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AN ANALYSIS OF PRODUCTIVITY SPILLOVERS FROM FOREIGN DIRECT INVESTMENT IN INDIA'S SERVICES SECTOR [1]

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Abstract

The paper studies productivity spillovers from foreign direct investment in the services sector of India. Using firm-level data for the period 2000 to 2010, horizontal and vertical spillovers are tested with the help of panel data fixed effects 'within' model. Spillovers across different industries of the services sector are also examined. It is inferred that horizontal spillovers positively affect total factor productivity of domestic firms in the services sector. Spillovers through backward vertical channels and forward vertical channels are, however, encountered to be negative. At an industry-level, it is deduced that productivity spillovers vary across different industries with horizontal spillovers being more dominant than vertical spillovers.

Key words: Productivity spillovers, Foreign Direct Investment, Services sector, Panel data models

JEL Code (s): F21, F23, L60, O30, O47

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1. INTRODUCTION:

Most of the developing economies have opened their doors to foreign direct investment (FDI) in the recent years. The main reason behind this is to benefit from advanced production techniques and processes that accompany FDI. It is often argued that multinational enterprises (MNEs), through which majority of FDI is channelised, own firm-specific proprietary advantages like technical knowhow, marketing and managerial skills, access to cheap raw materials, export markets etc. which enable them to operate in the host country markets. Though all these advantages are non-tangible in nature, they possess the characteristics of a public good. Domestic firms can benefit from them *via* productivity spillovers (Caves 1974; Hymer1976; Kugler 2006; Javorcik 2004).

Analysis of productivity spillovers has, therefore, gained significant importance in the empirical literature. However, most of the studies have taken into account the manufacturing sector, ignoring the services sector completely (Anwar and Nguyen 2010; Javorcik 2004; Joseph 2007; Kohpaiboon 2009; Kugler 2006; Sasidharan and Ramanathan 2007; Smarzynska 2002; Wang and Gu 2006). There exist very few studies focusing on spillovers from FDI into the services sector (Lesher and Miroudot 2008). Lesher and Miroudot (2008) point out in this context that productivity spillovers from FDI are not solely confined to the manufacturing sector. In reality, the services sector also provides inputs to other sectors of the economy and is in turn recipient to inputs from them. Services sector, thus, has great potential to exploit the concomitant spillovers from FDI. In their study, Lesher and Miroudot (2008) assessed productivity spillovers across various services for the OECD countries. Using panel data fixed effects model for the period 1993 to 2006, they found positive horizontal spillovers in industries like hotels and restaurants, land transport, other transport services, finance and insurance, health and social work and other social and personal services. On the other hand, backward vertical spillovers were encountered to be positive for construction, hotels and restaurants, water transport, computer related activities, other business activities and education. Services like wholesale and retail trade, real estate, other business activities, education and health services gained from forward vertical spillovers. Their study suggested that services sector experienced significant spillovers from FDI. Assessment of productivity spillovers for the services sector is, therefore, crucial. The objectives of the paper are

twofold. Firstly, the paper tries to analyse productivity spillovers from FDI in the services sector of India. Secondly, a scrutiny of spillovers across all industries belonging to the services sector is also aimed at, in order to, determine which services benefit from spillovers. Taking into account the growing importance of services sector in the Indian economy, such type of an analysis would help in understanding whether FDI has aided the growth of services sector or not.

The rest of the paper is organised as follows. *Section* 2 reviews the channels through which productivity spillovers take place. The data and methodology applied for the purpose of analysis are explained in *Section* 3 and *Section* 4. *Section* 5 presents the empirical results, while the last *Section* concludes the paper.

