have not had a significant impact on the style of the management practices of their foreign buyers. The estimated coefficient of the backward spillovers variable is negative in all the three models but none of them are statistically significant. This fact seems to infer that the old

[9] Due to high and significant correlations between most of these variables, we enter them separately into the regression to avoid the multicolinearity problem.
[10] The forward and backward spillover variables are not included in the same regression because of high correlation between them.

practices used in local buyers companies may have a negative (though insignificant) impact on their foreign suppliers due to the stronger power on the buyer side in the buyer-supplier relationship. In general, results from Table 4 suggest that the spillovers of advanced management practices from local to foreign firms are limited and insignificant.

Robustness check

Tables 5 and 6 present the results of a robustness check using alternative measures of modern management practices adoption. As shown in Table 5, the sign, magnitude and significance of the estimated coefficients of the horizontal, forward and backward spillovers are highly consistent with those from the synergetic index equation. All this reinforced our earlier finding that there are significant managerial knowledge spillovers from foreign direct investment through the diffusion of advanced management practices. Estimated results of the control variables in Table 5 are also consistent with those in the synergetic index equations confirming that larger firms and firms belonging to large company groups adopt more advanced management practices. Table 6 reports the estimated results of the robustness check of the reverse spillovers. Results in this table are in the main consistent with those in Table 4. While all the rest estimated coefficients of the various spillovers variables remain insignificant, the estimated coefficient of horizontal spillovers also lost its statistical significance in the model when backward linkages are controlled for. Therefore, results of robustness check confirm our earlier finding that the reverse spillovers of management practices from local to foreign firms are limited and insignificant.

Another issue that needs more exploration is the possible endogeneity between the practices adoption and the horizontal spillovers variables. It is likely that foreign firms adopt more management practices because they observe that such practices are widely adopted in the local firms in the same industry. We have attempt to reduce this problem by including industry dummies which can, to certain extent, control for the possibility of industry co-concurrence. In addition to this, we also estimate the horizontal spillovers using the three-stage-least-squares (3SLS) method for robustness check. In addition to all exogenous variables in the model, market orientation, whether this establishment is one of a number of different workplaces in the UK belonging to the same organisation, as well as forward and backward linkages are used as instrumental

variables. Table 7 reports the estimated results. Consistent with earlier results, there appear to be significant positive practices spillovers from foreign to local firm, however, the practices spillovers from local to foreign firms are not statistically significant. The magnitude of the 3SLS results is larger than the OLS estimates for the foreign-to-local spillovers, but smaller for the local-to-foreign spillovers estimates. The 3SLS estimates for firm size and group size are similar to those of the OLS results, showing a significant positive association with the intensity of practices adoption. Foreign firms show a significant sensitivity to competition while the local firms do not.

V. The impact of managerial knowledge spillovers on TFP growth

To investigate whether managerial knowledge spillovers from FDI impact significantly on the productivity of local firms, we regress firm-level total factor productivity (TFP) on various HPMP spillover variables, controlling for firms' own adoption intensity and other firm specific characteristics. We start from a Cobb-Douglas production function as shown below,

$$Q = \alpha K^{\beta} L^{\alpha} A^{\gamma} \qquad (9)$$

where Q is real output, K is capital stock, L is the labour force, and A represents efficiency or total factor productivity. α and β represent the factor share coefficients and γ allows for factors changing the efficiency of the production process. TFP of a firm, $A_{it,}$ is calculated as $A_{it} = Y / K^{\beta} L^{\alpha}$. As discussed earlier, managerial knowledge is an important factor that shapes a firm's productivity as it determines how efficiently the productive inputs are transformed into outputs. With the growth of a firm, the requirement for a manager's capacity to deal with complex strategic and operating management tasks increases. Therefore, parameter A may be hypothesized to vary in the following manner:

$$A_{it} = e^{\delta_0 T_i} M_{it}^{\delta_1} H_{it}^{\delta_2}, \qquad \delta_{0,} \delta_1, \delta_2 > 0 \qquad (10)$$

where T is time trend, M is managerial knowledge proxied by adoption intensity of HPMP, and H is human and technological capital of a firm measured by the share of technical staff in total employees. To control for other possible channels of spillovers from FDI which may also result in a productivity increase (eg. technological knowledge spillovers), we bring into the regression the horizontal and vertical spillovers of

general FDI measured by the ratio of FDI stock to industrial output[1]. Thus the empirical model of the determinants of TFP is of the following form:

