Technology Gap, Competition and Spillovers from Direct Foreign Investment: Evidence From Establishment Data

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Abstract

Using detailed micro data from the Indonesian manufacturing sector, we examine the effect on productivity of direct foreign investment. The results suggest that direct foreign investment benefits locally owned establishments. The effect differs between groups of industries. Spillovers from DFI are found in sectors with a high degree of competition. The result suggests that the degree of competition affects the choice of technology transferred to the multinationals' affiliates and, hence, the potential for spillovers. Moreover, it seems to be domestic competition rather than competition from imports that affects spillovers from DFI. Our result concerning the effect from technology gap is unclear.

Key words: Direct Foreign Investment; Spillovers; Technology; Competition

JEL classification: F23; O30

I. INTRODUCTION*

Direct foreign investment [1](DFI) is presumably an important channel in international diffusion of knowledge and technology. Multinational companies conduct most of the world's R&D, and knowledge transferred from the parent firms to the affiliates might leak out to the host country. This externality is called the spillover effect from DFI. Various channels for the spillover have been suggested: labour turnover from multinationals to domestic firms, technical assistance and support to suppliers and customers, demonstration effects on domestic firms in issues such as choice of technology, export behaviour, managerial practices, etc.[2]

There are a number of studies examining spillovers from DFI. Positive spillovers are found in Australia [Caves, 1974], Canada [Globerman, 1979] and Mexico [Blomström and Persson, 1983]. No spillovers are found in Morocco [Haddad and Hendersson, 1993], and Venezuela [Aitken and Harrison, 1991].

The different results concerning spillovers from DFI suggest that such effects are not automatic but are affected by various economic and technological factors. Economic literature has identified some circumstances that enhance domestic firms' ability to benefit from DFI. Findlay [1978] constructs a dynamic model of technology transfer through DFI from developed to developing countries. The technology is hypothesised to spill over to the developing country. Findlay uses Gerschenkron’s [1952] catching-up hypothesis of a positive connection between the distance to the world's technological frontier and the rate of economic growth. The wider the technology gap between the developed and the developing country, the larger is the potential for technological imitation, which will spur economic growth. Moreover, Findlay assumes the technology to be transferred through personal contacts, which are accomplished through DFI. The result from Findlay's model is that, for a given amount of foreign presence, spillovers are larger the larger the technology gap between the foreign and domestic firms. Accordingly, for a given technology gap the spillovers increase with the degree of foreign presence. It has also been argued, however, that large technology gaps may constitute an obstacle to spillovers.[3] Technologies developed in the industrialised world may be less suited for conditions in developing countries, which prevents any useful technology spillovers. The larger the technology gap is between the industrialised country's technologies and the developing country's technologies, the smaller the spillovers.

Wang and Blomström [1992] construct a model of strategic interaction between the multinationals' subsidiaries and the domestic firms. In addition to Findlay's assumption of a positive relationship between the technology gap and spillovers, they stress the importance of competition. The more the competition the subsidiaries face from domestic firms, the more technology they need to bring in from the parent company in order to remain their market shares. The technology that is transferred to the subsidiaries might leak out to the domestic firms and thereby increase the competition facing the subsidiaries even more. The conclusion is that the tougher the competition, the more technology will be brought in by the MNC affiliate and the larger will the potential for spillovers be.[4]

Kokko [1994, 1996] examined the effect of DFI on levels of productivity in different manufacturing sectors. A high technology gap in combination with a low degree of competition was found to prevent spillovers. As pointed out by Aitken and Harrison [1991], however, there is an identification problem in examining levels of productivity, as it is likely that foreign firms locate in highly productive sectors. One might then for instance conclude that there are positive spillovers from DFI even if such do not exist. One possible way to avoid the causality problem could be to examine growth rates - instead of levels - of productivity, at a micro level.

The purpose of this paper is to examine spillovers from DFI in the Indonesian manufacturing sector. Firstly, we examine the effect on spillovers from competition and productivity gaps on an establishment level. Using micro data enables us to construct an industry specific variable on technological differences between domestic and foreign plants. Moreover, previous studies have concentrated on domestic competition but we will also examine competition from abroad. Finally, in examining the relation between spillovers, competition and technology gaps, we will examine not only levels of productivity but also growth in productivity. By using different model specifications we are less likely to draw conclusions from fragile results.

The econometric results show spillovers from DFI to have positive effects on productivity growth. The effects differ between different groups of industries.

Spillovers are found in industries with a high degree of competition whereas the effect from technology gap is not clear.

In part II of the paper, we discuss DFI in Indonesia. The empirical models, data and variables are presented in part III. The results from the econometric estimations are shown in part IV and discussed in part V. Conclusions are presented in part V.