2. UNDERSTANDING PRODUCTIVITY SPILLOVERS:

Spillovers occur when entry of MNEs leads to productivity increase in the host country firms and MNEs are unable to capture the quasi-rents out of it (Blomström and Kokko 1998; Caves 1974; Hymer 1976; Javorcik 2004; Kugler 2006). Spillovers from activities of MNEs can be classified as 'horizontal spillovers' and 'vertical spillovers'. Horizontal spillovers occur within the industries in which MNEs operate and are also called as *intra-industry* spillovers. They take place through competition, demonstration and labour turnover. According to Blomström and Kokko (1997), the entry of MNEs disturbs the existing equilibrium in domestic industry and forces domestic firms to upgrade themselves, in order to, retain their market share and profits. Foreign presence, therefore, increases competition and induces host country firms to introduce new technologies and use existing resources more efficiently. This, in turn, improves their allocative efficiency and increases production. Moreover, Blomström and Kokko (1997, 1998) state that spillovers from FDI are important because the technology brought in by MNEs is not easily available in the host economy. MNEs often introduce new products and processes in the host country markets which domestic firms can adopt through observation. Domestic firms can upgrade themselves by demonstrating new methods and techniques of production and, thereby, reduce their x-inefficiency (Caves 1974). Lastly, spillovers might also occur through labour turnover, especially when trained labour migrates from MNEs to domestic firms. MNEs place significant importance on training of labour and, hence, domestic labour can learn from migrated labour and

raise their human capital skills. However, Aitken and Harrison (1999) point out that, since MNEs possess technical expertise, their marginal cost of production is lower. Due to this, foreign firms can produce more than their domestic counterparts and steal away market demand from them. Thus, in this case, the negative effect from competition would dominate the positive knowledge spillover effect. In addition to this, Javorcik (2004), Kugler (2006) and Wang (2010) argue that as the main objective of MNEs is to earn profits, they generally try to prevent any type of leakage of their technical knowledge to domestic firms. The spillover effects within the industries can, therefore, be limited.

Vertical spillovers, on the other hand, occur when foreign firms establish linkages with domestic firms operating in different industries in the host country. Such types of spillovers are also known as *inter-industry* spillovers. Inter-industry spillovers can be, further categorised as spillovers from 'backward linkages' (backward vertical spillovers) and spillovers from 'forward linkages' (forward vertical spillovers). Backward linkages are created when foreign firms in the downstream sectors develop relationships with the upstream domestic firms. In backward linkages, foreign firms are the customers of raw materials and intermediate products of local suppliers. According to Blomström and Kokko (1998) and Javorcik (2004), backward linkages create demand for inputs of local firms and help them set up new production facilities. Moreover, since the product requirements of MNEs are high in quality, they generally support local firms in the purchase of raw materials, provide technical assistance and training, thereby, assisting them to upgrade their production and management techniques. Training provided to the employees of domestic firms also helps in raising the levels of human capital. In the case of forward linkages, foreign firms play the role of suppliers of intermediate products to domestic firms. Domestic firms are provided with better quality inputs and costumer services at a lower cost. According to Clare (1996), spillovers through linkages are strong when the demand for intermediate products by MNEs is comparatively large and the communication costs between MNEs and their head quarters are significant. Otherwise, MNEs can impact negatively by creating their own enclaves and preventing any linkages to occur.

The main aim of the paper is, thus, to test productivity spillovers (horizontal and vertical) from FDI in the services sector of India. After liberalisation of the Indian economy, services sector

has emerged as one of the major contributors to GDP. Most of the services like trade, hotels and restaurants, communication, finance and banking, real estate, business services, education and health services have witnessed significant increase in their growth rates (Eichengreen and Gupta 2010; Gordon and Gupta 2003). Taking this into consideration, the paper, further, attempts to analyse spillovers across various services in this sector. Moreover, FDI in services sector has increased manifolds during the post-liberalisation era (GOI, 2014). Services sector, therefore, provides good opportunity in the terms of assessing productivity spillovers. As most of the empirical studies have concentrated solely on manufacturing sector, this paper would definitely add to the literature on productivity spillovers from FDI.

