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SPILLOVER EFFECTS OF FDI AND TRADE ON DEMAND FOR SKILLED LABOUR IN MALAYSIAN MANUFACTURING INDUSTRIES

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ABSTRACT

Malaysia has been among the top recipients of foreign direct investment (FDI) in the world. However, the benefit of FDI spillovers on skill upgrading in Malaysia remains ambiguous. This is particularly important to countries such as Malaysia, as the volume of FDI inflows has continued to increase over time. The present study adds to the literature investigating the effects of FDI as a spillover channel through which foreign trade enhances the relative demand for skilled labour in 50 Malaysian manufacturing industries during the 2000–2008 period. Our empirical results based on the generalised method-of-moments system estimator reveal that the spillover effects of FDI are significant for skill upgrading and, in turn, lead to increased demand for skilled labour. Although the coefficient for FDI indicates a negative relationship between FDI and skilled labour demand, the effect of FDI is positive and statistically significant. This result gives an indication that the spillover effects of FDI appear to be quickly assimilated by workers in the Malaysian manufacturing industries through the "learning effect" and that the fast pace is biased towards skilled workers. Nevertheless, this study finds no evidence of spillover effects from trade on the demand for skilled labour. The findings from this study potentially contribute to long-run FDI policy, especially to encourage FDI inflows into low receiving industries.

Keywords: FDI, trade, skilled labour demand, spillover effects

INTRODUCTION

A plethora of studies has documented the spillover effects of FDI and trade as their main channel. The literature covers both macro- and microeconomic evidence, including industry-level studies (Acemoglu, 1998; Coe & Helpman, 1995). The theory of spillover effect reveals that there are complementarities of technology diffusion and, hence, an increase in the demand for skilled labour.

These technology spillovers not only introduce and create new technologies for domestic usage but also expand the utilisation of spillovers, thus inducing organisation improvement, which fosters restructuring processes and increases both the demand for and supply of skills (Bruno, Crinò, & Falzoni, 2012). As foreign ownership is often associated with skill-biased technology, the advantages enjoyed by skilled workers tend to be higher than that of unskilled workers. This is due to the effective bargaining ability of skilled workers in foreign firms, causing a relative expansion of skill intensive sectors and improving the relative position of skilled workers as well as increasing wage inequality (te Velde, 2002). Nevertheless, how inward FDI influences human capital development in terms of skill upgrading on the supply side is much less clear, regardless of whether it is taking place at the micro or macro level (Slaughter, 2002).

With regards to Malaysia's aim to increase the number of skilled workers as it moves towards becoming a high-income country, Malaysia recognises the association between the upgrading processes of knowledge and skill and foreign technology spillovers through the channels of FDI and trade (World Bank, 2007). Since the 1980s, multinational companies (MNCs) have been the main sources of investment contributing to trade, capital formation and productivity. They also act as catalysts in job creation and improvement of labour quality (Ariff, Yokoyama, & Kenkyūjo, 1992). According to Malaysia Industrial Development Authority (MIDA), the size of FDI inflows rose sharply in Malaysian manufacturing industries from RM45.7 billion in 2004 to RM61.6 billion in 2010. The United Nations Conference on Trade and Development (UNCTAD) ranked Malaysia as a top host country for FDI in the 2011–2013 period.

Despite being among the major recipients of FDI in the world, the benefits of FDI spillovers on skill upgrading in Malaysia remain ambiguous. This issue is particularly important for a country such as Malaysia whose recent volume of FDI inflows has been increasing, as shown in Table 1. In terms of the share of investment projects in the manufacturing sector (measured by approved investment projects), Table 2 shows that the share of foreign investment registered the highest share compared to domestic investment from 2000 to 2010 (with the exception of 2009 and 2011)[1]. Projects involving foreign investment show an increasing trend from RM19.84 billion in 2000 to RM34.2 billion in 2011. Therefore, the pattern raises the question of the real benefits produced by technology spillovers that Malaysia is able to reap from the presence of FDI.

Table 1
FDI inflows in Malaysia (US$ million)

Year	US$ million
2000	6,324
2001	2,714
2002	3,203
2003	2,473
2004	4,624
2005	3,967
2006	6,072
2007	8,538
2008	7,248
2009	1,405
2010	9,155
2011	12,000

Source: UNCTAD (1998; 2002; 2004; 2006; 2012)

In previous research on the effects of technological change on skilled labour demand, the importance of technological change is undisputable. However, there are also significant effects of spillovers from the trade and FDI channels to explain the demand for skilled labour (Araújo, Bogliacino, & Vivarelli, 2009). Nevertheless, the spillover effects of both FDI and trade on relative demand for skilled labour are still absent from the empirical literature and are still under scrutiny, particularly in developing countries and at the industry level. Most previous studies focus on the manufacturing sector at a high level of aggregation (Feenstra & Hanson, 1995, 1996, 1997a, 1997b, 2001; Berman, Bound, & Griliches, 1994, Egger, Pfaffermayr & Wolfmayr-Schnitzer, 2001; Cheung & Lin, 2004; Egger & Egger, 2005; Taylor & Driffield, 2005; Fajnzylber & Fernandes, 2009). Only recently have studies started using firm-level data (Head & Ries, 2002; Pavcnik, 2003; Görg & Hanley, 2005; Yamashita, 2008; Bandick & Hansson, 2009; Meschi, Taymaz, & Vivarelli, 2011; Agnese, 2012). However, most of the above-mentioned studies focus on developed countries.