II. DFI IN INDONESIA

Between independence in 1949 and 1966 there were basically no foreign investments in Indonesia, because of the political and economic instability and the nationalisation of foreign owned firms. The "New Deal" was initiated in 1967, including deregulation of trade and foreign investments. Foreign firms were given tax holidays for up to six years, exemptions from duty on import of capital goods were made together with guarantees on profit and capital repatriations.[5]

Following on the prevalent export pessimism in the seventies and because of nationalistic sentiments mistrusting foreign involvement, a more restrictive policy was announced in 1974/75. A large number of sectors were - for so called strategic reasons - closed off to foreign investors. Furthermore, foreign ownership was limited to 80% of a company - which was to decrease to 49% within ten years - and employment of foreign personnel was restricted. The restrictive policy for foreign investments continued until the beginning of the 1980's, when the drop in oil prices forced the country onto another development path. A substantial phase of deregulation started in 1986. The reforms included reductions in import licensing restrictions, relaxation of foreign investment rules, replacement of non-tariff barriers with tariffs as well as a reduction in tariffs.[6] In 1989 import licenses were further liberalised and the required minimum foreign investment was lowered from one million US$ to 250,000 US$. In 1992 foreign investors were allowed to possess 100 % of the equity in certain projects.

The structure of the Indonesian manufacturing sector in 1980 and in 1991 is shown in Table 1. Tobacco, food and textiles were the three largest industries in 1980. These three industries constituted around 45 percent of the total Indonesian manufacturing gross output at that time. By 1991, the industry structure had changed.

Most notable are the sharp decline in the tobacco industry and the large increase in wood products. The overall concentration of Indonesian manufacturing gross output seems to have declined by 1991. The three largest industries, food, textiles and wood, made up around 37 percent of the total Indonesian manufacturing gross output in 1991.

The absolute amount of DFI in Indonesia increased substantially between 1980 and 1991. The number of newly approved DFI projects, for instance, was 20 in 1980 and 376 in 1991.[7] The foreign share of gross output has, however, fallen because of the considerable increase in gross output of domestically owned firms. We see in table 1 that the share of gross output in foreign owned establishments has declined from 19.7 percent in 1980 to 13.8 percent in 1991. In 1980, sectors such as beverages, other chemicals, glass, cement, metal products, machinery, electrical goods and other manufactures had a large foreign share of gross output. Hill [1988: 89-91] discusses the reasons for DFI in Indonesia in some detail. Brand names are, according to Hill, the main reason for a large foreign share in beverages, where the brewery industry is dominated by three big joint ventures with foreign firms. In the other sectors, technological advantage is the main explanation for a large foreign presence in 1980. In 1991 footwear and professional goods were, together with machinery and other manufactures, the sectors with the largest foreign shares of gross output.

The large foreign presence in footwear and professional goods is remarkable, as there were no foreign presence at all in these two sectors in 1980. Both technological advantages and ownership of brand names are of significance for DFI in professional goods.[8] Firms moving away from high-wage newly industrialised economies to Indonesia can explain the large increase in foreign ownership in the footwear industry. The foreign share of gross output is small in sectors such as printing, clay, non-metal products, leather, wood, tobacco and glass. In the glass sector, a relatively large foreign presence in 1980 had vanished by 1991.

TABLE 1

SECTOR WISE DISTRIBUTION OF INDONESIAN MANUFACTURING GROSS OUTPUT (all variables are in percent)

Sector	ISIC	Sector's share of total Indonesian manufacturing gross output		Foreign share of sector's manufacturing gross output	
		1980	1991	1980	1991
All sectors		100	100	19.7	13.8
Food products	311/12	15.0	14.5	17.6	7.7
Beverages	313	1.2	0.7	43.6	23.6
Tobacco products	314	18.0	6.9	8.2	3.0
Textiles	321	12.2	2.3	18.3	14.3
Clothing	322	0.4	3.3	3.7	10.3
Leather products	323	0.3	0.5	1.2	5.0
Footwear	324	0.5	1.5	0.0	34.0
Wood products	331	5.5	10.9	8.0	5.0
Furniture	332	0.1	1.1	11.5	9.6
Paper products	341	1.6	3.8	21.6	14.1
Printing	342	1.2	1.2	6.6	1.2
Industrial chem.	351	4.8	5.6	7.7	23.0
Other chemicals	352	5.6	5.1	55.9	26.1
Coal products	354	0.0	0.2	0.0	6.6
Rubber products	355	8.1	3.8	20.5	18.8
Plastic products	356	1.1	2.3	24.1	5.5
Pottery	361	0.2	0.6	13.3	12.5
Glass products	362	0.7	0.6	33.2	0.1
Cement	363	3.3	2.1	30.6	8.0
Clay products	364	0.1	0.1	0.0	0.0
Non-metal products	369	0.1	0.4	0.0	3.4
Iron and steel	371	3.5	5.3	20.7	8.8
Non-ferrous metals	372	0.0	1.5	0.0	22.4
Metal products	381	4.2	3.3	32.7	16.9
Machinery	382	1.1	1.6	37.1	29.4
Electrical goods	383	5.8	3.7	39.3	25.0
Transport equipm	384	4.9	6.5	4.8	27.0
Professional goods	385	0.03	0.1	0.0	35.0
Other manufactures	390	0.4	0.5	47.2	29.5

Source: Indonesian Central Bureau of Statistics.