3. DATA SOURCES AND METHODOLOGY:

The study makes use of a secondary database 'PROWESS' compiled by the Centre for Monitoring Indian Economy. PROWESS reports data on listed and un-listed companies operating in the Indian economy. The primary sources of data are, mainly, annual financial statements of the companies. Data for variables like total sales, net fixed assets, salaries and wages, expenses on research and development and expenses on staff training and welfare have been extracted for the purpose of analysis. The original data set consisted of more than 8,000 firms. However, firms with missing values have not been included in the analysis. After cleaning the data, the study constitutes of 2768 firms, out of which 2505 are domestic firms and 263 are foreign firms. A detailed description of number of domestic firms and foreign firms at industry-level is presented in Appendix-A. Foreign firms are defined as firms with more than 10 percent foreign equity as per IMF guidelines (IMF 2008). The time period chosen for the analysis is from 2000 to 2010. However, to allow for entry of new firms and the exit of the old ones, the final structure of data is an unbalanced panel.

Since the data involves number of observations for several time periods, panel data techniques are employed for the estimation purposes. Panel data sets can be estimated using a 'fixed effects model' or a 'random effects model'. In the present study, a fixed effects model has been used as the data comprises of different firms with their own peculiar characteristics. Furthermore, fixed effects model takes into account the unobserved firm-level heterogeneity

(Baltagi 2005; Hsiao 2005). Amongst the various approaches through which a fixed effects model can be estimated, the '*fixed effects within model'* has been applied. In the within model, data is transformed into mean deviation form. Such a transformation wipes away the unobserved effects and makes the estimation procedure unbiased (Baltagi 2005; Greene 2003; Hsiao 2005; Wooldridge 2003). The results of the panel data fixed effects within model are computed using the 'R' statistical software (Croissant and Millo 2008).

4. MODEL:

In order to test productivity spillovers from FDI in the services sector of India, total factor productivity (TFP) is calculated in the first step. Most of the studies (Das, Banga and Kumar 2011; Li and Prescott 2009; Mark 1982) dealing with productivity in the services sector, argue that measuring productivity for services is complicated as compared to the manufacturing sector. This is because services sector is more labour intensive with quality of service provided playing an important role than the capital inputs or material inputs. In addition to it, inputs and outputs of various services are heterogeneous in nature, posing the problem of selection of appropriate deflators. Despite this, all the above mentioned studies state that a multi-factor production function is more accurate than a single-factor production function (labour/capital). The current study has, therefore, used Cobb-Douglas production function for estimating TFP (Lesher and Miroudot 2008; Anwar and Nyugen 2010).

$$Y_{jit}=A_{jit}K_{jit}^{\alpha}\ L_{jit}^{\beta} \qquad \text{..... (1)}$$

Where,

Y_{jit} = Output of the j^{th} firm in i^{th} industry at time period t.

K_{jit} = Capital used by the j^{th} firm in i^{th} industry at time period t.

L_{jit} = Labour of the j^{th} firm in i^{th} industry at time period t.

A_{jit} = Technology parameter capturing TFP of j^{th} firm in i^{th} industry at time period t.

α and β are the capital and labour coefficients respectively.

Taking log on both the sides, TFP is calculated as,

$$\ln A_{jit} = \ln Y_{jit} - \alpha \ln(K_{jit}) - \beta \ln(L_{jit}) \quad \text{.....} \quad (2)$$

In the next step, the impact of productivity spillovers on TFP is analysed with the help of following log-linear equation using panel data fixed effects 'within' model:

$$\ln \Delta A_{jit} = \beta_1 \ln \Delta R_{jit} + \beta_2 \ln \Delta HK_{jit} + \beta_3 \ln \Delta HFDI_{it} + \beta_4 \ln \Delta BFDI_{it} + \beta_5 \ln \Delta FFDI_{it} + \Delta \varepsilon_{jit} \quad \text{.....} \quad (3)$$

Where,

R_{jit} = Research activities of the j^{th} firm in i^{th} industry at time period t.