Malaysia is no different in this phenomenon, where the relationship between employment and FDI is not very substantial, especially over the long run, and it has become an issue of current interest (Pinn, Ching, Kogid, Mulok, Mansur, & Loganathan, 2011) This might be because FDI could cause skilled-biased technological change in the country, causing a minimal increment in demand for skilled labour in Malaysia. In this regard, we extend such work by adding FDI as a spillover channel, in addition to foreign trade, to investigate to what extent the spillover effects of FDI contribute to skill upgrading and thus increase demand for skilled labour in the Malaysian manufacturing industry. The dataset provided by Department of Statistics Malaysia (DOSM) includes information on the share of local workers in foreign firms to total employment (parents and affiliates) at the establishment level, which enable us to directly analyse whether the spillover effects of FDI contribute to skill upgrading and thus increase skilled labour demand within these firms. Previous studies use dummy variables to measure the spillover effects of FDI on skilled labour demand[2].

Table 2
Approved investment project in the manufacturing sector, 2000–2011(RM billion)

	Domestic investment (RM billion)	Share of domestic investment (%)	Foreign investment (RM billion)	Share of foreign investment (%)	Total capital investment (RM billion)
2000	13.76	40.9	19.84	59.1	33.60
2001	5.24	24.7	16.11	75.3	21.35
2002	6.30	35.3	11.57	64.7	17.87
2003	13.50	46.3	15.64	53.7	29.14
2004	15.63	54.3	13.15	45.7	28.78
2005	13.17	42.4	17.88	57.6	31.05
2006	25.76	56.0	20.27	44.0	46.03
2007	26.51	44.2	33.43	55.8	59.94
2008	16.69	26.6	46.01	73.4	62.70
2009	10.49	32.1	22.14	67.9	32.63
2010	18.12	38.4	29.10	61.6	47.22
2011	21.90	55.4	34.20	44.6	56.07

Source: MIDA (2000–2012)

To the best of our knowledge, no study has empirically examined the spillover effects of both trade and FDI on skilled worker demand, particularly using establishment-level data for Malaysian manufacturing industries. Studies by McNabb and Said (2013) and Devadason (2005; 2011) have focused on the effect of trade on skilled labour demand. McNabb and Said (2013) and Devadason (2005; 2011) have matched SITC (Standard International Trade 4 Classification) trade data at the 3-digit industry-level with the Household Income Survey and ASMI (provided by DOSM). Only recently, in a study by Jauhari and Khalifah (2013) using the establishment-level data to analyse different types of trade linkages, including outsourcing intensity, export intensity and vertical trade intensity while controlling for foreign ownership (FDI) in the Malaysian E&E

industry during the 2000–2005 period. In terms of spillover effects via FDI, Fajnzylber and Fernandes (2004, 2009) used data from Investment Climate Surveys performed by the World Bank in Asia and Latin America to examine how the effects of international diffusion of technology through the channels of importing intermediate inputs, exports and FDI on demand for skilled labour in Malaysia.

Many previous studies show positive results of technology spillover effects on demand for skilled labour, but these results suffer from aggregation bias or failure to control for endogeneity due to limited panel data at the industry level and the difficulty of finding instrumental variables (Keller, 2004). Consequently, using panel data at the industry level, we employ a more advanced dynamic panel econometric technique that formally addresses industry-specific effects and simultaneity bias. The method relies on the generalised method-of-moments (GMM) estimator, which has a number of advantages over the cross-section estimator.

LITERATURE REVIEW

The importance of technology spillovers attracts considerable attention in theoretical and empirical works as an effective channel increasing demand for skilled labour (Acemoglu, 1998; Coe & Helpman, 1995). According to Acemoglu (1998), international trade and FDI play key roles that contribute to skill upgrading through the spillover of skill-biased technologies from industrial countries to developing countries. The mechanism of spillovers from one country to other countries is in line with the endogenous growth models that are extended from Romer's closed-economy framework to an open-economy setting.

Theoretically, the spillover effects of MNCs contribute to initial knowledge by introducing new technologies and products to domestic firms. In line with the evolutionary theory, Blomström and Kokko (1998) outlined four ways through which FDI spillovers of this technology and knowledge into local firms might influence the host country: (i) through the training effect that causes the movement of highly trained and skilled staff from foreign firms to domestic firms; (ii) through the so-called "demonstration-imitation effect" that arises from arm's-length relationships between MNCs and domestic firms, thus enabling the domestic firm to learn and adopt superior production technologies and managerial and organisational skills; (iii) through the "competition effect" on domestic firms when competition from MNCs forces domestic rivals to upgrade production technologies and techniques to remain productive and competitive; and iv) through the "linkage effect," which is related to export spillovers by which the domestic firms can learn to export from the MNCs. This is a positive move, as it helps to improve the productivity and competitiveness of local firms, forcing them to operate efficiently by transforming the knowledge acquired into practical and commercial use; yet, these gains cannot be internalised by these foreign firms (Lall, 1978). These results are known as "spillover" effects (Fan & Warr, 2000).

With regard to the empirical evidence of the spillover effects of FDI in developed countries, a study by Bandick and Hansson (2009) on 50 Swedish manufacturing firms during the 1993–2002 period showed that demand for skilled labour tended to increase in non-multinational firms but did not show any effect in multinational enterprises (MNEs). By using propensity score matching with difference-in-differences estimation, an interesting finding was observed in which the larger presence of foreign MNEs appeared to have a positive impact on the relative demand for skills in Swedish MNEs within the same industry as well as on the elasticity of substitution between skilled and less-skilled labour, which seemed to be lower in MNEs compared to non-MNEs. This was supported by Figini and Görg (1999) and Taylor and Driffield (2005) who asserted that FDI inflows contributed to skills upgrading and increasing wage dispersion in Irish and in United Kingdom (UK) manufacturing. Branstetter (2006) showed that capital investment acted as an effective channel for knowledge spillover from Japanese MNEs to firms in the United States. However, a study by Blonigen and Slaughter (2001) on US manufacturing from 1977 to 1994 showed that the spillover effects of FDI insignificantly increased demand for skilled workers within the US manufacturing sector. This result indicated that FDI does not generate positive intra-industry spillovers for domestic firms in spite of FDI being a primary technology transporter to local firms in the US. A similar result was found by Konings (2001), which showed a negative effect of FDI spillovers on domestic firms in Bulgaria and Romania, while there were no spillover effects of FDI observed in Poland.