$$\ln(TFP_d) = \delta_0 + \delta_{11} MP_{horizontal} + \delta_{12} MP_{forward} + \delta_{13} MP_{backward} + \delta_{14} MPD_d + \delta_2 H + \delta_3 V + \delta_{41} FDI_{horizontal} + \delta_{42} FDI_{forward} + \delta_{43} FDI_{backward} + \mu \quad (11)$$

where V is a vector of firm and industry specific characteristics including firm size, product market competition and an industry dummy[2]. $FDI_{horizontal,}$ $FDI_{forward}$ and $FDI_{backward}$ are horizontal, forward and backward vertical spillovers of general foreign presence, respectively. Since knowledge externalities from foreign presence may take time to manifest themselves, two specifications are employed: one with contemporaneous and one with lagged spillover variables. As there is a six-year time interval between the two surveys, the lagged spillovers variable is defined as the average of those for 1998 and 2004. We use equations (8) and (11) for the actual empirical estimation. Again, due to the high correlation between the various spillover variables[3], especially between forward and backward spillover variables[4], we enter them into the regression alternatively to avoid the multi-colinearity problem.

There are two issues concerning the econometric estimation. First, there is a possible endogeneity between investment and output. To control for the endogeneity between inputs and outputs, we use the Olley and Pakes (1996) estimator for productivity. Output (Y) is measured by the turnover of firms. Investment (R) is measured by the sum of the capital expenditure for new building work, land and buildings, vehicles, and other fixed capital. Capital (K) is calculated using the Perpetual Inventory Method[5]. Labour (L) is measured by number of employees. Expenditure on materials (M) is measured by purchases of materials. Output, investment and expenditures on materials are deflated using relevant deflators. We estimate productivities for manufacturing and non-manufacturing sectors separately to allow for different production functions for the two sectors.

The second issue is the possible reverse causality between management practices and firm performance. A Wu-Hausman test is employed to test the possible endogeneity between these two variables. Following

Bloom and van Reenen (2007), we use industry concentration ratio and industry average wage as the instrumental variables. The test statistics suggest that there is no significant endogeneity between management practices and firm performance in the current sample. Therefore, the standard panel model estimates are preferred to the instrumental variables approach. To take into account the time lag with respect to HPMP spillovers, we use TFP in year t+1, $TFP_{t+1,}$ as the dependent variable in the regression.

For the estimation of productivity effects of managerial knowledge spillovers, objective financial performance data for the panel is collected from the linked Annual Response Database (ARD) over the period 1997 to 2005. The ARD is a census of large firms (with more than 250 employees) and a stratified survey of smaller firms[6]. Only firms that reported financial data in 1997 and/or 1998 and that have more than five observations over this period are retained. Missing values in other years are inserted based on the 1997 values and the logarithmic growth rate. The cleansed ARD dataset includes 8,286 firms and around 170 of these firms could be matched to WERS. Total factor productivity (TFP) of the firms is estimated using the 1997-2005 panel for the matched firms. The estimated TFP is then linked to the WERS panel using management practices information in 1998 and 2004. After deletion of observations with itemised missing values and exclusion of foreign firms and firms in public services sectors[7], the number of observations of domestic firms entering the productivity effects regression is 186. To test for possible sample bias arising from the reduction in sample size due to the different coverage of ARD and WERS and the missing values in the sample over the years, a comparison was undertaken of the proportion of foreign firms in the sample, the size ratio of foreign-local firms and the mean score of practice adoption of the small sample and the larger sample. No significant differences were found.

Results: The impact of managerial knowledge spillovers on firm productivity

Tables 8 and 9 present the estimated results of the contemporaneous and lagged effects of HPMP spillovers on TFP of local firms, respectively. The results from the random effects model are reported in the table because the Hausman test statistics suggest that the random effects estimates are preferred to the fixed effects estimates and also because a fixed effects model is not suitable when there are time-invariant dummy variables. Equation (1) is the baseline model; equations (2) to (7) report the productivity effects of

contemporaneous spillover variables. As discussed earlier, in order to isolate the productivity effects of managerial knowledge spillovers, we controlled for other possible types of spillovers from FDI by inclusion of the spillover variables of general foreign presence as well as other firm- and industry-specific variables.