III. DATA AND EMPIRICAL MODELS

The empirical analyses are based on industrial data supplied by the Indonesian Central Bureau of Statistics (Biro Pusat Statistik). An industrial survey is conducted yearly and covers all Indonesian establishments with more than 20 employees. An establishment is in Indonesian data a plant rather than a firm.[9] Data for two years - 1980 and 1991 - were supplied. We define domestically owned establishments, as plants where the share of domestic ownership is above 85%. Our sample consists of 8.086 establishments (7.760 domestically owned) in 1980 and 16.382 establishments (15.671 domestically owned) in 1991. Furthermore, figures on 2.892 domestic establishments are available for both 1980 and 1991. This group is used in our growth estimations. The establishments are divided into 329 industries at a five-digit level of ISIC.

As previously noted we will use two different model specifications in our empirical analyses. Firstly, we will examine the effect of foreign presence on the level of labour productivity in domestic establishments. All establishments operating in 1980 and/or 1991 are used and all variables are in nominal terms. The drawback with this specification is that the causality between DFI and productivity levels is not clear. There is a possibility that foreign firms locate in sectors with high productivity. Our second model specification examines growth in productivity. Growth in productivity is measured in establishments operating in both 1980 and 1991. One problem with this method could be that establishments operating in 1980 but have exit the market or establishments that have entered the market after 1980 are not in the sample. An additional problem could be that we have to use the same aggregated manufacturing price deflator for all establishments. Price increases are, however, likely to vary between sectors. To sum up, there are drawbacks and potential bias connected with both methods, but by including both we can reduce the risk of drawing conclusions on spurious results.

We start with examine the effect on levels of labour productivity from DFI. To ensure comparability with pervious studies conducted at a sector level, we follow Caves [1974], Globerman [1979], Blomström and Persson [1983] and Kokko [1994, 1996] and estimate labour productivity in domestically owned establishments as a function of various factors, including DFI. Labour productivity in establishment *i* at time *t* is expressed as:

$$(1) \qquad \frac{VA_{it}}{L_{it}} = f\left(\frac{I_{it}}{L_{it}}, SCALE_{it}, DFI, Z\right)$$

The dependent variable is value added per employee. Data on capital stocks are, unfortunately, not available. *I/L is* total investment per employee and is constructed to control for capital intensities. We would expect a positive coefficient for *I/L* in the econometric estimation. *DFI* is the share of foreign gross output at a five-digit level of ISIC. The larger the share of foreign ownership the larger is the scope for spillovers. We expect a positive coefficient for *DFI* if there are positive spillovers from DFI. *SCALE* is measured as an establishment's production and is included to control for increasing returns to scale: if there are scale economies present, the coefficient for *SCALE* will be positive and statistically significant. *Z* finally, is a set of additional variables, which may affect labour productivity. All variables are measured in nominal terms and will be estimated in log forms.

In addition to the level model, which has been used in most previous work on spillovers from DFI, we will investigate the effect on growth in productivity.[10] We start with a simple production function with two factors of production:

$$(2) \qquad Y_{it} = A_{it} f\left(L_{it}, K_{it}\right),$$

where Y_{it} is value added in establishment *i* at time *t,* and *A, L* and *K* are the level of productivity, the number of employees and the capital stock. Assuming a Cobb-Douglas type of production function, taking total derivatives of *equation (1)* and leaving out the indices for simplicity, one gets:

$$(3) \qquad \dot{Y} = \dot{A} + \beta_1 \dot{L} + \beta_2 \dot{K},$$

where a dot over a variable indicates its growth and where β_1 and β_2 are the elasticity of output with respect to *L* and *K.* Since capital stocks are not available, we replace *dK* with total investment, *I*, which enables us to write *equation* (2) as:

(4) $$\dot{Y} = \dot{A} + \beta_1 \dot{L} + \alpha_2 \frac{I}{Y},$$

where α_2 is the marginal product of capital. We assume that productivity growth can be expressed as a function of the scale of production and of spillovers from DFI:

(5) $$\dot{A} = f(SCALE, DFI, Z) + e.$$

Thus, combining *equation (4)* and *equation* (3) we end up with the following equation to be estimated:

(6) $$\dot{Y} = \beta_0 + \beta_1 \dot{L} + \alpha_2 \frac{I}{Q} + f(SCALE, DFI, Z) + e,$$

where *Q is* gross output and *e* is a residual. Growth in value added and employment is between 1980 and 1991. We choose to estimate investment as a share of gross output rather than as a share of value added. We use figures on investment as a share of gross output from 1980. An establishment's investments are assumed to be constant over the period. We also tried alternative measures on capital. Using the average value on investments as a share of gross output or including sector specific figures on energy consumption did not have any major effect on the results. *DFI* is measured as the average foreign share of a sector's gross output between 1980 and 1991. We would expect a positive coefficient for growth in labour, investment and *DFI. SCALE* is included to achieve some comparability with the level estimations. A positive coefficient for *SCALE* means that large establishments have a high growth in productivity.