HK_{jit} = Human capital of the j^{th} firm in i^{th} industry at time period t.

$HFDI_{it}$ = Horizontal spillovers in the i^{th} industry at time period t.

$BFDI_{it}$ = Backward vertical spillovers in the i^{th} industry at time period t.

$FFDI_{it}$ = Forward vertical spillovers in the i^{th} industry at time period t.

Δ represents that the variables are transformed using mean deviation.

ln symbolises that the variables are in log form.

Lastly, spillovers across all industries of the services sector are analysed with the help of Equation (3). The explanation on the construction of variables is provided in detail in Appendix-B (Section B1).

5. EMPIRICAL RESULTS:

Table 1 presents the empirical results from panel data fixed effects within model for the services sector. It can be depicted from the table that coefficient for horizontal spillovers is positive and significant at one percent level of significance (l.o.s). Positive horizontal spillovers imply that domestic firms from the services sector are demonstrating new methods of production by observing and imitating foreign firms in same industries. The presence of MNEs is forcing the domestic firms to upgrade themselves so as to retain their market share and profits. This is also helping them to effectively cope up with the fierce competition induced due to existence of MNEs.

It can be observed from Table 1 that a 1 percent increase in horizontal spillovers is culminating into an increase in TFP of the services sector by 0.82 percent. Spillovers through horizontal channels are, thus, leading to an increase in TFP of domestic firms in the services sector.

On the contrary, it can be seen that productivity spillovers through linkages with MNEs are negative. The coefficients for variables representing both, backward vertical spillovers and forward vertical spillovers are negative and statistically significant. In the case of backward vertical spillovers, MNEs are customers of raw materials from domestic firms. Since input requirements of MNEs are high in quality, they usually assist their local suppliers in purchase of raw materials and provide them technical expertise to ensure the quality. This helps domestic suppliers to improve their production techniques and upgrade the quality of their products. Negative spillovers from backward linkages imply that domestic firms in the services sector are not able to capture the accompanying gains *via* backward vertical spillovers. MNEs from the services sector are, hence, not relying on domestic firms for their purchase of raw materials and intermediate products. They might be producing it themselves or importing from other sources. Similarly, in the case of forward vertical spillovers, domestic firms are customers of raw materials and intermediate products from MNEs. As products of MNEs are of high quality, domestic firms are provided with high quality inputs. The spillovers through this channel are also negative asserting that inputs provided by MNEs are not helping domestic firms in their production process. Infact, they are adversely affecting TFP of domestic firms in the services sector. Therefore, domestic firms from the services sector are not benefitting from the relationships developed with MNEs through backward and forward linkages.

In addition to productivity spillovers, the analysis also takes into consideration the role of research and development and human capital. Both the variables represent absorptive capacity of the host economy. It is often argued that the host country must possess a minimum threshold level of absorptive capacity in the form of technology and human capital to gain from productivity spillovers (Joseph 2007; Kathuria 2001; Todo and Miyamoto 2006; Xu 2000; Wang 2010). Blalock and Simon (2009, p. 1098) define absorptive capacity as "ability to recognize the value of new information, assimilate it and apply it to commercial ends". According to them, absorptive capacity assists in exploiting new technology brought in by MNEs and incorporating it in the

existing production process. Firms with greater absorptive capacity, therefore, have more ability to disseminate the knowledge of MNEs. It can also be figured from Table 1out that the coefficient for research related activities and human capital is negative and statistically significant (1 percent l.o.s). A negative coefficient value implies that India's services sector is lagging behind in this arena. Since services sector is labour intensive in nature, human capital, is one of the important factor determining its growth process. Development of human capital is, therefore, crucial to benefit from productivity spillovers accompanying FDI. Moreover, Das, Banga and Kumar (2011) point out that growth of India's services sector is concentrated mainly in modern services where technological changes play an important role. Research and development is, thus, an indispensable factor in these fast growing services. Enhancing the absorptive capacity of services sector is, hence, necessary to exploit the benefits from productivity spillovers to the fullest.