The results in Table 8 indicate that contemporaneous HPMP spillovers via backward linkages have a positive and significant effect on the productivity of firms. This result is robust across different model specifications. The estimated coefficient of the forward spillover variable is positive and significant in most regressions. However, when both the horizontal and forward spillovers of general FDI are controlled, the estimated coefficient loses its statistical significance. The estimated coefficient of the horizontal HPMP spillovers bears the expected positive sign but it is not statistically significant. These results suggest that vertical managerial knowledge spillovers from FDI through the supply chain have contributed significantly to the TFP growth of domestic firms. The insignificance of horizontal spillovers of managerial knowledge may be due to the two faces of foreign managerial knowledge: sources of advanced knowledge and drivers of competitive pressure. The benefits from demonstration effects and labour movement may be offset by the crowding out effects of foreign competition.

The results also show that other types of spillovers from FDI, eg. technological spillovers have a significant and positive impact on the productivity of domestic firms through horizontal and especially vertical channels. The estimated coefficient of $FDI_{Forward}$ is about 1.90, which is approximately twice the size of that of $FDI_{Backward}$, and is statistically significant at the 1% level. This strong forward linkage effect reflects the sample composition which includes firms in both manufacturing and services sectors, suggesting a significant contribution by FDI in the services sector to productivity growth in the economy as a whole.

Table 9 reports the estimated productivity effects of lagged spillover variables. The coefficients of lagged values, which are better indicators of the causality effects, are consistent with those of contemporaneous spillovers. However, they appear to be of a larger size than that of the contemporaneous spillover effects. This fact is reinforced by the finding that foreign managerial knowledge which has spilled over through the supply chain has a significant positive effect on the productivity growth of local firms but it takes some time

to be assimilated and fully deliver its potential impact. The estimated coefficients of the lagged general FDI spillovers are broadly consistent with those of contemporaneous spillover effect[8]. The estimated coefficients of a firm's own practice adoption index bear the expected positive sign and are statistically significant in all specifications. Table 10 reports the results of a robustness check using alternative measures of HPMP adoption. We use the weighted index generated directly from factor analysis, a method widely used in the management literature to summarise management practices. The results again reinforce the finding that vertical spillovers within the supply chain have made a positive and significant contribution to the productivity of local firms.

VI. Conclusions

This paper analyses the nature and extent of managerial knowledge spillovers from foreign direct investment, and provides the first empirical evidence of their existence, size and the transmission mechanisms based on establishment-level panel data from the UK. Results from the study demonstrate that MNEs have adopted more high performance management practices than local firms, even in an industrialised country. Controlling for firm size and other firm specific characteristics, the gaps between the local and foreign firms are statistically significant. Empirical evidence suggests that there are significant horizontal and vertical spillovers of managerial knowledge from foreign to local firms. Vertical spillovers within the supply chain are found to be the most effective channel with the greatest spillover effects. However, the reverse spillovers of management practices from local to foreign firms are not significant.

Findings from this study have important policy and practical implications. First, results from this paper attest to the existence and significance of the long claimed intangible benefits from foreign direct investment: managerial knowledge spillovers. FDI can serve as a vehicle that facilitates the transfer of advanced managerial knowledge from foreign to local firms, either unintentionally through demonstration-by-implementation and movement of trained staff or intentionally through transfer of advanced management practices to business partners in the supply chain. Findings from this study indicate that knowledge transfer

and spillovers through the supply chain is the most effective channel through which foreign managerial knowledge spills over into local firms.

On the other hand, the most promising practices are also locally specific (Delbridge, 2008). Local context and cultural distance may be an important mediating factor due to the imperfect applicability and different perceptions of management practices in different settings. Therefore, future study is needed to explore the mediating effects of cultural distance on the relationship between advanced foreign managerial knowledge and productivity of local firms. Moreover, adoption of new management practices requires the unlearning of previous managerial practices. Organisational inertia, absorptive capacity and complementary changes in organisation, as well as the commitment of top management, may all affect the assimilation of foreign management knowledge. Therefore, more must be learned about the factors which affect the effectiveness of managerial knowledge assimilation. This is particularly the case in the context of developing countries where the distance between indigenous firms and MNEs in both culture and extent of development is considerable. Finally, this paper has used two alternative indices for the measurement of management practices adoption. Since managerial knowledge includes also tacit knowledge other than codified management practices, further research is needed to fully explore the spillovers of tacit knowledge between foreign and local firms.

