Chapter 5

FDI Forward Linkage Effect and Local Input Procurement- Evidence from Indonesian Manufacturing

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May 2012

This chapter should be cited as

Takii, S. and D. A. Narjoko (2012), 'FDI Forward Linkage Effect and Local Input Procurement- Evidence from Indonesian Manufacturing-', in Hahn, C. H. And D. A. Narjoko (eds.), *Dynamics of Firm Selection Process in Globalized Economies*. ERIA Research Project Report 2011 no.3, pp.111-146. Available at: http:/www.eria.org/RPR_FY2011_No.3_Chapter_5.pdf

CHAPTER 5

FDI Forward Linkage Effect and Local Input Procurement
- Evidence from Indonesian Manufacturing -

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This paper examines FDI spillovers through forward linkages using the case study of Indonesian manufacturing over the period 2000-08. It examines whether productivity of a plant in the industry is correlated with the presence of MNEs in upstream industry. An exercise of dynamic panel data model econometric is undertaken to examine the forward linkage effect. The study includes a descriptive analysis that provides some basic facts about forward linkage and its pattern over the time and across industries. The econometric results provide evidence on the positive spillovers impact through forward linkages. The impact, however, is found to depend on the extent, or share, of locally procured inputs. The dependency of the forward linkage effect suggests that the availability of cheaper, but at the same time, high quality inputs produced by MNEs in local economy may encourage firms to switch from importing the inputs to procure locally. This study underlines the strategic importance of FDI policy to direct and/or promote FDI in upstream industries.

Keywords: FDI, Forward Linkages, Indonesian manufacturing, Panel Data
JEL classification: F23, D24, O24

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1. Introduction

Developing countries always consider establishment of foreign firms as a high priority in their policy agenda. Providing evidence to this, history has witnessed investment liberalizations and an increasing foreign direct investment (FDI) in many developing Asian countries since early of the 1990s. Policy makers in these countries are interested not only in the efficient technology brought by the FDI but also in positive productivity impact for local firms through technological spillovers to them (Saggi, 2006).

Channels of FDI therefore play an important role in order to materialize the positive productivity impact. One of these channels is linkage; that is, the linkage between multinationals (MNEs) with other firms within an industry (horizontal linkage) or with firms in other industries (vertical linkage). FDI spillovers through backward linkage occur when MNEs establish an inter-firm relationship with firms in downstream industries with a purpose to supply intermediate inputs for the MNEs. The backward spillovers effect then takes place through direct knowledge transfer, requirement for higher quality input, and increased demand that allows firms in downstream industries to gain from economies of scale (Javorcik 2004). Meanwhile, the spillovers through FDI in upstream industries, (forward linkages), occur when domestic firms in downstream industries benefit from high quality and less costly intermediate inputs produced by MNEs operating in the upstream industries. The analytic of FDI spillovers put forward a hypothesis that the vertical linkages, either through backward or forward linkages, are relatively more importantly than the horizontal FDI linking MNEs with other firms within the same industry. MNEs are likely to protect their knowledge from possible use by their competitors, whereas this is unlikely in the case of vertical linkage, and this is because there is no competition threat from sharing knowledge to firms in other industries.[1] A number of recent empirical works, such as Javorcik (2004), Blalock &Gertler (2008), Havranek & Irsova (2011), and Xu & Sheng (2011) support this hypothesis.

Evidence on vertical linkages however, has been skewed toward backward linkages. As Saggi (2006) wrote, “a voluminous informal and empirical literature exists on backward linkages”. Reflecting this, Javorcik (2004) found strong evidence for the spillovers coming through backward linkages but she only found a weak evidence for the spillovers coming through forward linkages. The skewed evidence may have been, to some extent, affected by the nature of FDI going in to developing countries which usually promote export oriented industries or experience a rapidly growing demand from

[1]See Blalock & Gertler (2008) for the conceptual framework that explains the behavior of MNEs in sharing their knowledge and technology with firms in other industries vis-à-vis with firms within the same industry.

population growth. In other words, much of this FDI is located in downstream industries; hence, it is not surprising if the evidence of backward linkage effect appears more frequently.

This paper focuses on forward linkages. It examines whether the productivity of a plant is correlated with the presence of MNEs in upstream industries, using the case study of Indonesian manufacturing. This study, in other words, tests the existence of FDI spillovers coming through forward linkages.