We will estimate different samples of our observations in order to examine if technology gap and competition affect spillovers from DFI. Kokko [1994] uses three different measures on the technology gap. Firstly, the different industries' capital intensities. Secondly, the amount of patent fees in different industries, and finally the difference in labour productivity between foreign and domestic establishments. The first two measures capture expected differences in technology rather than observed differences. Capital intensive industries as well as industries with a large amount of patents are assumed to have high levels of technology. Moreover, the higher an industry's level of technology, the larger is the assumed difference between the technology level in domestic and foreign firms. The last measure, differences in labour productivity is on observed differences between domestic and foreign firms. This measure is instead suffering from the possibility that the cause is differences in capital intensities or scale of production rather than in technologies.

We propose an alternative measure on technology differences. Since we have micro level data we can for each industry estimate the difference in labour productivity between domestic and foreign establishments, after controlling for capital intensities and scale of production. We estimate the following expression for each industry at a three-digit level of ISIC:

$$\frac{Y}{L} = \beta_0 + \beta_1 SCALE + \beta_2 \frac{I}{L} + fordummy + T + e. \tag{7}$$

The expression is estimated in nominal terms and with all observations in 1980 and 1991. T is a dummy variable for time with the value one for 1991 and *fordummy* is a dummy variable with the value one for foreign owned establishments. The coefficient for *fordummy* is a measure on the difference in technology. Industries with high values on *fordummy* experience a large difference between domestic and foreign establishments' technology. The sample of establishments has been divided in two. The median value for the coefficient on *fordummy* over all industries is used as the selection criteria. Industries with coefficients on *fordummy* above (below) the median have been included in the group with high (low) technology difference.

TABLE 2

SECTOR SPECIFIC DIFFERENCES IN TECHNOLOGY BETWEEN DOMESTIC AND FOREIGN ESTABLISHMENTS

	Sector (ISIC)	Technology differences
	Footwear (324)	-0.29
	Clothing (322)	0.10
	Beverages (313)	0.31
	Furniture (332)	0.33
	Plastic products (356)	0.33
	Glass products (362)	0.39
Low technology differences	Leather products (323)	0.48
	Other manufactures (390)	0.48
	Wood products (331)	0.55
	Cement (363)	0.55
	Rubber products (355)	0.65
	Printing (342)	0.71
	Pottery (361)	0.75
	Other chemicals (352)	0.77
	Non-ferrous metals (372)	0.78
	Textiles (321)	0.88
	Food products (311)	0.90
	Electrical goods (383)	0.91
	Non-metal products (369)	0.94
	Iron and steel (371)	1.0
High technology differences	Industrial chemicals (351)	1.02
	Transports Equipment (384)	1.04
	Metal products (381)	1.13
	Paper products (341)	1.17
	Machinery (382)	1.29
	Professional goods (385)	1.67
	Tobacco products (314)	2.58
	Coal products (354)	2.79

Note: The technology differences are estimated as the value on *fordummy* from equation (7).

The estimated differences in technology between domestic and foreign establishments are shown in Table 2. Foreign establishments have a higher technology level in all industries except one - the footwear industry. The difference is relatively small in industries such as Clothing, Beverages, Furniture, Plastic products, and relatively large in Coal, Tobacco, Professional goods and Machinery. As previously said, capital-intensities has been used as a proxy variable on technology differences in previous studies. There seems to be a relationship between capital-intensities and differences in technology in labour intensive industries:

footwear, clothing, furniture, leather and wood products are all relatively labour intensive. However, the most capital-intensive industries such as chemicals non-ferrous metals, iron and steel are not the ones with the largest differences in technology. Instead, the largest difference is found in industries with intermediate capital-intensities.

One problem with our measure on technology differences is that it may to some extent capture the effect from brand names.[11] Foreign firms with brand names may exhibit higher value added and therefore be estimated to have a relatively superior technology. We will therefore use differences in investment ratios as an alternative measure on the technology gap. A large difference in investment per employee indicates a large difference in capital intensities and, presumably, in technologies.

We will also examine whether the effect from DFI differs between sectors with different degrees of competition. It is desirable to incorporate both the degree of competition on the domestic market as well as the degree of competition from abroad. We use the Herfindahl index to measure the degree of concentration in different sectors and the effective rate of protection to measure the degree of openness to foreign competition. Our measure on competition is constructed as an interaction term between the Herfindahl index and the rate of effective protection. We construct *Competition* for each industry *j* at a five-digit level of ISIC as:

$$(8) \qquad Competition_j = ERP_j * Herfindahl_j, \forall ERP_j \succ 0$$
$$Competition_j = \frac{\mathrm{ERP_j}}{\mathrm{Herfindahl_j}}, \forall ERP_j \prec 0$$

where ERP is the effective rate of protection and Herfindahl is the Herfindahl index. The Herfindahl index is equal to the sum of squared establishments' shares of the industry's total gross output. Unfortunately, we cannot control for the possibility that the same firm owns many establishments. It is likely, however, that there is a positive correspondence between the number of establishments and the number of firms in a certain industry. A high value on *Herfindahl* means a high concentration of an industry's gross output. The Herfindahl index is calculated for 1980 as well as for 1991. Figures on the degree of effective rate of protection are for the years 1987 and