Regarding the evidence of spillover effects via FDI in developing countries, a study by Cheung and Lin (2004) in China showed that FDI impacts were positively associated with skills upgrading and increased local innovation in China through reverse engineering and the demonstration-imitation process. A similar study performed by Zhao (2001) asserted that FDI could increase the relative wages of skilled labour through labour market segmentation and high labour mobility costs. They estimated the relative wages in Chinese state-owned enterprises (SOEs) and foreign-invested enterprises (FIEs) by correcting for possible sample selectivity caused by the employment choice between SOEs and FIEs. Thenceforth, they investigated the employment choice to provide evidence of the costs of labour mobility. The overall results showed that the skill premium in a country with labour market distortions may increase faster than skills upgrading, which was caused only by skill-biased technology. In terms of the spillover effects of FDI by country, Todo, Zhang, and Zhou (2009) found that Japanese MNEs do not contribute highly to knowledge spillovers, despite the increasing number of skilled workers in Chinese manufacturing firms. Nevertheless, they found that spillover effects from US MNEs were effective in enhancing the share of skilled labour in Chinese manufacturing firms. Meanwhile in Indonesia, te Velde (2002) found evidence of sector bias in utilising skilled workers in a local Indonesian firm, resulting in 60% higher wages for skilled workers working in foreign-owned firms. In Thailand manufacturing firms, Matsuoka (2001) showed higher wage premiums paid to skilled workers in foreign-owned by 12% and 16% relative to unskilled workers in 1996 and 1998, respectively.

The spillover effects of trade on the demand for skilled labour are closely associated with fragmentation trade through imported inputs. Duranton (1999) found that the fragmentation of intermediate goods was more effective in influencing labour demand than final goods. This could be because the production of the final goods requires advanced production technology, which necessitates resorting to trade to acquire high-quality intermediates abroad due to the scarcity of local skilled labour rather than the intermediate goods. The import of intermediate inputs acts as a channel of technology diffusion influencing demand for skilled labour in the firms of developing countries through the use of inputs that embody state-of-the-art technology, especially if these inputs could not be acquired domestically (Grossman & Helpman, 1991; Keller, 2004). Consistently, Mei-ci (2010) asserted that technology spillovers through the import of intermediate goods that embody knowledge are also skill-biased, which makes developing countries increase their relative demand for skilled labour based on 28 Chinese manufacturing firms during the 1996–2006 period. Mei-ci (2010) applied a translog cost function and first built an endogenous technical progress model with imported intermediate goods from industrial countries. The results also showed that the effect of technology spillovers differed across types of manufacturing industries. For the technology-intensive sector, the technology spillovers were skill-biased compared to the labour-intensive sector for which the technology spillovers were skill-neutral. However, this finding contradicts a tenet of basic trade theory according to which trade liberalisation results in a reduction of wage inequality in countries with low-skilled, labour-abundant economies (Stolper & Samuelson, 1941). Stolper and Samuelson (1941) asserted that the relative wages of skilled labour can increase due to higher imports of inputs.

The empirical evidence on the skilled labour demand effect of fragmentation, measured by share of imported of capital good, provides a consensus of a positive association between the two variables. Robbins (1996) showed that the import of capital goods, such as machinery and components, has contributed to increased skilled labour demand in several developing countries over the last two decades.

This occurred through the adaption or adoption of these capital goods that embodied knowledge and modern technology. This technology has been used in most advanced countries, thereby showing a substantial increase in the demand for skilled labour within developing countries (Lee & Vivarelli, 2006). For instance, Mazumdar and Quispe-Agnoli (2002) revealed that increased imports of machinery followed by liberalisation contributed to the increased demand for high-skilled white-collar workers in the manufacturing industries of Peru in early 1990. This result was supported by Milkman and Pullman (1991), who argued that new processes using technologically complex machinery resulted in increased demand for skilled technicians, maintenance workers and engineers, particularly in automobile assembly plants. Nevertheless, it is important to note that the effect of trade liberalisation on skilled labour demand is greater in developing countries compared to industrialised countries and can be clearly seen when the gap between existing and newly imported technology is large (O'Connor & Lunati, 1999).

In East Asian countries, Yamashita (2008) found that the expansion of fragmentation trade with East Asia (developing countries) significantly upgrades the skills of Japanese manufacturing employment, while fragmentation trade with the Organisation for Economic Co-operation and Development, OECD (developed countries) had a skill downgrading effect, which led to a 1.02% decline in the share of skilled workers over the 1980–2000 period. The result was consistent with the proposed argument that component imports, such as highly capital and technology-intensive content from high-income countries, might substitute for domestic skilled workers. This result suggested that increased component imports from high-income countries require more unskilled workers for further processing. However, some evidence indicated that the effect of trade fragmentation on demand for skilled labour is not clear-cut because there are cases of positive effects, no effects and negative effects. For instance, Geishecker and Görg (2005) studied German industries using data for the period from 1991 to 2000 and asserted that the impact of trade fragmentation on the host country was still unclear, particularly when labour was mobile between industries. Fragmentation in one industry may affect labour in other industries as workers move away from the affected industries. Thus, the effects of trade fragmentation may not be merely confined to changes in demand between industries but to relative demand within industries (Feenstra, 1998; Hijzen, Görg, & Hine, 2005).