Table 1: Empirical Results from Fixed Effects 'Within' Model
(Services Sector)

Variables	Estimated Coefficients
ln R	-0.06044***
ln HK	-0.22198***
ln HFDI	0.820853***
ln BFDI	-0.26065***
ln FFDI	-0.36123***
*** significant at 1 percent l.o.s	

After evaluating spillovers at an aggregate level, an insight into various industries of the services sector can be undertaken with the help of Table 2. Table 2 represents productivity spillovers from FDI across various industries of the services sector in India. In order to evaluate spillovers at an industry-level, the firm-level data from PROWESS is arranged according to National Industrial Classification (NIC) of 2008. However, while estimating productivity spillovers at an industry-level, two industries, *viz*., real estate activities (68) and professional, scientific and technical activities (69-71) have been excluded due to the problem of multicollinearity. In a similar manner, multicollinearity has been found to be present in the case of forward vertical spillovers for most of the industries. These include water transport (50), air transport (51), accommodation, food and beverage service activities (55-56), computer programming, consultancy and related activities (62) and information service activities (63).

Productivity spillovers for these industries are investigated without including the variable representing forward vertical spillovers.

It can be inferred from Table 2 that productivity spillovers vary across various industries belonging to the services sector. Out of the fourteen industries studied, productivity spillovers through horizontal channels are more pronounced than vertical channels. In the case of horizontal spillovers, six industries display positive coefficients that are statistically significant. These comprise of water transport (50), accommodation, food and beverage service activities (55-56), computer programming, consultancy and related activities (62), information service activities (63), financial service activities, except insurance and pension funding (64) and other financial services (66). This indicates that domestic firms from these industries are gaining by observing foreign firms and demonstrating new methods of production to upgrade themselves. They are, thus, effectively coping up with the competition posed by MNEs. On the other hand, industries like air transport (51) and other services activities (94-96) experience negative spillovers from horizontal channels. It can be asserted that domestic firms from these industries are adversely affected due to fierce competition from MNEs. Foreign firms are stealing away market demand and profits from the host country firms and preventing any leakage of their knowledge in these industries. Thus, rivalry effect from competition is dominating the knowledge sharing effect for these industries.

In the context of backward vertical spillovers, it can be observed that only three industries witness positive spillovers through backward linkages. These constitute of industries like air transport (51), accommodation, food and beverage service activities (55-56) and other services activities (94-96). Domestic firms from these industries are, hence, benefitting from the linkages created with MNEs. MNEs as customers of raw materials are creating demand for intermediate inputs produced by domestic firms. They are also assisting domestic suppliers in these industries in their production process by providing them technical expertise. This is indirectly helping domestic firms to upgrade their production techniques and quality of their intermediate products. It can be, further, noticed that backward vertical spillovers are negative for services like wholesale trade, except of motor vehicles and motorcycles (46), water transport (50), telecommunications (61), computer programming, consultancy and related activities (62), information service activities (63) and financial service activities, except insurance and pension funding (64). MNEs in these

industries are, therefore, not relying on domestic firms for their intermediate inputs. They might be either producing the intermediate products themselves or importing them from their subsidiaries abroad. Thus, industries depicting negative backward vertical spillovers are considerable in number than those experiencing positive backward vertical spillovers.

Lastly, it can be seen that out of nine industries, three industries, *viz*., wholesale trade, except of motor vehicles and motorcycles (46), financial service activities, except insurance and pension funding (64) and other service activities (94-96) gain from forward vertical spillovers. Local firms in these industries are, thus, benefitting from the intermediate products supplied by MNEs. Since MNEs possess technical knowhow and advanced managerial skills, local firms in these industries are supplied with inputs of high quality at competitive prices. This is facilitating in achieving higher levels of TFP. In addition, two industries comprising of warehousing and support activities for transportation (52) and other financial services (66) decipher negative spillovers from forward vertical channels. However, since coefficients for these industries are statistically insignificant, empirical conclusions for these industries cannot be drawn.