1989 and are taken from Fane and Phillips [1991] and from Wymenga [1991]. The former year is used for calculating competition for 1980 and the latter for 1991. The median value on *Competition* has been used to divide our sample in industries with high and low degree of competition. Industries with a value above (below) the median value have been included in the sample with low (high) competition. The average value on *Competition* between 1980 and 1991 are used in the growth estimation.

TABLE 3
THE DEGREE OF COMPETITION IN DIFFERENT INDUSTRIES

Year	**HighCompetition** Sector (ISIC)	Value on *Competition*	**Low Competition** Sector (ISIC)	Value on *Competition*
	Sawmills (33111)	-1094.8	Misc. Leather (32330)	371.0
	Animal feeds (31290)	-721.2	Slaughtering (31111)	324.7
1980	Tauco (31242)	-639.5	Processing of meat (31112)	243.4
	Soya Sauce (31241)	-504.0	Cleaning of Seed (31164)	227.7
	Printing (34200)	-377.9	Footwear (32400)	173.7
	Sawmills (33111)	-1486.4	Smoked Fish (31143)	600.0
	Leather tanneries (32312)	-776.5	Misc. Furniture (33230)	536.0
1991	Preserved leather (32311)	-269.4	Cleaning of Roots (31166)	529.0
	Cooking oil (31151)	-210.6	Starch (31219)	444.0
	Herbal medicines (35523)	-169.5	Motorcycles (38442)	367.7

Note: The value on *Competition is* estimated from equation (8). Misc. - Miscellaneous.

The value on *Competition* for the five industries with most and least competition in 1980 and 1991 are found in Table 3. A few interesting features can be observed from the figures. Firstly, different types of food products are among the industries with the highest as well as the lowest degree of competition in both 1980 and 1991. Moreover, different sorts of leather products are among the industries with the highest competition in 1991 but there was low competition in a similar industry in 1980. Hence, the heterogeneity of industries within aggregate sectors suggests that it is important to use highly disaggregated data in examining the effect of competition. Furthermore, there is a large change in the degree of competition in the respect that it is not the same industries that show the highest (lowest) competition in

1980 and in 1991. The one exception is sawmills, which has the highest degree of competition in both years.

One drawback with our measure on competition is that industries with negative effective rate of protection will always have lower values on *Competition* than industries with positive effective rate of protection, irrespective of the value on the Herfindahl index. Around twelve percent of the observations are in industries that have a negative effective rate of protection. We will conduct our estimations with including and excluding the observations with negative values to examine the sensitivity of our results to the construction of our variable *Competition.* Furthermore, we will examine the effect from domestic concentration and effective rate of protection separately. The latter method enables us to see if there is a different effect on spillovers from domestic and foreign competition.

IV. EMPIRICAL RESULTS

We start by examine if there are positive spillovers from DFI in the total Indonesian manufacturing sector. Pre-testing revealed heteroscedasticity; consequently, all variance-covariance matrixes have been estimated according to White's [1980] method. The estimated effect from a high share of foreign production on the level and growth in productivity is shown in Table 4. All variables, except *SCALE* in the growth estimation, have statistically significant coefficients with the expected signs and provide some support for our prior hypotheses regarding the direction of effects. The coefficient for growth in labour is above unity. One possible reason is that we only control for the quantity of labour and not for the quality. The coefficient is therefore likely to incorporate the effect of human capital. The three estimations give a positive and statistically significant coefficient for *DFI* although the size of the coefficient is rather low in the level estimations. We conclude that there are positive effects, spillovers, on domestic establishments from foreign presence within the sector. Finally, the growth model seems from the relative high R-square to be better than the level models in describing the data.

TABLE 4
SPILLOVERS FROM DFI

Variables	Level estimation 1980 (dependent variable - value added per employee)	Level estimation 1991 (dependent variable - value added per employee)	Growth estim. 1980-1991 (dependent variable - growth in value added)
Constant	5.98 (157.47)***	7.41 (298.90)***	31.35 (12.67)***
Investment per employee	0.03 (21.62)***	0.03 (31.11)***	---
Growth in employment	---	---	1.09 (29.79)***
Investment / output	---	---	0.11 (3.11)***
Scale	0.04 (14.89)***	0.04 (25.97)***	0.000 (0.52)
DFI	0.005 (1.97)***	0.01 (6 93)***	0.54 (2.97)***
R-square adjusted	0.11	0.13	0.36
Number of observations	7760	15671	2892

Note: t-statistics within brackets are based on White's [1980] adjustment for heteroscedasticity. *) Significant at the 10 per cent level, **) Significant at the 5 per cent level, ***) Significant at the I per cent level.