Empirical evidence shows that demand for skilled workers is also affected by international outsourcing. A study by Hijzen, Görg and Hine (2005) investigated the impact of international outsourcing on labour demand by using import-use matrices of input-output tables for manufacturing industries in the UK for the 1982–1996 period. As international outsourcing is an important component of explanations of the changing skill structure of manufacturing industries in the

UK, it shows a strong impact on skill demand but has a negative impact on unskilled labour demand. Hsieh (2005) also showed increasing demand for skilled workers in Hong Kong due to the outsourcing of unskilled-labour activities to Mainland China. However, a study by Thangavelu and Chongvilaivan (2011) of manufacturing industries in Thailand based on the aggregation of establishment-level data at the 4-digit industrial classification found that both intermediate inputs and service outsourcing are relatively skill-biased. Further, this result shows that intermediate inputs outsourcing has negative impacts on the relative demand for skilled and unskilled workers, whereas service outsourcing shifts demand towards skilled workers at the expense of unskilled workers. Agnese (2012) also focused on industry-level data for Japanese manufacturing firms; however, that study analyses both materials as well as services offshoring activities across occupations and across three major sectors of the economy (manufacturing, services and primary plus energy) for 1980–2005. The study concludes that highly skilled occupations gain from services offshoring, while production workers (unskilled) benefit from materials.

Consistent with endogenous growth theory, which stresses the importance of investigation of the role of spillover effects from the channels of FDI and trade, recently, there have been an increasing number of studies investigating these spillover effects upon skilled labour demand in the certain types of countries. For instance, a recent study by Lee and Wie (2015) investigated the impact of technology diffusion of imports and FDI on skilled labour demand in the Indonesian manufacturing sector. This study uses labour force survey data for the 1990–2009 period. Based on a supply-demand analysis, this study finds that both between- and within-industry shifts in labour demand that favoured skilled workers contributed to widening wage inequality since the early 2000s. Meanwhile, evidence from firm-level data in the manufacturing sector indicates that the diffusion of technology through imports and FDI caused demand to shift towards more skilled labour and increased wage inequality between skilled and unskilled workers. This study reveals that the estimated coefficient on FDI is positive, meaning that demand for non-production workers would increase by 5.2% if the domestic firms increased the share of FDI inflows of their total investments by 10%. The coefficient on imported materials is also positive and statistically significant, showing that a 10% increase in the import share of investment (other factors fixed) leads to a 4.5% increase in the share of non-production workers.

Fajnzylber and Fernandes (2004) examined how the international diffusion of technology affects demand for skilled labour through the channel of importing of intermediate inputs, exports and FDI in Brazil, China and Malaysia in 2004. They used data from Investment Climate Surveys performed by the World Bank in Asia and Latin America. To analyse the effects of the international diffusion of technology on demand for skilled labour, this study used OLS with standard errors corrected for possible heteroskedasticity. The results showed that imports intermediate inputs and FDI had a significant and positive effect on demand for skilled labour in Brazilian and Malaysian firms. In contrast, both intermediate inputs and FDI have a negative effect on skilled labour in China. The negative effect of FDI and intermediate inputs is due to China's production using more unskilled labour-intensive goods, and thus, the effect of skill-biased technology diffusion from both channels is reduced. Exports are negatively associated with demand for skilled workers in China and Malaysia, and, to a lesser extent, in Brazil. This result is consistent with international sales, leading to a greater degree of specialisation according to the comparative advantage of countries in unskilled labour-intensive goods. The overall finding in 2004 revealed that FDI and technology licensing act as an effective channel for the diffusion of skilled-biased technology in fostering demand for skilled labour among Brazilian and Malaysian firms.

Fajnzylber and Fernandes (2009) extended their study in 2009, but they only focused on Brazil and China. A similar result was found as that found in 2004, which showed that the import of intermediate inputs and FDI were statistically significant and positive, but exports show a negative effect on demand for skilled labour in Brazil and China. The results also indicated that the presence of FDI in Brazilian and Chinese firms led to increasing demand for workers in managerial, engineering and technical occupations and for workers with tertiary educations. The results also suggested that the presence of FDI led to an increase in the number of skilled workers of approximately 59% in Brazil and 51% in China when the FDI is measured based on the wage bill share. If FDI is measured as the employment share, the number of skilled workers increased only by 38% and 29%, respectively, in Brazilian and Chinese firms. The overall changes in skilled labour demand in both Brazilian and Chinese firms are mostly due to variability across firms within industries rather than to variability across industries. A similar study was conducted by Bruno et al. (2012) in Poland, the Czech Republic and Hungary between 1993 and 2001. That study found that the presence of MNEs was statistically significant and positive in Poland but was insignificant in Hungary and had a very small negative effect in the Czech Republic. Consistent with standard neoclassical trade theory, the results showed that exports of final goods led to a decrease in the share of skilled labour by approximately 3% to 4% for all three countries. The overall findings were consistently supported by Coe and Helpman (1995) and Potterie and Lichtenberg (2001), showing that technology spillovers through inwards FDI and imports of intermediate input acted as effective channels of technology and knowledge diffusion compared to outwards FDI and export flows.

DATA DESCRIPTION

The data used in this study are obtained from the Department of Statistics Malaysia (DOSM) based on a survey of manufacturing industries for the main variables, namely, Research and Development (R&D) investment, value added, physical capital stock (gross fixed capital formation), depreciation value of physical capital stock, number of workers in foreign firms and number of employees by job position. Meanwhile, imports of intermediate and capital goods are gathered from Malaysia's official external trade data and are compiled by the DOSM. These data are published at the two-digit Standard International Trade Classification level in, inter alia, the Department of Statistics' publication, Malaysia External Trade Statistics. These data, which are classified according to the three-digit Standard International Trade Classification (SITC), have then been matched to the three-digit Malaysian Standard Industrial Classification System 2000 (MSIC 2000).