This study essentially extends the work previously done by Blalock & Gertler (2008) which only considered backward linkage effect. Examining FDI spillovers through forward linkages, particularly in the context of industrialization in Indonesia, is important at least for three reasons. First, over more than two decades of industrialization with relatively opened trade and investment regime, FDI in to the country has gone not only to downstream industries but also to the upstream ones, even though in terms of magnitude it may have been lower than the one went to downstream industries as argued by Blalock & Gertler. As described in Section 3 (see Table 1), FDI coming in to the group of capital-intensive sectors of the Indonesian manufacturing, such as resource-based capital intensive (RCI), electronics (ELE), and footloose capital intensive (FCI), had increased over time since 1990s.[2] Moreover, the

[2]The five categories are based on the following ISIC groups (and corresponding SITC

spillovers through forward linkages – if any –should arguably have been much stronger more recently, after a rather long-term engagement of FDI in upstream industries in the country.

Second, the large size and resource abundance of Indonesia support the establishment of a relatively complete supply chain. As indicated by Blalock & Gertler (2008), these characteristics could provide more incentive to foreign firms to establish not only in the downstream but also in upstream industries.

Third, for policy-making purpose, inviting FDI to upstream industries not only brings new knowledge or technology but also introduces competitive pressure for incumbents, which, in some developing countries, are dominated by state-owned enterprises (SOEs). SOEs in upstream industries are likely inefficient and tend to be ‘protected’; hence, directing FDI to upstream industries may pose credible treat of competitive pressure which eventually could improve efficiency in upstream industries.

In examining the forward linkages, this study further test whether the benefit stemming from forward linkages depends on the extent of locally

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groups for export statistics). Unskilled labour-intensive: ISIC 32 (textiles and garments), 332 (furniture), 342 (printing and publishing), and 39 (other manufacturing). Resource based, labour-intensive: ISIC 31 (food and beverages) and 331 (wood products). Resource based, capital-intensive: ISIC 341 (paper and paper products), 35 (chemicals, rubber, and plastics), 36 (non-metallic minerals), and 37 (basic metals). Electronics: ISIC 383 (electrical machinery). Footloose capital-intensive: ISIC 381 (metal products), 382 (non-electrical machinery), 384 (transport equipment), and 385 (professional and scientific equipment).

procured inputs. The conjecture is that, the productivity-enhancing effect because of forward linkage should be higher for a firm that sources locally many of its intermediate inputs. The availability of high quality inputs produced locally by MNEs, but at relatively cheaper price/cost than imported inputs, allowing any firm to switch, from sourcing low quality locally produced inputs to procuring the high quality ones.

The rest of this paper is organized as follows. Section 2 provides presents the methodology of our study, outlining the empirical model and the testable hypotheses as well as describing the dataset and variables used by the study. Section 3presents and discusses our empirical results, and Section 4offers the policy implication coming out from the analysis.

2. Data and Methodology

2.1.Specification and Hypotheses

Previous studies of technology spillovers through vertical linkages typically estimate the following function (Javorcik 2004; Blalock &Gertler 2008):

$$\Delta\omega_{ijt} = \beta_{ijt} + \beta_F Forw_{jt} + \beta_H Horz_{jt} + \beta_B Bacw_{jt} + \varepsilon_{it},$$

where ω_{ijt}, $Forw_{jt}$, $Horz_{jt}$, and $Bacw_{jt}$ are the natural logarithm of total factor productivity of plant i in year t, and the proxies for forward, horizontal and backward spillover effects in industry $j$ofyear t, respectively. The Δstands for difference operator. The linkage variables are measured as output shares of foreign-owned plants in upstream (forward effect), own (horizontal effect) and downstream (backward effect) industries, respectively. The *Horz* variable is calculated as the output share produced by foreign owned plants in industry j and the *Forw* and *Bacw* variables are calculated as weighted average of*Horz* variables for upstream and downstream industries of industry $j$with weights taken from Input-Output (IO) tables.[3]

In our current analysis, we extend the basic model focusing on the spillovers through forward linkages, which was not examined in a previous study on the Indonesian manufacturing conducted by Blalock &Gertler (2008).In our empirical analysis, thefollowing equation is estimated:

$$\omega_{ijt} = \beta_{ijt} + \beta_{\omega}\omega_{ijt-1} + \beta_F Forw_{jt} + \beta_{F*Rdm} Forw_{jt} * Rdm_{it} \\ + \beta_H Horz_{jt} + \beta_B Bacw_{jt} + \varepsilon_{it}. \quad (1)$$

This specification is consistent with an assumption that productivity is dependent on its lagged variables in an estimation techniqueused in our analysis (see section 2.2),and is different from that of previous studies.First,

[3]Exactly speaking, the coefficients used as weights are not weight because the sum of the weight is not equal to one. The *Horz* variable was calculated as a 3-years moving average.