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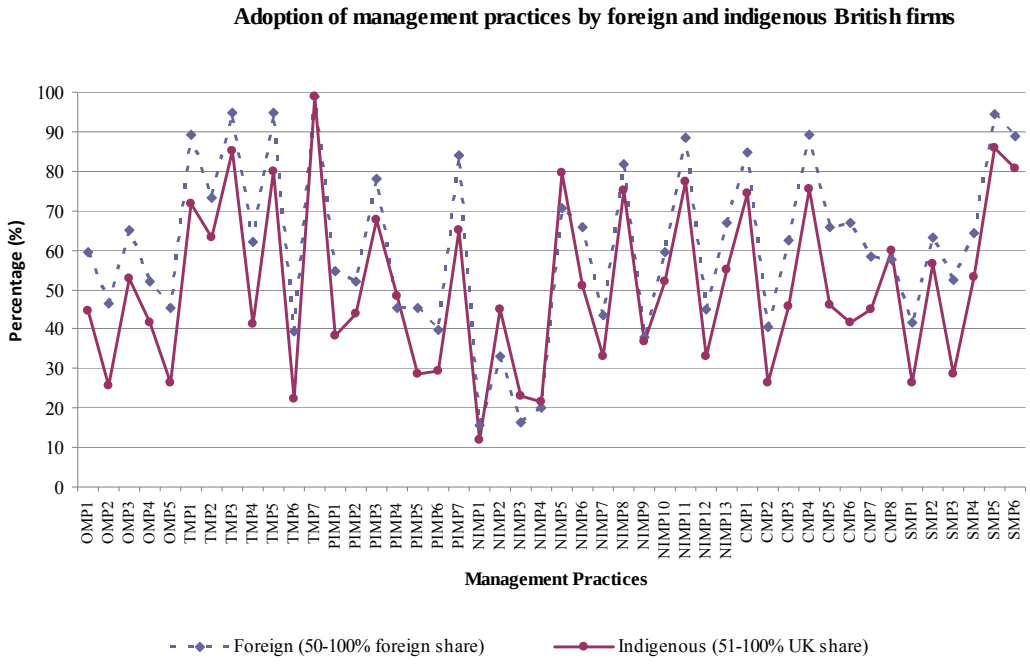
Figure 1



Notes:
1. 'Indigenous firms' refers to firms with 51-100% UK-owned equity (1,314 firms); 'Foreign firms' refer to firms with 0-49% UK-owned equity and 50-100% foreign-owned equity (376 firms).
2. Source: author's calculation based on WERS 2004.
3. Classification and definitions of management practices:
OMP1-5 refers to operational management practices, reflecting organisational change; usage of just-in-time system; team working among employees; the usage of computers in the workplace; and problem-solving groups or quality circles.
TMP1-7 refers to target and monitoring management practices, reflecting a formal strategic plan; existence of a dedicated working team for specific products and services; targets themselves; employees' knowledge of the targets; appraisement of employees' performance; job evaluation schemes in the workplace; and quality monitoring in the workplace.
PIMP1-7 refers to pecuniary incentive management practices, reflecting profit-related payments; the influence of productivity levels on amount of pay; the influence of organizational financial performance on amount of pay; the influence of the ability to recruit or retain employees based on the amount of pay; the influence of performance on individual employees' pay; the influence of negotiation with trade unions on employees' pay; and the entitlement of managers to employee benefits, such as an employer pension scheme, car allowance, private health insurance, over 4 weeks of paid annual leave and sick pay in excess of statutory requirements.
NIMP1-13 refers to non-pecuniary incentive management practices, reflecting the authority of supervisory employees to take the final decision on dismissing workers; the variety in the work of individual employees; the discretion of individual workers as to how they undertake their own work; the ability of individual employees to control the pace at which they work; employees' expectations of long-term employment; assistance provided by employees in ways not specified in their job description; the flexibility of working time including working at home; ability to reduce working hours; flexitime; ability to change shift patterns; formal written policy on equal opportunities at the workplace; adjustments to accommodate disabled employees; and patterns of taking time off for male employees as a new father, such as paternity leave and annual leave.
CMP1-8 refers to communication management practices, including meetings between senior managers and the whole workplace; joint consultative committees at the workplace; adoption of a survey of employees' views or opinions; methods of management communication including notice boards; emails; and intranet; whether management releases the internal investment plan to employees; and whether management releases the staffing plan to employees.
SMP1-6 refers to skills management practices, including the presence of internal labour markets; the importance of qualifications when recruiting new employees; the conducting of personality or attitude tests when filling vacancies; the conducting of performance or competency tests when filling vacancies; a standard introduction programme for new employees; and training undertaken in the workplace.