The present study focuses on manufacturing industries because technology spillovers have been associated with the manufacturing sector for a long time. In line with Malaysia's aim to become a high-income country by 2020, the manufacturing sector will be given special attention by the government. This sector will be supported by private investment, and the regulatory framework will be changed to attract both domestic and foreign investments, thus potentially contributing to economic growth. For instance, the government has focused on the E&E industry as part of its strategy for greater specialisation, as E&E is the largest single contributor to the manufacturing sector. E&E accounted for 26.1% of manufacturing output and shows potential to create high incomes as the multi-national companies that dominate the E&E scene move into more R&D (Economic Planning Unit, EPU, 2010).

This study covers the 2000–2008 period, considering that FDI inflows, imports of capital and intermediate goods volumes were large during that period, particularly after the launch of the Eighth Malaysian Plan (2000–2006) and the Ninth Malaysia Plan (2006–2010). Limitation of coverage is due to the industrial classification system (MSIC 2000, previously known as the Malaysia Industrial Classification (MIC), 1972: revised in 1979). After 2008, the MSIC code was overhauled by DOS. To balance out the panel data between industries and variables, this study uses a sample of 50 three-digit levels of manufacturing industries. The summary of statistics for the variables used in this study as shown in Appendix A.

In this study, employment refers to the number of paid (full-time) employees per year. Following Hollanders and Ter Weel (2002), skilled workers in this study refer to high-skilled workers comprised of legislators, senior officials and managers, professionals, technicians and associate professionals[3]. Therefore, the dependent variable in this study is the share of skilled workers of the total employment within each firm.

EMPIRICAL METHODOLOGY

The purpose of this section is to estimate the impact of technology spillovers through the channels of both FDI and trade on firm-level skilled labour demand for the 2000–2008 period. We follow the Hollanders and Ter Weel (2002) approach in constructing a translog model of the relative demand for skilled labour. We assume the employment share of groups as $s = f$ (ln$x$1, ln$x$2…lnxs). Expanding this function into a second-order Taylor series around the mean of the respective x and interpreting the derivatives as coefficients, the following function is obtained:

$$s = \beta_0 + \sum_{q=1}^{Q} \beta_q \, 1nx_q + \frac{1}{2} \sum_{q=1}^{Q} \sum_{r=1}^{Q} In\, x_q \, In\, x_r + \varepsilon \quad (1)$$

where s is the employment share of skilled labour, and the group of xs one might think of are capital stock (K_{it}), value added (Y_{it}), stock of technology ($TECH$), such as R&D intensity and spillovers from trade and FDI, and relative wages for skilled and unskilled workers w^s/w^u . In particular, the function that explains the share of skilled labour (s) in industry i in year t is:

$$s_{it} = \alpha_0 + \beta_1 \ln K_{it} + \beta_2 \ln Y_{it} + \beta_3 TECH_{it} + \beta_4 \ln \left(\frac{w^s}{w^u} \right)_{it} \quad (2)$$

where K_{it} is physical capital stock, Y_{it} is value added, $TECH_{it}$ is a stock of technology and w^s/w^u is the relative wage rates for skilled and unskilled workers. Capital and technology stocks are assumed to be quasi-fixed (see, e.g., Adams, 1999). As is common practice in many empirical works, we use the perpetual inventory method (PIM) to measure physical capital and technology stock (local R&D stock) as suggested by Griliches (1980). The formulas for physical capital and local R&D are as follows:

$$K_t = (1-\gamma)K_{t-1} + IK_t \quad (3)$$

$$RD_t = (1-\delta)RD_{t-1} + IRD_t \quad (4)$$

where γ and δ are the depreciation rates for physical capital and R&D stock of 5% and 15%, respectively, following Adams (1999). He assumes that the rates of depreciation do not substantially change the estimation results. IK_t and IRD_t refer to gross fixed capital formation and R&D investment, respectively. Assuming capital and output grow at the same rate, the initial level of capital investment and R&D investment are determined using the following formula:

$$K_0 = \frac{(IK_1)}{(\gamma + 0.05)} \text{ and } RD_0 = \frac{(IRD_1)}{(\delta + 0.05)} \qquad (5)$$

As has been documented, the technology stock comes from two sources: (i) local R&D and (ii) international technology through participation in international trade and inwards FDI (Hollanders & Ter Weel, 2002). In line with the empirical work of Coe and Helpman (1995), we use R&D investment as a proxy for local R&D. To capture the effect of local R&D on demand for skilled labour, Machin and Van Reenen (1998) suggest lagging R&D expenditures by one year in all specifications[4]. Thus, domestic R&D is measured as the proportion of value added with a 1-year lag. There is a positive and significant correlation with the degree of skill upgrading and R&D intensity in almost every specification, which indicates the changes in the technology stock and employment structure (Hansson, 2005; Hollanders & Ter Weel, 2002; Machin & Van Reenen, 1998).

To measure the stock of technology from international sources, this study uses trade and FDI as the main channels of technology diffusion or spillover. Trade (i.e., imports) and FDI are widely viewed as important channels for knowledge spillovers (Grossman & Helpman, 1991). Following Meschi et al. (2011), the spillover effects from trade are measured as a share of imported inputs (total imports of intermediate and capital goods) to imports of total inputs at the sectoral level. Technology spillovers from FDI are measured based on the share of local employment in foreign firms to total employment (parents and affiliates) (Blonigen & Slaughter, 2001; Figini & Görg, 1999; Girma, Greenway, & Wakelin, 2001). To examine whether FDI facilitates technological change and allows workers to assimilate knowledge over time through the "learning effect", we consider the quadratic effects technique that has been applied by Figini and Görg (1999) and Taylor and Driffield (2005)[5].