Javorcik (2004) regressed the growth of productivity ($\Delta\omega_{ijt}$) on the linkage variables assuming that the coefficient β_{ω}in our estimated model is one; second, Blalock &Gertler (2008) regressed the level of productivity on the backward linkage variable assuming that the coefficient β_{ω} is zero. In our analysis, the coefficient and thus the lag structure is to be estimated in more general specification with a lagged dependent variable on the right-hand side. Second, we hypothesis that the magnitude of forward linkage effect vary among benefiting plants depending on the extent that plants procure inputs locally or by importing them. The variable Rdm is share of material inputs procured locally in total material inputs. If the coefficient β_{F*Rdm} is positive, it suggests thatplants procuring more material inputs locally can benefit more from forward linkage effects. The hypotheses of our interest can be written as:

$$\mathrm{H}_0: \beta_F = 0, \quad \mathrm{H}_1: \beta_F > 0$$

and

$$\mathrm{H}_0: \beta_{F*Rdm} = 0, \quad \mathrm{H}_1: \beta_{F*Rdm} > 0.$$

2.2. Variables and Estimation Issues

The previous studies estimated the productivity variable $\omega_{ijt}$with a technique suggested by Olley & Pakes (1996) in order to account for endogeneity of input choiceusing investment as a proxy for unobservable productivity shocks in production function.[4] However, the technique requires that investment responds to the productivity shocks smoothly and that positive (nonzero) investment was reported by plants in sample observations. In our analysis, the productivity is estimated with a technique suggested by Levinsohn & Petrin (2003) using material inputs as a proxy for unobservable productivity shocks. The methodology is more appropriate for the Indonesian manufacturing where the number of plants reporting positivematerial inputs is greater than plants reporting positive investment. Furthermore, Olley & Pakes'(OP) method avoids selection bias by taking exit decision of plants into account, while Levinsohn and Petrin's (LP)method does not.However, the latter is more appropriate for our analysis because there is relatively large number of plants that did not report capital stock, resulting to missing value of the variable. In the OP method, capital stock is a key determinant of the plant exit decision. In the case where dataset contains many missing values of capital stock for existing plants, we cannot properly estimate the probability of exit.

In the estimation process, we set up a following production function:

$$y_{it} = \alpha_0 + \alpha_l l_{jt} + \alpha_l k_{it} + \alpha_m m_{it} + \omega_{it} + \eta_{it},$$

Where$y_{it}$is the logarithm of output calculated as the sum of value added and

[4]Another related previous study on Indonesian manufacturing by Negara & Firdausy (2011) does not take account for the endogeneity.

expenses for material inputs or revenue minus the expenses for energy and fuel, assuming additive separability of energy and fuel inputs in production function. l_{it}, k_{it} and m_{it} are the logarithm of the number of workers, capital stock and material input. The output, capital stock and material inputs are deflated values.[5] Similarly with the OP and LP methods, the productivity ω_{it} is presumed to follow a first-order Markov process (in the estimation process of the productivity), and it is also assumed that material inputs is a strictly monotone function of the productivity and responds to productivity shocks smoothly. Under these assumptions, the total factor productivity ω_{it} is estimated by applying LP method for each industry at a two-digit ISIClevel.