We continue by examining if spillovers are affected by the size of the technology gap. According to Findlay [1978] we would expect domestic establishments in industries lagging far behind foreign technologies to benefit relatively much from DFI. The empirical results in Table 5 are not clear. Whereas a small technology gap seems to spur spillovers from DFI according to the level estimation for 1980 and the growth estimation, the level estimation for 1991 gives an opposite result.[12] The results were stable to inclusion of the measure on technology gap.

The measure on technology gap was estimated with inclusion of all observations in both 1980 and 1991. The size of the technology gap can, however, have changed during the period. Therefore, we estimated and used the technology gap for 1980 and 1991 separately but it did not have any major effect on the results. Furthermore, excluding footwear where domestic establishments have a relatively high technology did not change the empirical results.[13]

We also tried our alternative measure on technology gap, differences in investment ratios. As previously mentioned, a large difference in investment per employee indicates a large difference in capital intensities and technologies. There was no clear pattern whether high or low differences in investment ratio increase or decrease spillovers from DFI (see Table Al in the appendix).

Kokko [1994] made an interaction term with the degree of foreign presence and various proxies on technology gaps. Large foreign shares in combination with a high technology gap were found to prevent spillovers. We conducted a similar estimation with an interaction term on DFI and technology gap, but found no clear results. The coefficient was positive and statistically significant in both level estimations but insignificant in the growth estimation.[14]

TABLE 5
TECHNOLOGY GAP AND SPILLOVERS

	Level estimation 1980 (dependent variable – value added per employee)		Level estimation 1991 (dependent variable – value added per employee)		Growth estimation 1980-1991 (dependent variable - growth in value added)	
Variables	Small technology gap	Large technology gap	Small technology gap	Large technology gap	Small technology gap	Large technology gap
Constant	6.2 (96.65)***	5.92 (118.83)**	7.43 (229.58)***	7.57 (199.76)***	39.86 (7.12)***	31.55 (10.81)***
Investment per employee	0.02 (11.15)***	0.04 (21.04)***	0.02 (15.72)***	0.04 (29.46)***	---	---
Growth in employment	---	---	---	---	1.10 (17.61)***	1.04 (27.08)***
Investment/ output	---	---	---	---	0.19 (7.63)***	0.05 (1.50)
Scale	0.05 (9.46)***	0.04 (13.29)***	0.04 (23.02)***	0.04 (17.42)***	-0.000 (1.33)	0.000 (0.96)
DFI	0.02 3.00)***	-0.007 (2.35)**	-0.001 (0.20)	0.04 (13.46)***	0.78 (2.77)***	0.06 (0.25)
R-square adj.	0.13	0.15	0.13	0.18	0.37	0.33
Number of Observations	2487	5340	7173	8525	805	2016

Note: t-statistics within brackets are based on White's (1980) adjustment for heteroscedasticity. *) Significant at the 10 per cent level, **) Significant at the 5 per cent level, ***) Significant at the 1 per cent level.

We continue our analyses in Table 6 by examine the effect of competition on spillovers from DFI. According to Wang and Blomström [1992], we would assume the extent of spillovers from DFI to increase with the degree of competition. The level estimation for 1980 and the growth estimation do indeed show statistically significant effects from DFI only in sectors with relatively high competition. However, F-tests revealed a statistically significant difference in the size of the coefficient for DFI only in the level estimation for 1980. The level estimation for

1991 shows DFI to have a positive and statistically significant effect on productivity in both samples.

As previously said, *Competition* is asymmetric in the respect that industries with negative effective rate of protection have always lower value than industries with positive effective rate of protection, irrespective of the value of the Herfindahl index. We therefore excluded industries with negative effective rates of protection but a high degree of competition was still found to increase spillovers. Moreover, we included the variable *Competition* in the regressions as a further test of the stability, but it did not change our results. The different estimations suggest competition to have a positive effect on spillovers from DFI.

As previously mentioned, our measure of competition incorporates both the degree of domestic concentration and the protection from international competition. We did also divided our sample of establishments according to either domestic concentration or effective rate of protection (see Table A2 and A3 in the appendix). It seems to be domestic concentration rather than protection from imports that are important for spillovers. DFI is positive and statistically significant in all estimations in the sample with low concentration but in none of the estimations with high concentration. Moreover, F-tests revealed a statistically larger coefficient for *DFI* in the high competition sample both in the level estimation for 1980 and in the growth estimation, whereas there was no significant difference in the level estimation for 1991. There is no clear pattern how effective rate of protection affects spillovers from DFI.