Table 1. Comparison of adoption of practices by foreign and indigenous firms: by location of Head Offices in 2004

Category	Practice	UK	North America	Germany/ France/ Italy	Japan	Other	χ^2 (p-value)
TMP	Workplace is covered by a formal strategic plan	70.52	87.02	88.24	85.71	93.06	0.682
	Working teams are given responsibility for specific products/services	61.85	84.75	87.23	100.00	78.46	0.563
	Targets in the workplace	84.15	93.86	98.04	71.43	94.44	0.088
	Employees are informed of targets	40.05	63.36	72.55	14.29	55.56	0.017
ISMP	Profit-related payments	35.92	61.07	47.06	42.86	51.39	0.122
	Employees expect long-term employment in this organisation	79.93	62.60	74.51	100.00	66.67	0.000
	Employees asked to assist in ways not specified in their job description	50.62	67.18	64.71	85.71	63.89	0.001
	Workplace has a formal written policy on equal opportunities	76.05	89.31	92.16	71.43	86.11	0.105
	Internal labour markets present	25.19	41.22	52.94	28.57	51.39	0.004
	Recruitment is based on: qualifications	55.41	64.12	72.55	85.71	63.89	0.003
	Performance or competency test when filling vacancies	51.69	66.41	70.59	57.14	63.89	0.102
OCMP	More than 80% of employees work in teams	51.36	62.60	66.67	42.86	59.72	0.784
	Problem-solving groups or quality circles in the workplace	24.69	48.09	50.98	57.14	44.44	0.001
	Meetings between senior managers and the whole workforce	73.66	87.79	84.31	100.00	77.78	0.111
	Joint consultative committees at the workplace	24.69	42.75	50.98	14.29	52.78	0.000
	Management releases the internal investment plan to employees	43.77	59.54	62.75	14.29	59.72	0.118
	Management releases the staffing plan to employees	59.37	59.54	45.10	71.43	56.94	0.071

Notes:
1. TMP (targets and monitoring practices), ISMP (incentive and skills management), OCMP (operations and communications management)
2. Chi^2 test tests the null hypothesis that the means of each group are equal.
3. Source: author's calculation based on WERS2004 survey data.

Table 2. Management practices spillovers by industry, 2004

Industry	*N*	*MPD*	$MP_{Horizontal}$	$MP_{Forward}$	$MP_{Backward}$
Food products	2%	5.961	5.298	2.828	1.564
Textiles & wood, printing & publishing	4%	5.248	6.398	2.79	1.386
Chemical, plastic & fuel products	4%	6.608	6.610	2.231	1.873
Metal & mechanical products	7%	5.219	6.922	3.086	3.806
Office, IT & communications equipment	4%	6.274	7.218	2.951	1.133
Transport equipment	2%	6.165	5.905	4.555	3.025
Other manufacturing	1%	5.674	6.325	6.001	0.873
Electricity, gas & water	4%	7.636	6.162	1.495	0.681
Construction	5%	5.610	7.461	3.147	4.207
Retail/wholesale trade & repairs	13%	6.572	6.334	6.087	8.339
Hotels & restaurants	10%	5.463	6.523	5.475	3.133
Transport & communications	7%	6.362	5.974	4.01	5.366
Financial services	6%	6.660	7.043	4.926	4.113
Real estate & business services	14%	5.725	6.444	2.532	5.776

Source: author's calculation based on WERS1998-2004 panel; UK input-output table from www.ons.gov.uk. Shares do not add up to 100 percent since public services, which account for 18% of total number of firms, are not included in the table.

Table 3. Managerial knowledge spillovers from foreign to local firms

	Dependent variable: synergetic weighted index of HPMP adoption				
	Foreign-to-local				
	1	2	3	4	5
$MP_{Horizontal\_F}$	0.336***			0.257***	0.218**
	(0.083)			(0.088)	(0.094)
$MP_{Regional\_F}$		0.931***		0.667**	
		(0.248)		(0.262)	
$MP_{Forward\_F}$			0.570***		0.400***
			(0.136)		(0.154)
Firm size	0.471***	0.481***	0.474***	0.477***	0.472***
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Group size	0.597***	0.590***	0.601***	0.592***	0.600***
	(0.170)	(0.169)	(0.169)	(0.170)	(0.170)
% tech. staff	0.249	0.241	0.124	0.170	0.108
	(0.346)	(0.347)	(0.349)	(0.346)	(0.348)
Competition	-0.156	-0.156	-0.153	-0.158	-0.156
	(0.149)	(0.149)	(0.149)	(0.149)	(0.149)
Constant	1.965***	3.292***	3.394***	2.103***	2.329**
	(0.681)	(0.581)	(0.890)	(0.709)	(1.004)
Industry dummies	Yes	Yes	Yes	Yes	Yes
N	853	853	853	853	853
R^2 (between)	0.288	0.29	0.289	0.289	0.289

Note: ***, **, * indicate significance at 1%, 5% and 10% levels.
Robust standard errors in brackets. Random effects estimates.
Fourteen SIC 2-digit industry dummies are included in all the models.