The horizontal effect variable, *Horz*, is calculated as:

$Horz_{jt}$

Conceptually, this effect captures mainly demonstration effect (and competition effect) of productivity spillovers within own industry. However, it should be noted that thisvariable also captures forward and backward

[5]Output is deflated by the wholesale price index, which appears to be appropriate for each 3-digit ISIC classification. Deflated capital stock is calculated by following steps. Buildings, machinery and equipment, vehicles and other fixed capital are respectively deflated using wholesale indices for construction materials of buildings, imported machinery, transport machinery, and the general wholesale price index, respectively and then the sum of the four categories is calculated as the measure of deflated capital stock for each plant. Because of lack of sufficient information on prices, intermediate input is deflated by corresponding wholesale price index of output.

linkage effects within the own industry. Backward linkage effect variable, *Bacw*, measures the presence of foreign owned plants in the downstream industriesprocuringfrom industry *j*, and it is calculated as the following:

$$Bacw_{jt} = \sum_{k=1}^{K} \alpha_{jk}\, Horz_{kt},$$

where the coefficient α_{jk} is the proportion of output in industry *j* supplied to industry *k* and is taken/calculated from Indonesia's Input-Output (IO) tables for 2000 and 2005.[6] Similarly, the forward linkage effect variable, *Forw*, is defined as:

$$Forw_{jt} = \sum_{k=1}^{K} \alpha_{kj}\, Horz_{kt}.$$

These two variables capture vertical linkage effects include not only inter-industry but also intra-industry effects, because in the definition of these variables, there is a term of foreign presence in own industry ($\alpha_{jj} Horz_{jt}$).Therefore, the estimated model based on these definitionshas a limitation in estimating the magnitude of spillovers through backward and forward linkage and through horizontal separately for the reason that backward and forward linkage effects *within* the own industry has been captured by both the *Bacw/Forw* and *Horz* variables. Javorcik (2004)

[6]This variable corresponds to the Downstream_FDI in Blalock & Gertler (2008).

useddifferent definitions of the backward and forward variables whereby α_{jj} is set to zero. This means thereis no backward/forward linkage effect*within* the own industry.[7] However, this is not a well-grounded solution because it is unrealisticto assume no intra-industry linkage effect even if we use a highly aggregated industrial classification. Therefore, we do not impose $\alpha_{jj} = 0$ in the definitions of the *Bacw/Forw* variable.

Using these definitions, equation (1) is estimated together with the other control variables including capital intensity, ratio of non-production workers in total employment, and plant size measured by output in previous year. When we estimate the model, another estimation issue arises because the model is a dynamic panel data model that requires strict exogeneity of independent variables in order to be estimated by OLS/DVLS consistently. A generalized method of moment (GMM) estimator for a dynamic panel data model with endogenous/predetermined variables was developed by Arellano & Bond (1991) and Blundel & Bond (1998). We apply the estimator suggested by Blundel & Bond (1998) assuming that the spillover variables are exogenous while plant size is predetermined and the ratio of material input procured domestically, capital intensity, and the ratio of non-production workers are endogenous as well as the lagged dependent variable. In this estimation method, two-year and further lags of the independent and

[7]Another purpose of setting to zero is to avoid colinearity with the horizontal variable.

dependent variables can be used as instruments for (orthogonal) differenceequation, and one-year and further lag of differenced dependent variables can be used as instrument for level equation. When we seek for a set of valid instrumental variables, the possibility of the presence of measurement errors in variables is taken into account by excluding/including two-year lags of instruments for difference equation and one-year lag for level equation, as suggested by Bond (2002).[8]

2.3. Data and Sample

This study uses and utilizes a plant-level panel dataset of Indonesian manufacturing. The dataset was constructed collecting data for relatively large manufacturing plants with 50 or more workers from annual surveys conducted by the Indonesia’s statistical agency since 1975. The study considers the period 2000-2008 as the period forthe analysis and therefore a panel dataset for this period was constructed. It contains useful information related to both locally and foreign-owned plants, including value added, employment, capital stock, intermediate inputs and other variables that are necessary for the calculation of TFP. However, there are several outliers and apparently incorrect data entries in the original dataset. In order to avoid misleading results, data that appeared to be outliers or contain measurement

[8]For the estimation, xtabond2 command was used in stata program. “Forward orthogonal deviations” was used instead of first difference because the dataset is an unbalanced panel with “gap,” as suggested by Roodman (2009).

errors were modified/eliminated from the panel dataset.