TABLE 6
COMPETITION AND SPILLOVERS

	Level estimation 1980 (dependent variable – value added per employee)		Level estimation 1991 (dependent variable - value added per employee)		Growth estimation 1980-1991 (dependent variable - growth in value added)	
Variables	Low Competition	High Competition	Low Competition	High Competition	Low Competition	High Competition
Constant	6.15 (73.11)***	5.93 (140.42)***	7.67 (142.42)***	7.34 (263.77)***	30.26 (6.65)***	31.24 (10.44)***
Investment per employee	0.03 (10.21)***	0.03 (18.90)***	0.03 (16.05)***	0.03 (26.75)***	---	---
Growth in employment	---	---	---	---	1.17 (16.61)***	1.04 (26.26)***
Investment / output	---	---	---	---	0.16 (2.76)***	0.10 (2.49)**
Scale	0.03 (6.13)***	0.04 (13.84)***	0.04 (10.72)***	0.04 (23.91)***	0.000 (0.98)	0.000 (0.85)
DFI	-0.003 (0.69)	0.01 (3.46)***	0.03 (9.81)***	0.01 (2.49)**	0.34 (1.27)	0.70 (2.83)**
R-square adj.	0.12	0.11	0.15	0.13	0.42	0.34
Number of observations	1581	6179	3703	11968	816	2076

Note: t-statistics within brackets are based on White's [1980] adjustment for heteroscedasticity. *) Significant at the 10 per cent level, **) Significant at the 5 per cent level, ***) Significant at the 1 per cent level.

V. DISCUSSION

Our empirical results suggest that competition has an impact on the degree of spillovers from DFI. One explanation could be that the higher competition for the foreign firms the more technology has to be brought in to make them competitive and the larger is the scope for spillovers. Our result is, hence, in accordance with Blomström *et al* [1994] who find competition to spur technology transfer to affiliates and with Kokko [1996] who find some support of a positive effect from competition on spillovers.

We found no effect from the effective rate of protection on the degree of spillovers. One explanation could be that in sectors with high tariffs, foreign firms chose to serve Indonesia through DFI rather than through export. Our result may be biased if the effective rate of protection is a determinant on DFI, and if high tariffs are caused by the will to protect weak domestic establishments. Weak domestic establishments may have difficulties in absorbing foreign technologies. One should also note that the effective rate of protection is an imperfect measure of the degree of protection. A part of the protection from imports in Indonesia, at least in 1980, is in the form of non-tariff barriers, which are not captured by the effective rate of protection.

Unlike the study by Kokko [1994] we find no connection between the size of the technology gap and the degree of spillovers. One possible explanation to our different results could be different methodologies. Another explanation could be a bias caused by omitted variables. For instance, it is likely that institutional factors affect the results. As previously discussed, there are restrictions on localisation of foreign affiliates in Indonesia. An important issue for further research is to examine if the institutional framework affects spillovers.

One reason for lack of clear results is our use of different model specifications. We have used both level and growth estimations since there are potential drawbacks with both methods. It is difficult to say which model that is most appropriate since they are used on different samples of observations. If for instance the growth model is the most appropriate model, one could conclude that small technology gaps between domestic and foreign firms spur the extent of spillovers. To make stronger conclusions, further research could try to evaluate which model specification that is most appropriate.

VI. CONCLUDING REMARKS

A number of studies have examined spillovers from DFI in various countries. Spillovers are found only in some of the countries, suggesting spillovers not to be automatic but affected by various factors. We have examined if spillovers are affected by competition and by technology gaps between domestic and foreign establishments. We contributed to the existing literature in some respects. Firstly, we examined the issues at hand at an establishment level using both levels and growth of productivity. Secondly, we examined the effect from domestic competition as well as from competition from imports. Finally, we used observed differences on technology rather than proxy variables measuring the expected differences.

Our results show competition to have an effect on the degree of spillovers from DFI. Spillovers from DFI are found in sectors with a high degree of competition. The result suggests that the degree of competition affects the choice of technology transferred to the multinationals' affiliates and, hence, the potential for spillovers. Moreover, it seems to be domestic competition rather than competition from imports that affects spillovers from DFI. Our result concerning the effect from technology gap is unclear and depends on the specification of the test equation.

ENDNOTES

[*] *Remark:* I thank Steven Globerman and Ari Kokko for valuable comments. Financial support from the Tore Browaldhs foundation for Scientific Research and Education is gratefully acknowledged.

[2] See e.g. Blomström and Kokko [1997].

[3] See Lapan and Bardhan [1973: 585].

[4] Blomström *et al* [1994] find in an empirical study on Mexico that various proxies for competition are positive related to the amount of technology brought in by foreign firms.

[5] Sumantoro [1982: 34-39], Poot *et al* [1992: 85-121].

[6] See e.g. Guillouet [1990], Ahmed [1991], Kian Wie and Pangestu [1994].

[7] Indonesian Financial Statistics.

[8] Professional goods includes such industries as scientific equipments and cameras.

[9] The Indonesian definition of an establishment is; "A production unit engaged in a certain location, keeping a business record concerning the production and cost structure, and having a person or more that bear the responsibility or the risk of that activity" [Statistik Industri, 1991].

[10] See Haddad and Harrison [1993] for a study on spillovers with growth in productivity as the dependent variable.