Table 4. Reverse spillovers of management practices from local to foreign firms

	Dependent variable: synergetic weighted index of HPMP adoption				
	Local-to-foreign				
	1	2	3	4	5
$MP_{Horizontal\_D}$	0.634*			0.625	0.960**
	(0.390)			(0.439)	(0.478)
$MP_{Regional\_D}$		0.715		0.0473	
		(0.950)		(1.056)	
$MP_{Forward\_D}$			-0.0357		-1.133
			(0.788)		(0.951)
Firm size	0.531***	0.529***	0.524***	0.531***	0.528***
	(0.096)	(0.096)	(0.096)	(0.096)	(0.096)
Group size	0.26	0.254	0.263	0.259	0.284
	(0.262)	(0.263)	(0.264)	(0.263)	(0.263)
% tech. staff	0.272	0.209	0.23	0.271	0.357
	(0.611)	(0.614)	(0.616)	(0.614)	(0.615)
Competition	-0.004	0.0169	0.0175	-0.004	-0.007
	(0.227)	(0.227)	(0.228)	(0.228)	(0.227)
Constant	-0.0412	2.431	3.690***	0.114	-3.276
	(2.495)	(1.495)	(1.169)	(5.223)	(3.453)
Industry dummies	Yes	Yes	Yes	Yes	Yes
N	226	226	226	226	226
R^2 (between)	0.331	0.327	0.324	0.331	0.333

Note: ***, **, * indicate significance at 1%, 5% and 10% levels.
Robust standard errors in brackets. Random effects estimates.
Fourteen SIC 2-digit industry dummies are included in all the models.

Table 5. Managerial knowledge spillovers from MNEs: robustness check using alternative measure of management practices adoption

	Dependent variable: principal factor of HPMP adoption				
	Foreign-to-local				
	1	2	3	4	5
$MP_{Horizontal\_F}$	0.374***			0.287***	0.274***
	(0.098)			(0.103)	(0.103)
$MP_{Regional\_F}$		1.094***		0.805**	
		(0.299)		(0.314)	
$MP_{Forward\_F}$			0.574***		0.442***
			(0.142)		(0.150)
Firm size	0.227***	0.231***	0.227***	0.230***	0.227***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Group size	0.350***	0.348***	0.353***	0.348***	0.352***
	(0.083)	(0.082)	(0.083)	(0.083)	(0.083)
% tech. staff	0.180	0.144	0.098	0.130	0.093
	(0.167)	(0.168)	(0.169)	(0.167)	(0.168)
Competition	-0.073	-0.073	-0.072	-0.074	-0.073
	(0.072)	(0.072)	(0.072)	(0.072)	(0.072)
Constant	-1.411***	-1.557***	-1.046**	-1.559***	-1.427***
	(0.311)	(0.317)	(0.430)	(0.317)	(0.311)
Industry dummies	Yes	Yes	Yes	Yes	Yes
N	853	853	853	853	853
R^2 (between)	0.292	0.293	0.292	0.292	0.292

Note: ***, **, * indicate significance at 1%, 5% and 10% level.
Robust standard errors in brackets. Random effects estimates.
Fourteen SIC 2-digit industry dummies are included in the model.

Table 6. Reverse spillovers from local to foreign firms: robustness check using alternative measure of management practices adoption

	Dependent variable: principal factor of HPMP adoption				
	Local-to-foreign				
	1	2	3	4	5
$MP_{Horizontal\_D}$	0.492			0.410	0.550
	(0.394)			(0.421)	(0.459)
$MP_{Regional\_D}$		0.904		0.561	
		(0.940)		(1.005)	
$MP_{Forward\_D}$			0.335		-0.229
			(0.795)		(0.924)
Firm size	0.244***	0.246***	0.244***	0.246***	0.244***
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
Group size	0.114	0.108	0.109	0.11	0.117
	(0.125)	(0.125)	(0.125)	(0.125)	(0.125)
% tech. staff	0.124	0.0896	0.0935	0.112	0.135
	(0.287)	(0.287)	(0.289)	(0.288)	(0.290)
Competition	0.0287	0.0353	0.0348	0.0295	0.0284
	(0.108)	(0.108)	(0.108)	(0.108)	(0.108)
Constant	-1.102**	-1.381***	-1.393***	-1.076**	-1.101**
	(0.467)	(0.382)	(0.382)	(0.470)	(0.467)
Industry dummies	yes	yes	yes	yes	yes
N	226	226	226	226	226
R^2 (between)	0.337	0.333	0.33	0.337	0.337

Note: ***, **, * indicate significance at 1%, 5% and 10% level.
Robust standard errors in brackets. Random effects estimates.
Fourteen SIC 2-digit industry dummies are included in the model.