The data modification process took following steps. First, incorrect data entries were modified. For example, a plant reported 100 percent foreign ownership share in a year but it reported the share of 0 percent in previous and subsequent years. In this case, the data entry of the 100 percent foreign ownership share was replaced with 0 percent. Second, the dataset contains estimates by the statistical agency for non-responds to the surveys. In general, the agency does not provide information on whether data entries were original replies from plants or were estimated by the agency because the plants did not respond. However, in some cases, we can speculate it. For example, original datasets for 2001-2005 contain data entries indicating that labor productivity (value added divided by the number of workers) is exactly the same for several plants within a 5-digit ISIC level.[9] Observations for these plants were totally excluded from our sample because the data entries appear to be estimates by the agency. Third, before estimating a production function by the LP method, it was estimated by OLS and residual was calculated. If observations with the residual whose absolute value were 2.5 times greater than estimated standard error, then the observations were excluded from sample for the LP estimation. This step eliminated outliers

[9]For example, calculated labor productivity is exactly the same for 497 plants in industry 18101 in 2001. For these plants, the value of calculated labor productivity is integer, which is usually non-integer. The number of such data entries decreased year by year and disappeared in dataset for 2006.

and incorrect entries in value added, and other production factor variables.

Another data used in this analysis is IO tables for 2000 and 2005. The Indonesia's statistical agency has published four types of IO tables every 5 years. In our analysis, a table for domestic transaction at producers' prices is used to calculate the *Forw/Bacw*variables.[10] For 2000 and 2005, α_{jk}s are calculated from the tables. α_{jk}s for 2001-2004 and 2006-2008 are inter or extrapolated using α_{jk}s for 2000 and 2005.

3. Results and analysis

3.1. Descriptive Analysis

Indonesia has been adopted, and it continues to adopt, a policy to attract FDI for the development of its manufacturing sector. In the late 1980s and during the first half of 1990s before the 1997/98 economic crisis, the government consistently introduced measures to liberalize the country's investment regime.[11] The policy direction to attract FDI continues after the crisis; in fact, the emphasis was greater in this period because of the perceived decline in the extent of FDI entering Indonesia after the 1997/98 crisis. Reflecting the greater emphasis, the government introduced a new investment

[10]Other options are (1) total transaction including imports and (2) at consumers' prices. Thus, there are four combinations of these options.

[11] See, for example Pangestu (1996) and Aswicahyono *et al*. (2010) for the detail of foreign direct investment policy in Indonesia over the before and after the 1997/98 economic crisis, respectively.

law in 2007 in an effort to increase FDI flow in to the country.

The picture about foreign ownership in the Indonesian manufacturing points to a rising pattern over the period 1990–2008 (Table 1). The share of manufacturing output produced by firms with foreign equity rose from 22 per cent in 1990 to 47 per cent in 2008. It rose more or less continuously throughout the period, but particularly immediately before and after the crisis, 1993–1999. It is important to note a jump in 2008, which may have been the result of an immediate impact of the new investment law introduced in early 2007. Overall ,the crisis had no major impact on this secular trend of rising foreign ownership. The increase in foreign ownership is evident in most industries, except for paper and chemical products, where local firms have become more active. As expected, foreign presence is greatest in the two most multinational enterprise (MNE)-intensive industries, automotive products and electronics, as well as in the resource-based capital intensive (RCI) and footloose capital intensive industry (FCI). Recalling the definition of *Forw*, the increase in the presence of MNEs in an industry indicates an increase in the share of intermediates produced by MNEs. If the MNEs in upstream industries produce similar products with imported inputs, therefore there should be a higher chance for plants in the downstream industry to procure inputs locally.

Table 1: Foreign Ownership Share, Indonesian Manufacturing, 2000-2008

Foreign ownership (share, in %)

		1990	**1993**	**1996**	**1999**	**2002**	**2005**	**2008**
31	Food, beverages, and tobacco.	8.5	9.7	14.0	15.8	9.4	24.9	24.4
32	Textile, clothes and leather industry.	17.8	21.8	29.3	37.4	32.1	32.8	44.5
33	Wood and wood products	10.1	11.7	22.9	15.8	11.6	11.2	19.1
34	Paper and paper products	30.2	14.9	33.8	23.5	46.4	29.0	27.3
35	Chemicals and chemical products	33.1	36.6	43.0	44.8	29.7	26.3	53.5
36	Non metalic mineral products	18.0	23.3	33.4	34.6	28.3	35.9	39.2
37	Basic metal industries.	24.8	35.3	24.3	43.1	29.4	30.5	28.2
38	Fabricated metal , machinerie, and eq.	46.1	36.4	42.4	58.0	67.6	68.3	77.9
39	Other manufacturing industries.	19.5	44.4	51.9	56.1	33.7	46.9	71.2
1-ULI	Unskilled Labour Intensive	16.2	21.1	27.3	35.4	28.8	30.0	42.2
2-RLI	Resource Based, Labour Intensive	9.0	10.2	16.8	15.9	9.8	22.8	24.4
3-RCI	Resource Based, Capital Intensive	29.5	32.5	35.9	40.0	34.9	29.9	45.6
4-ELE	Electronics	41.7	43.0	48.7	82.4	71.5	68.9	76.0
5-FCI	Footloose Capital Intensive	47.2	34.7	39.5	44.0	66.0	68.1	78.5
	Non-Oil and Gas Manufacturing	**21.9**	**23.4**	**30.9**	**35.5**	**33.5**	**37.2**	47.6