Apart from productivity spillovers, it can be seen that the variable human capital has a negative impact on TFP for majority of industries. This is somewhat worrisome as human capital skills are crucial for growth of labour intensive services sector like India. The coefficient for research and development activities is also negative in most of the cases. This variable depicts the initiatives taken by domestic firms on their technological upgradation and is one of the important factors determining productivity spillovers from FDI (Kathuria 2001, 2010). Both these variables taken together represent the absorptive capacity of the services sector industries. It can be pointed out that development of human capital and research related activities must be accorded significant importance to reap the concomitant spillovers from FDI.

Table 2: Empirical Results from Fixed Effects 'Within' Model (Industry-wise)

Division	Industry	ln R	ln HK	ln HFDI	ln BFDI	ln FFDI
41-43	Construction	0.0917	0.0287	-0.2042	-0.2742	0.4799
46	Wholesale trade, except of motor vehicles and motorcycles	-0.1648***	-0.4720***	0.3745	-0.5162*	0.3576**
50	Water Transport	0.0497	0.0131	2.9162***	-2.4002***	---

51	Air Transport	-1.2448**	-0.1017	-4.1682**	1.7740**	---
52	Warehousing and support activities for transportation	-0.1034	0.0887	0.4844	-0.0180	-0.0525
55-56	Accommodation, food and beverage service activities	-0.0106	-0.0970	0.2585*	0.1485***	---
59	Motion picture, video and television programme production, sound recording and music publishing activities	-0.3461***	-0.3395***	-2.2093	0.7963	1.4262
61	Telecommunications	-0.1675*	-0.5596***	1.1386	-1.4906***	0.2973
62	Computer programming, consultancy and related activities	-0.0765***	-0.3840***	3.9914***	-4.0979***	---
63	Information service activities	-0.0718	-0.1365**	1.7706***	-1.6429***	---
64	Financial service activities, except insurance and pension funding	0.0208	0.0338	5.6172***	-7.8619***	2.5551***
66	Other financial services	-0.1852***	-0.5776***	1.7091**	-1.2788	-0.3226
79	Travel agency, tour operator and other reservation service activities	0.8213	0.2029	-0.7326	1.4326	0.8066
94-96	Other Service Activities	0.1008	-0.4443***	-5.5783***	2.9558***	3.0533***
*** significant at 1 percent l.o.s, ** significant at 5 percent l.o.s, significant at 10 percent l.o.s						

6. CONCLUSIONS:

The present study tries to analyse productivity spillovers from FDI in the services sector of India. Both horizontal and vertical spillovers have been tested using a panel data fixed effects within model for the period 2000 to 2010. It can be deduced from the analysis that the services sector has witnessed positive spillovers from horizontal channels during the underlying time period. This implies that domestic firms from the services sector are demonstrating new methods of production to compete with MNEs in same industries. This is helping them to upgrade themselves and retain their market share and profits. Since horizontal spillovers for the services sector are positive, it can be concluded that benefits from market sharing are experienced by domestic firms in this sector. Spillovers through backward vertical linkages and forward vertical linkages are, however, negative. Domestic firms from the services sector are, thus, not gaining from the relationships developed with MNEs.