Table 7. Horizontal spillovers of management practices: robustness check using 3SLS

	Foreign-to-local		Local-to-foreign	
	(1)		(2)	
	Coef.	Std. error	Coef.	Std. error
$MP_{Horizontal\_F}$	0.707***	0.087		
$MP_{Horizontal\_D}$			0.318	0.371
Firm size	0.341***	0.105	0.311***	0.119
Group size	1.485*	0.768	-0.745	0.620
% tech staff	-0.680**	0.341	-0.434	0.424
Competition	-1.193	0.763	1.784**	0.785
Industry dummies	yes		yes	
Year dummies	yes		yes	
Firm dummies	yes		yes	
N	787		290	
R^2	0.825		0.780	

Note: ***, **, * indicate significance at 1%, 5% and 10% levels.
Robust standard errors in brackets.
Fourteen SIC 2-digit industry dummies are included in all the models.
Instrumental variables: all exogenous variables in the model plus market orientation, whether the firm has multiple production sites as well as forward and backward linkages.

Table 8. Productivity effects of HPMP spillovers: contemporaneous effect

	1	2	3	4	5	6	7
$MP_{Horizontal}$	0.246	0.202	0.264	0.226	0.274		
	[0.163]	[0.287]	[0.138]	[0.228]	[0.135]		
$MP_{Forward}$	0.080**		0.046			0.057*	
	[0.025]		[0.161]			[0.076]	
$MP_{Backward}$		0.059**		0.054**			0.056**
		[0.050]		[0.038]			[0.041]
$FDI_{Horizontal}$			0.517	0.619*	0.643*		
			[0.164]	[0.078]	[0.073]		
$FDI_{Forward}$			1.849***	1.907***		1.906***	
			[0.002]	[0.002]		[0.003]	
$FDI_{Backward}$							0.908*
							[0.053]
MPD_d	0.082***	0.086***	0.078***	0.079***	0.087***	0.084***	0.087***
	[0.001]	[0.000]	[0.002]	[0.002]	[0.000]	[0.001]	[0.000]
N	186	186	186	186	186	186	186
R^2-overall	0.532	0.532	0.567	0.577	0.526	0.539	0.537

Source: ONS.
Notes: Robust p-value in brackets.
The dependent variable is $\ln(TFP_{t+1})$. Model: random effects.
Each regression includes firm size, percentage of technical staff, competition and sector dummy.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9. Productivity effects of HPMP spillovers: lagged effects

	1	2	3	4	5	6	7
$MP_{Horizontal}$-lagged	-0.063	-0.195	-0.077	-0.203	-0.02		
	[0.642]	[0.116]	[0.665]	[0.190]	[0.891]		
$MP_{Forward}$-lagged	0.084*		0.060			0.068*	
	[0.064]		[0.154]			[0.092]	
$MP_{Backward}$-lagged		0.085**		0.090***			0.081**
		[0.042]		[0.006]			[0.033]
$FDI_{Horizontal}$-lagged			1.124	1.325	1.139		
			[0.235]	[0.129]	[0.227]		
$FDI_{Forward}$-lagged			1.977**	2.244**		1.779**	
			[0.026]	[0.012]		[0.041]	
$FDI_{Backward}$-lagged							-1.553
							[0.712]
MPD_d	0.101**	0.099***	0.083*	0.072*	0.123***	0.086**	0.108***
	[0.012]	[0.009]	[0.053]	[0.055]	[0.005]	[0.045]	[0.006]
Observations	93	93	93	93	93	93	93
Adjusted R^2	0.635	0.652	0.672	0.703	0.628	0.656	0.647

Source: ONS.

Notes: Robust p-value in brackets for Part B.

The dependent variable is $\ln(TFP_{t+1})$.

Each regression includes firm size, percentage of technical staff, competition and sector dummy.