However, there are some problems with estimating Equation (1) in relation to relative wages. Wages are endogenous, and the estimation and interpretation of the result should be performed meticulously. As a common practice in the literature, the relative wages term is replaced by time dummies (Machin & Van Reenen, 1998). A time dummy is efficient in capturing real variation in wages instead of the relative wage terms, but it is less appropriate to apply in our study, as we do not have rich panel data (Chennells & Van Reenen, 1999). For this reason, we follow Meschi et al. (2011) and drop the wage term by using a lagged dependent variable. Hence, the equation for estimation is as follows:

$$\ln s_{it} = \alpha_0 + \beta_1 \ln s_{it-1} + \beta_2 \ln K_{it} + \beta_3 \ln Y_{it} + \beta_4 \ln\left(\frac{RD}{Y}\right)_{it-1} + \beta_5 \ln Rf_{it}^{Trade} + \beta_6 \ln FDI + \beta_7 \ln FDI^2 + \varepsilon_{it} \quad (6)$$

where i is the industry and t is the time index, and s_{it} refers to the share of share of skilled workers of the total employment (Hollanders & Ter Weel, 2002). s_{it-1} is the lagged share of skilled workers; K is physical capital stock[6]; Y is value added[7]; and RD/Y is local R&D relative to value added. Rf_{it}^{Trade} is the share of imports of capital and intermediate goods to Malaysia's total imports in the manufacturing sector. *FDI* denotes shares of local employment in foreign firms of total employment in the manufacturing sector. FDI^2 represents the route of technological change through the learning process[8]. ε_{it} is the error term.

The present study employs the Generalized Method of Moments (GMM) technique as proposed by Arellano and Bover (1995) to estimate the labour demand function during the 2000–2008 period. The data cover 50 industries in the manufacturing sector. There are at least two reasons for choosing a GMM estimator, be it a Different-GMM (DIFF-GMM) or System-GMM (SYS-GMM). The first is to control for industry-specific effects, which cannot be conducted with industry-specific dummies due to the dynamic structure of the regression equation. The second is to control for simultaneity bias caused by the possibility that some of the explanatory variables may be endogenous. This can be conducted by using the lagged levels of the regressor as an instrument. Some authors, for example, have found that FDI is likely to be endogenous, as higher output may attract more market-seeking FDI, thus overstating the effect of spillovers (Azman-Saini, Baharumshah, & Law, 2010).

However, it is well documented that the DIFF-GMM estimator has very poor finite sample properties in terms of both bias and precision. Consequently, Blundell and Bond (1998) propose the use of extra moment conditions in the SYS-GMM estimator resulting in lower bias and higher efficiency. In addition, the basic advantages of the SYS-GMM, compared with the DIFF-GMM, are due to the valid instrumental variables for the untransformed equations in levels. The SYS-GMM not only increases the efficiency of the estimates but also allows for the exploitation of all of the variable information in the level and difference equations (Arellano & Bover, 1995). In the present study, the application of SYS-GMM is more appropriate than DIFF-GMM because the time series for the observations are short (450 observations) and consist of a small panel (N = 50).

EMPIRICAL RESULTS

GMM estimators are typically applied in one- and two-step variants (Arellano & Bond, 1991). The analysis begins with estimation of the labour demand model using SYS-GMM with one- and two-step variants, as shown in Table 3. The results in column (1) reveal that, for the one-step estimator, all of the endogenous variables have insignificant influences on the demand for skilled workers, except for the lagged share of skilled labour. Meanwhile, for the two-step estimator, the results reveal that the lagged share of skilled labour, value added and local R&D have significant effects on demand for skilled workers. These results in column (2) show that the two-step estimates of the standard errors tend to be downward biased because they use so-called optimal weighting matrices, where the moment conditions are weighted by a consistent estimate of their covariance matrix (Arellano & Bond, 1991; Blundell & Bond, 1998). This makes the two-step estimators asymptotically more efficient than one-step estimators. However, capital intensity, imports of intermediate and capital goods, FDI and FDI^2 are not statistically significant in either variant. These results clearly indicate that the use of the two-step estimator in small samples, as in this study, has several problems as a result of the proliferation of instruments.

In a simulation analysis, Windmeijer (2005) show that the two-step GMM estimation with numerous instruments can lead to biased standard errors and parameter estimates in some variables. Moreover, Bowsher (2002) and Roodman (2009) show that numerous instruments may lead to weakened over-identification test. It is indicated by the Hansen test that when the *p*-value equals to 1 or is very close to 1, it is seen as a warning of the instrument proliferations problem. Hence, this study does not fail to reject the null hypothesis for over identifying the restriction, which implies endogeneity in the instruments and insignificant statistics.

Due to the problems of generating too many instruments, this study reduces the number of instruments by collapsing the instrumental variable matrix as suggested by Calderon, Chong and Loayza (2002), and the results are tabulated in columns (3) to (5). To control for the possible endogeneity of value-added and physical capital that simultaneously impact the labour demand, both capital and value-added variables will be lagged when estimating in levels (Machin & Van Reenen, 1998). This is a common approach to addressing endogeneity when estimating the translog cost function and it is difficult to find convincing instruments.