In addition to it, the analysis also focused on examining productivity spillovers across various industries of the services sector. It can be inferred that productivity spillovers vary across industries. None of the industries gain from all three variables capturing productivity spillovers. In a manner similar to aggregate level, horizontal spillovers are found to be more pronounced than vertical spillovers at an industry-level. Industries such as water transport (50), computer

programming, consultancy and related activities (62) and information service activities (63) gain from horizontal spillovers. On the other hand industries like air transport (51) and wholesale trade, except of motor vehicles and motorcycles (46) witness backward vertical spillovers and forward vertical spillovers respectively. Accommodation, food and beverage service activities (55-56) is the only industry experiencing horizontal and backward vertical spillovers while financial service activities, except insurance and pension funding (64) and other service activities (94-96) are the ones deciphering positive spillovers from horizontal and forward vertical channels. However, it can be noticed that industries like construction (41-43) and telecommunications (61) do not benefit from productivity spillovers. Both these industries contribute heavily in GDP of the services sector and are recipient to significant amounts of FDI inflows. Despite this, productivity spillovers from FDI in these industries are non-existent.

In addition to productivity spillovers, the present study also tries to point out the role of absorptive capacity in increasing TFP of the services sector. It can be asserted that the contribution of variables representing absorptive capacity is weak and adversely affecting TFP of domestic firms. Enhancing the absorptive capacity of services sector is of significant importance to reap more benefits from productivity spillovers. Lastly, it can be stated that the study takes into account only horizontal and vertical channels through which productivity spillovers occur. However, in reality, spillovers can take place through mediums like licensing, franchising, exports etc. which the study did not consider (Blomström and Kokko (1998)). Moreover, productivity spillovers symbolise gains from FDI to the host economies. Taking into account the tax exemptions and other incentives provided to MNEs, it is equally important to assess the costs from FDI. Taking all these factors into consideration would facilitate an overall understanding on the impact of FDI on TFP of the services sector.

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Appendix: A

Table A1: Industry-wise Description of Domestic Firms and Foreign Firms in the Services Sector

Division	Industry	Total Firms	Domestic Firms	MNES	MNEs/ Total Firms (%)
41-43	Construction	186	173	13	6.99

46	Wholesale trade, except of motor vehicles and motorcycles	505	477	28	5.54
50	Water Transport	40	31	9	22.50
51	Air Transport	22	19	3	13.64
52	Warehousing and support activities for transportation	80	65	15	18.75
55-56	Accommodation, food and beverage service activities	162	156	6	3.70
59	Motion picture, video and television programme production, sound recording and music publishing activities	126	117	9	7.14
61	Telecommunications	86	73	13	15.12
62	Computer programming, consultancy and related activities	255	212	43	16.86
63	Information service activities	83	66	17	20.48
64	Financial service activities, except insurance and pension funding	536	472	64	11.94
66	Other financial services	199	187	12	6.03
68	Real Estate activities	108	106	2	1.85
69-71	Professional, scientific and technical activities	169	155	14	8.28
79	Travel agency, tour operator and other reservation service activities	17	13	4	23.53
94-96	Other service activities	194	183	11	5.67
	Services Sector	**2768**	**2505**	**263**	**9.50**

Appendix: B

Section B1: Construction of Variables

The variables used for the purpose of estimation are defined as follows:

- **Output (Y_{jit}):** Output is defined as total sales of the j^{th} firm in i^{th} industry at time period t. The total sales are deflated using the GDP deflator with 2004-05 as the base year (RBI, 2014).

- **Capital (K_{jit}):** Capital is constructed using net fixed assets of the j^{th} firm in i^{th} industry at time period t. It is deflated using the WPI (average) of machinery and machine tools and transport equipments with year 2004-05 being the base year.

- **Labour (L_{jit}):** Labour is estimated with the help of salaries and wages paid by the j^{th} firm in i^{th} industry at time period t. It is computed as the ratio of j^{th} firm's wage to the average industry wage at a particular time period.

- **Research (R_{jit}):** The variable research is calculated as the ratio of expenses of j^{th} firm in i^{th} industry at time period t on research related activities to its total sales.

- **Human Capital (HK_{jit}):** Human capital is estimated as the ratio of expenses of the j^{th} firm in the i^{th} industry at time period t on staff training and welfare to its total sales.