By taking the lagged variables of spillovers, the data set is reduced to a cross section of 93 observations.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Productivity effects of HPMP spillovers: alternative measures of HPMP

	1	2	3	4	5	6	7
$MP_{Horizontal}$	0.480	0.455	0.487	0.449	0.556		
	[0.185]	[0.216]	[0.183]	[0.232]	[0.138]		
$MP_{Forward}$	1.154***		1.067***			1.165***	
	[0.000]		[0.002]			[0.000]	
$MP_{Backward}$		0.750**		0.879***			0.672**
		[0.015]		[0.008]			[0.025]
$FDI_{Horizontal}$			0.358	0.34	0.626*		
			[0.307]	[0.345]	[0.080]		
$FDI_{Forward}$			1.999***	2.290***		2.140***	
			[0.000]	[0.000]		[0.000]	
$FDI_{Backward}$							1.059**
							[0.012]
MPD_d	0.184***	0.177***	0.172***	0.162***	0.180***	0.186***	0.184***
	[0.000]	[0.000]	[0.001]	[0.003]	[0.000]	[0.000]	[0.000]
N	186	186	186	186	186	186	186
R^2-overall	0.548	0.531	0.584	0.577	0.525	0.565	0.537

Source: ONS.
Notes: Robust p-value in brackets.
The dependent variable is $\ln(TFP_{t+1})$. Model: random effects.
Each regression includes firm size, percentage of technical staff, competition and sector dummy.
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 1. Variance-Covariance of residuals of practice adoption regressions

	resocmp	restmp	resismp
resocmp	1.001		
restmp	0.536	1.001	
resismp	0.229	0.213	1.002

Note: resocmp: standardised residual of OCMP adoption regression.
restmp: standardised residual of TMP adoption regression.
resismp: standardised residual of ISMP adoption regression.

Appendix 2.

Factor analysis results of the panel data

Factor	Variance	Proportion	Cumulative
Factor1	2.3882	0.9882	0.9882

Rotated factor loadings (pattern matrix) and unique variances

Category	Practice	Factor1	Uniqueness
TMP	Workplace is covered by a formal strategic plan	**0.5431**	0.7050
	Working teams are given responsibility for specific products/services	**0.3817**	0.8543
	Targets in the workplace	**0.3774**	0.8576
	Management releases the financial position of the workplace to employees	**0.5497**	0.6978
ISMP	Profit-related payments	**0.2873**	0.9175
	Employees asked to help in ways not specified in their job description	0.1469	0.9784
	Employees expect long-term employment in this organisation	0.0278	0.9992
	Workplace has a formal written policy on equal opportunities	**0.3705**	0.8627
	Internal labour markets present	**0.2205**	0.9514
	Recruitment is based on: qualifications	0.1017	0.9897
	Performance or competency test when filling vacancies	**0.3854**	0.8515
OCMP	More than 80% employees work in teams	**0.3402**	0.8843
	Problem-solving groups or quality circles in the workplace	**0.4370**	0.8090
	Meeting between line managers or supervisors and all the responsible workers (briefing groups or team briefings)	**0.3895**	0.8483
	Joint consultative committees at the workplace	**0.4123**	0.8300
	Management releases the internal investment plan to employees	**0.5333**	0.7155
	Management releases the staffing plan to employees	**0.3747**	0.8596

Notes: Number of params =17; Rotation: orthogonal varimax

[1] The data of industrial position of inward foreign direct investment is collected from www.statistics.gov.uk. The data of industrial output is collected from the UK I-O table.

[2] In view of the small sample size for the productivity regression, we use one industry dummy which equals 1 for manufacturing and 0 for services rather than a vector of 15 SIC 2-digit dummies.

[3] The correlation coefficients between forward and backward FDI spillover variables are 0.648 for synergetic HPMP index and 0.784 for HPMP factors, and that between $MP_{backward}$ and $FDI_{backward}$ is 0.596.

[4] Ibid.

[5] The initial capital stock (in 1997) is calculated using $R_0/(g+0.15)$, where g is the average annual logarithmic growth rate, and 0.15 is the depreciation rate. The capital stock of other years is calculated using $K_t=(1-0.15)K_{t-1}+R_t$

[6] The coverage of the ARD was 52,171 firms in 2005.

[7] Firms in the public services sector are not included in the productivity regression because the nature of their activities, and therefore the measurement of their productivity, is very different from those in the private sector.

[8] The negative sign of the backward spillover variable of general foreign presence is likely due to the high correlation between this variable and the managerial backward spillover variable. Dropping the latter variable results in a positive and significant coefficient.