Table 3
SYS-GMM estimates: Demand for skilled labour, 2000–2008

Variable	1		2		3		4		5	
	SYS-GMM				Alternative SYS-GMM					
	One-step		Two-step		Two-step					
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
Lagged share of skilled labour	0.779	0.061 (0.000)*	0.789	0.0765 (0.000)*	0.242	0.251 (0.339)	0.550	0.151 (0.000)*	0.488	0.187 (0.009)**
Value added	–0.013	0.011 (0.239)	–0.022	0.012 (0.086)**	0.016	0.037 (0.651)	–0.032	0.019 (0.092)**	–0.031	0.018 (0.097)**
Physical capital	0.031	0.021 (0.162)	0.033	0.021 (0.123)	0.005	0.072 (0.937)	0.029	0.029 (0.306)	–0.007	0.033 (0.069)**
Share of imported input	0.004	0.012 (0.743)	0.011	0.013 (0.403)	8.000	0.008 (0.920)	0.049	0.057 (0.390)	0.008	0.040 (0.831)
FDI	–1.933	2.293 (0.389)	–2.893	2.562 (0.264)	–5.430	3.094 (0.079)**	–	–	–9.390	2.562 (0.076)**
FDI²	1.003	1.157 (0.389)	1.453	1.289 (0.265)	2.790	1.591 (0.080)**	–	–	4.700	1.289 (0.073)**
Local R&D intensity	–0.020	0.014 (0.144)	–0.024	0.011 (0.034)*	–0.055	0.041 (0.187)	–0.024	0.011 (0.034)	–0.053	0.053 (0.048)*
AR(2) test	0.668		0.677		0.990		0.659		0.636	
Hansen test (*p*-value)	1.000		1.000		0.955		0.298		0.556	
No. of sample	50		50		50		50		50	
Instrument	94		94		27		23		27	

Notes. All variables are transform into natural log. * denotes significant at 5%; ** denotes significant at 10%; Coeff. = Coefficient; s.e. = standard error.

The results are tabulated as shown in column (3). However, the result is largely unaffected because there still exists simultaneity between value added and physical capital in spite of experimenting with longer lags (in this case, lagged at T–4), and only the variables FDI and FDI^2 are insignificant in influencing the demand for skilled labour.

In line with the contribution of this study to examining the technology spillover effects of FDI on skilled labour demand, this study conducts several robustness tests. First, the physical capital and value added variables are not lagged as in column (3), and then, both variables FDI and FDI^2 are excluded from the model. The results provided in column (4) reveal that, when excluding the FDI and FDI^2 variables from the model, only the lagged share of the dependent variable and value added are significant. In a next step, we re-estimated the model by including the FDI and FDI^2 variables in the model as shown in column (5). The main econometric outcome clearly reveals that local R&D becomes significant when including the FDI and FDI^2 variables in the model. This result is supported by Hejazi and Safarian (1999), who argued that the spillover effects derived from FDI to host countries are larger and that FDI tends to influence the overall or other spillovers compared to inclusion of spillover effects via trade alone in the model. The previous research has recognised a strong association between FDI and local R&D (Blomström & Kokko, 1998). This result indicates that inflows of FDI should be encouraged to prepare Malaysian local R&D, as these R&D activities conducted by Malaysian enterprises are domestic market–oriented and involved in relatively low level technologies, biasing demand for semi-skilled and low-skilled workers. Such a condition makes enterprises feel less "pressure" to be innovative and competitive and thus restricts the utilisation of skilled workers (Malaysian Science and Technology Information Centre, MASTIC, 2008). The main contributor to these factors is a low capacity to absorb new technology, especially in the Malaysian manufacturing sector, and thus, it becomes a main hindrance to local firm R&D and to the internationalisation of R&D activities in international markets (MASTIC, 2008; Organisation for Economic Co-operation and Development, OECD, 2011). Therefore, the significant presence of MNCs is geared toward transitioning R&D activities from a "domestic market orientation" towards internationalisation of R&D activity in several ways. These include providing the fastest and most effective way to deploy new technologies in local firms; acting through the process of technology transfer; providing international linkages for Malaysian local firms; and becoming an important source of knowledge transfer in technology, management skills and development of the technical capabilities for local R&D (Ismail & Yussof, 2003).

Attention is now on the spillover effects derived from FDI on relative demand for skilled labour. Despite the negative relationship of FDI on skilled labour demand (with coefficient of 9.390), the effect of FDI^2 is positive and statistically significant at the 10% level. This result clearly indicates that the spillover effects of FDI as indicated by FDI^2 appear to be assimilated quickly by skilled workers in the Malaysian manufacturing industry through the learning effect. The results found in this study are also consistent with Taylor and Driffield (2005), who show that the assimilation of technology from FDI through the "learning effect" is quicker when FDI is specified as quadratic rather than through time lags.

One possible reason for the negative correlation between technology spillovers via FDI and demand for skilled labour is the existence of a crowding-out effect (Masron, Zulkafli, & Ibrahim, 2012). Crowding-out tends to occur when countries practice open or liberal economic policies, which allow MNCs to outsource their inputs from other efficient countries (Aitken & Harrison, 1999; Hu & Jefferson, 2002). Another possible cause that can be related with the negative relationship is the concentration of FDI inflows in selected industries[9]. Those industries that receive larger FDI inflows will enjoy better technology and lower production costs, which hence increase their productivity due to positive spillover effects. Unfortunately, this will depress other non-FDI industries due to the increased competition that is induced by the greater presence of FDI in domestic industries. This situation may force inefficient domestic firms to exit and surviving firms to improve their performance. This result is strongly consistent with the current Malaysian manufacturing industry in which most foreign investments focus on capital-intensive industries, especially the E&E and machinery industries, to intensify in-house R&D and Design and Development (D&D) activities compared to the labour-intensive industries, such as paper and printing, metal and wood (EPU, 2010; Masron et al., 2012).

Nevertheless, we do not find any evidence that the trade spillovers have statistically significant effects on demand for skilled labour. Our finding is empirically supported by Hejazi and Safarian (1999), who argued that the spillover effects of FDI on host countries are larger; hence, the importance of the trade channel is much reduced after controlling for FDI. The result is strongly consistent with traditional trade theory as expressed in the Heckscher-Ohlin model and Stolper-Samuelson theorem (HOSS). According to this theorem, the distinction between sectoral and factoral dimensions in industries or firms leads to different types of skills (Wood, 1994). Hence, in the case of Malaysia, the abundance of unskilled workers at various production stages and the low absorptive capacity of local firms are severe problems limiting Malaysia's ability to imitate the imported intermediate inputs, which embody technological knowledge (EPU, 2010). Furthermore, based on the Economic Transformation Programme (ETP) Annual Report 2011, the abundance of unskilled workers is due to many industries, including the E&E industry, which are still focused on the assembly of low value added tasks or stages of production. This would induce the opposite effect on demand for skilled workers. Another possible explanation for this result would be that the high levels of FDI enjoyed by Malaysia have been associated with capital investment that focuses on intermediate rather than on high value-added production. As a result, the overall impact of imported intermediate inputs is biased towards unskilled labour (McNabb & Said, 2013).