- **Horizontal Spillovers ($HFDI_{it}$):** Horizontal spillovers are defined as the share of foreign firms in total output of a particular industry (Javorcik, 2004). This variable appropriates foreign presence in a given industry, thus, assisting in examining the spillovers through competition and demonstration.

$$HFDI_{it} = \frac{\sum_{j \in i} FS_{jt}}{\sum_{j \in i} TS_{it}} \qquad \text{……..……} \quad (4)$$

Where,

FS_{jt} is the share of j^{th} foreign firm in i^{th} industry at time period t.

TS_{it} is the total output of i^{th} industry at time period t.

- **Vertical Spillovers**: Vertical spillovers comprise of spillovers through backward and forward linkages. They represent the relationships of MNEs with their local counterparts.
-

➢ **Backward Vertical Spillovers ($BFDI_{it}$):** Backward vertical spillovers capture the linkages created by MNEs as downstream customers of raw materials and intermediate products with its upstream domestic suppliers. Following Javorcik (2004) they are defined as,

$$BFDI_{it} = \sum_{\forall\, k \neq i} \delta_{ik}\ HFDI_{kt} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where, δ_{ik} is the proportion of output of i^{th} industry used as input by the k^{th} industry. The variable δ_{ik} is calculated from the input-output tables for the years 1999-2000, 2003-04 and 2007-08 (GOI, 2013). A detailed description of the construction of δ_{ik} is explained in Appendix-B (Section B2). δ_{ik} is multiplied by $HFDI_{it}$ to take into account the spillovers from foreign firms to its domestic suppliers.

➢ **Forward Vertical Spillovers ($FFDI_{it}$):** Forward vertical spillovers capture the linkages created by MNEs as upstream suppliers of intermediate products to the downstream domestic firms. They are defined as,

$$FFDI_{it} = \sum_{\forall\, k \neq i} \sigma_{ki}\, HFDI_{it} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where, σ_{ki} is the proportion of output used by the k^{th} industry as input from i^{th} industry, computed from the input-output tables for the years 1999-2000, 2003-04 and 2007-08 (Appendix-B (Section B2)). σ_{ki} is also multiplied by $HFDI_{it}$ in order to detect spillovers from foreign firms to its local customers.

Appendix: B

Section B2: Construction of Backward and Forward Linkages

For the construction of backward (δ_{ik}) and forward (σ_{ki}) linkages, input-output tables for the years 1999-2000, 2003-04 and 2007-08 have been used (GOI, 2013). The motive behind using different tables is to take into account the associated technological change over several time periods. The input-output tables comprises of two main matrices, the Absorption Matrix (AM) and the Make Matrix (MM).

- **AM:** The rows of AM correspond to commodities used by various industries as inputs to produce their output. The dimension of this matrix is, thus, commodity × industry.

- **MM:** It represents production of different commodities by different industries. The dimension of MM is, therefore, industry × commodity one.

In the first step, the rows of the AM are divided by total output (gross value of output), in order to, obtain a matrix of technical coefficients (B).

$$\frac{\text{AM}}{\text{Y}} = \text{B} \qquad \ldots\ldots\ldots\ldots (1)$$

In the next step, the rows of the MM are divided by the corresponding outputs. Let this matrix be D.

$$\frac{\text{MM}}{\text{Y}} = \text{D} \qquad \ldots\ldots\ldots\ldots (2)$$

In order to construct backward and forward linkages, an industry × industry matrix is to be calculated. In the final step, matrix D is multiplied by matrix B to derive at an industry × industry matrix (Z). Therefore,

$$Z = DB \qquad \ldots\ldots\ldots\ldots\ldots (3)$$

Each row of the Z matrix represents output of an industry used as input by other industries (δ_{ik}) while column gives the output of all industries used as input by one industry (σ_{ki}). The coefficients obtained are then multiplied by HFDI to calculate backward and forward vertical spillovers.

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