[11] This problem is also present when one use differences in labour productivity as a measure on technology gap.

[12] F-tests revealed statistically significant differences in the size of the coefficient for DFI between the samples in all three estimations.

[13] The results are available from the author on request.

[14] The results are available from the author on request.

APPENDIX

TABLE Al
INVESTMENT GAP AND SPILLOVERS

	Level estimation 1980 (dependent variable - value added per employee)		Level estimation 1991 (dependent variable - value added per employee)		Growth estimation 1980-1991 (dependent variable - growth in value added)	
Variables	Small investment gap	Large investment gap	Small investment gap	Large investment gap	Small investment gap	Large investment gap
Constant	6.28	5.88	7.51	7.49	43.85	29.97
	(80.38)***	(135.96)***	(224.81)***	(205.01)***	(6.95)***	(10.96)***
Investment per employee	0.02 (8.43)***	0.03 (19.25)* * *	0.02 (18.41)* * *	0.04 (25.42)* * *	---	---
Growth in employ. t	---	---	---	---	1.28 (18.64)***	1.01 (27.51)***
Investment / output	---	---	---	---	0.20 (9.66)***	0.03 (0 93)
Scale	0.03 (6.00)***	0.04 (13.82)***	0.04 (22.00)***	0.03 (14.12)***	0.00 (1.48)	0.00 (0.28)
DFI	0.01	- 0.01	0.03	0.01	-0.29	0.73
	(1.53)	(2.40)**	(11.83)***	(1.54)	(0.66)	(3 58)***
R-square adj.	0.11	0.11	0.14	0.14	0.42	0.34
Number of obs.	1419	6016	8891	6161	538	2283

Note: t-statistics within brackets are based on White's [1980] adjustment for heteroscedasticity. *) Significant at the 10 per cent level, **) Significant at the 5 per cent level, ***) Significant at the 1 per cent level.

TABLE A2
CONCENTRATION AND SPILLOVERS

	Level estimation 1980 (dependent variable - value added per employee)		Level estimation 1991 (dependent variable - value added per employee)		Growth estimation 1980-1991 (dependent variable - growth in value added)	
Variables	High concentration	Low concentration	High concentration	Low concentration	High concentration	Low concentration
Constant	6.01	5.97	7.74	7.35	32.16	31.38
	(61.72)***	(146.67)***	(113.10)***	(275.59)***	(5.56)***	(11.16)***
Investment	0.03	0.03	0.03	0.02		
per employee	(9.25)* * *	(19.74)* * *	(13.80)** *	(27.82)***		
Growth in					1.11	1.08
employment					(16.11)***	(25.13)***
Investment /					0.14	0.11
output					(1 95)*	(2.67)***
Scale	0.04	0.04	0.02	0.04	0.00	- 0.00
	(6.33)***	(14.00)***	(6 93)***	(26.14)***	(0.66)	(0.63)
DFI	-0 02	0.01	-0.007	0.02	0.46	0.61
	(4.02)***	(4.76)***	(1.29)	(9.29)***	(1.58)	(2.57)* *
R-square adj.	0.12	0.12	0.13	0.13	0.36	0.36
Number of Observations	1510	6250	1929	13742	612	2280

Note: t-statistics within brackets are based on White's [1980] adjustment for heteroscedasticity. *) Significant at the 10 per cent level, **) Significant at the 5 per cent level, ***) Significant at the 1 per cent level.

TABLE A3
EFFECTIVE RATE OF PROTECTION AND SPILLOVERS

	Level estimation 1980 (dependent variable - value added per employee)		Level estimation 1991 (dependent variable - value added per employee)		Growth estimation 1980-1991 (dependent variable - growth in value added)	
Variables	High ERP	Low ERP	High ERP	Low ERP	High ERP	Low ERP
Constant	5.97 (123.30)***	5.95 (99.08)***	7.46 (203.97)***	7.36 (217.30)***	30.96 (8.50)***	32.19 (9.43)***
Investment per employee	0.03 (9.98)***	0.03 (16.63)***	0.02 (20.37)***	0.03 (23.66)***	---	---
Growth in employment	---	---	---	---	1.15 (21.06)***	1.03 (22.48)***
Investment / output	---	---	---	---	0.17 (2.55)***	0.09 (2.51)**
Scale	0.03 (9.98)***	0.05 (11.09)***	0.04 (16.65)***	0.04 (20.29)***	0.00 (1.93)*	- 0.00 (1.19)
DFI	0.01 (2.59)**	-0.001 (0.13)	0.03 (9.30)***	0.002 (0.98)	0.28 (0.91)	0.73 (3.20)***
R-square adj.	0.10	0.12	0.14	0.13	0.39	0.33
Number of Observations	4071	3653	7086	8584	1354	1538

Note: t-statistics within brackets are based on White's [1980] adjustment for heteroscedasticity. *) Significant at the 10 per cent level, **) Significant at the 5 per cent level, ***) Significant at the 1 per cent level.

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