More important findings report that the spillover effects of FDI, local R&D intensity, value added and physical capital are more robust using the alternative two-step SYS-GMM by collapsing the instrumental variable. This technique is found to be an efficient way to mitigate the problem of many instruments by using the level of the regressor as an instrument, as proposed by Arellano and Bond (1991). This is valid under the assumptions in the model that the error term is not serially correlated and that the lag of the variables is weakly exogenous. This can be supported by two tests. First, the Arellano-Bond test shows that AR(2) failed to reject the null. That is, there is no serial correlation problem in the model. Second, the Hansen test, which tests for validity of the instrument, shows that there is no evidence of too many instruments, as the number of instruments (27) is substantially smaller than N (50). Failure to reject the null of both tests provides support for the estimated model.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

This study investigates the spillover effects of FDI and trade on skill upgrading and, thus, increasing the relative demand for skilled labour in 50 Malaysian manufacturing industries for the period from 2000 to 2008. After controlling for endogeneity using the SYS-GMM estimator, the results confirm that the spillover effects from FDI are significant for skill upgrading, which in turn leads to an increased demand for skilled labour. Although the FDI coefficient indicates a negative correlation between FDI and skilled labour demand, the effect of technology spillovers via FDI, as indicated by FDI^2, is statistically significant and positive. This gives an indication that the effects of technology spillovers via FDI appear to be assimilated quickly by workers in Malaysian manufacturing industries through "learning effects", and the fast pace is biased towards skilled workers. Our empirical results suggest that the "learning effect" from FDI spillovers can be further enhanced when MNCs provide training for employees and hands-on learning opportunities, thus increasing the labour productivity of skilled workers. In regards to the possibility of crowding-out effects from FDI spillovers in Malaysian manufacturing industries, efforts must be further intensified to encourage and promote FDI inflows into low receiving industries as proposed by Aitken and Harrison (1999). Special attention also needs to be placed on long-run FDI policy to ensure that FDI leads to skill development for all types of workers (Masron et al., 2012). This parallels the government's aim to ensure the function of FDI transfer of knowledge to labour, which must be based on Key Performance Indicators (KPIs).

This study finds no evidence of spillover effects of trade on the demand for skilled labour. Our results suggest that Malaysia needs to seek better market access by further reductions of tariffs and non-tariff barriers, particularly in the E&E industry and for leading R&D countries such as the European countries. Demand for skilled labour could be increased by reductions of input tariffs, which in turn could induce the import of technologically advanced inputs (Machin & Van Reenen, 1998). Finally, in an effort to hasten the assimilation process of foreign spillovers by local workers, reducing regulatory constraints (i.e., of labour, business and credit) is also importance to maximise FDI spillovers (Kohpaiboon, 2006). For example, fewer regulations in hiring and firing workers will encourage labour mobility across firms. Therefore, workers who have previously worked with MNCs are more able to transfer their knowledge and experience with new technologies to domestic firms.

NOTES

1. The share of foreign investment declined in 2009 due an increase in capital outflows from Malaysia, which was affected by the global economic crisis. However, in 2011, the share of domestic investment was higher than foreign investment by 21.7% due to the greater response from the domestic direct investments (DDI) to spearhead the Economic Transformation Programme (ETP).
2. Meshi et al. (2011) use dummy variable (>10% foreign firms). Fajnzylber and Fernandes (2009) use both foreign share and dummy variables.
3. This is not a standard definition of skill levels in Malaysia (Sander & Hanusch, 2012).
4. Katz and Autor (1999) expected that high R&D activities involve the employment of high-skilled workers. Measuring the stock of R&D as a proportion of value added enabled estimates in terms of levels and first differences rather than merely using R&D expenditure from the level equation in a differenced equation.
5. To measure the "learning effect" from FDI spillovers, some empirical studies have lagged FDI^2 to measure the effect of FDI as a route of technological change (Taylor & Driffield, 2005). This is due to the spillover effects of FDI, trade and technology change, which are likely to involve a lag period. However, in this study, the FDI variable could not be lagged because we do not have vast panel data.
6. Physical capital stock is the stock of fixed assets, which comprises net book value of land, land improvements, buildings, transport equipment, computers, machinery and equipment at the end of each reference year.
7. Value added is the net output of a sector after adding up all the outputs and subtracting the intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.

The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3.

8. FDI^2 is obtained by squared the share of local employment in foreign firms relative to total employment.
9. A study by Masron et al. (2012) shows that the crowding-out phenomenon potentially occurs in labour intensive sectors, such as paper and printing, apparel and metal products. These sectors receive the smallest amounts of FDI inflows.

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APPENDIX A
Summary Statistic

Variable	Obs	Mean	Std. Dev.	Min	Max
Share of skilled labour	50	3.27	0.40	1.61	4.84
Value added	50	15.68	2.90	6.30	22.95
Gross fixed capital formation	50	21.28	1.32	16.92	25.15
Local R&D intensity	50	1.42	3.02	–7.26	7.26
Import of intermediate input	50	–1.31	2.10	–8.52	3.54
FDI	50	2.91	1.04	–1.14	4.51
FDI^2	50	5.83	2.07	–2.30	9.02

Note: All variables transform into natural log