Source: StatistikIndustri (SI), various years.

Table 2 presents the average value of *Forw* and *Bacw* for the period 2000-08 for the whole and by industry groups of Indonesian manufacturing. The table shows that for the whole manufacturing, the value of *Bacw* is higher than that of *Forw*. This reflects large extent of FDI in Indonesian manufacturing went to downstream industries, which is consistent with export orientation and large domestic demand of the Indonesian economy.

Table 2: Forward and Backward, Indonesian Manufacturing, 2000-08

ISIC 2 Digit	Sectors	Forward	Backward
15	Food products and beverages	19.72	33.63
16	Tobacco	22.79	21.81
17	Textiles	26.35	33.41
18	Wearing apparel	37.46	36.40
19	Leather products and footwear	31.34	22.39
20	Wood products	32.08	28.70
21	Paper	27.03	11.74
22	Publishing	31.32	38.36
23	Petroleum products	41.21	30.47
24	Chemicals	32.01	37.00
25	Rubber and plastics products	45.25	42.87
26	Non-metallic mineral products	35.04	32.49
27	Basic metals	33.10	45.90
28	Fabricated metals	34.98	40.53
29	General machinery	31.44	62.44
30	Electrical machinery	58.71	70.94
31	Office and computing machinery	52.91	57.26
32	Radio, TV and communication	68.27	78.30

33	Precision machinery	49.93	75.11
34	Motor vehicles	45.38	82.28
35	Other transport equipment	43.20	65.92
36	Furniture and miscellaneous	33.03	40.08
37	Recycling	23.36	26.54
	Manufacturing	36.67	43.43

Another important observation is that, there is variation in the *Forw*value across industries, ranges from the lowest 19.7 percent in food products and beverages (ISIC 15) to radio, TV and communication (ISIC 32). But more importantly, there is rather skewed pattern in the distribution of *Forw*, with many capital intensive industries, such as electrical machinery, office and computing, radio, TV and communication, precision machinery, and motor vehicles (ISIC 30, 31, 32, 33, and 34, respectively), record a value well above the average value for the whole manufacturing. All of these industries are the industries where MNEs are likely to locate. It is interesting to note that the value of *Forw*in apparel (ISIC 18) is slightly above the whole manufacturing average. This is interesting because this industry is labor-intensive in nature, deviating from the skewness pattern the table has just revealed. The cross-section pattern of the *Bacw* seems to resemble closely the one of *Forw*, including the concentration of the value above whole-industry average in capital-intensive industries. Moreover, it is observed that the values of*Bacw* are significantly high for motor vehicle (the highest), precision machinery, radio-TV and communication, and electrical machinery (ISIC 34, 33, 32, and 30, respectively).

The cross-section variation in the value of *Forw* and *Bacw* also varies over the time, as it is shown by the changes over the 2000-08 period graphed in Figure 1 and 2. Consider the pattern of *Forw* (see Figure 1), there are about half of two-digit ISIC industries that registered positive change over this period, while the other half recorded a negative change in the value. Assuming the technical coefficient does not change substantially over the period, the positive change therefore suggests an increase in the foreign share of output produced by upstream industries. Observing Figure 1, industries that significantly increased their foreign-shared output are capital intensive industries, such as motor vehicle, fabricated metal products, and general machinery. The pattern is similar for *Bacw* (see Figure 2), where there is wide cross-section variation over the time. Most of the industries that gain the increase are those coming from the group of capital-intensive industries.

Figure 1: Change in Forward between 2008 and 2000, Indonesian Manufacturing

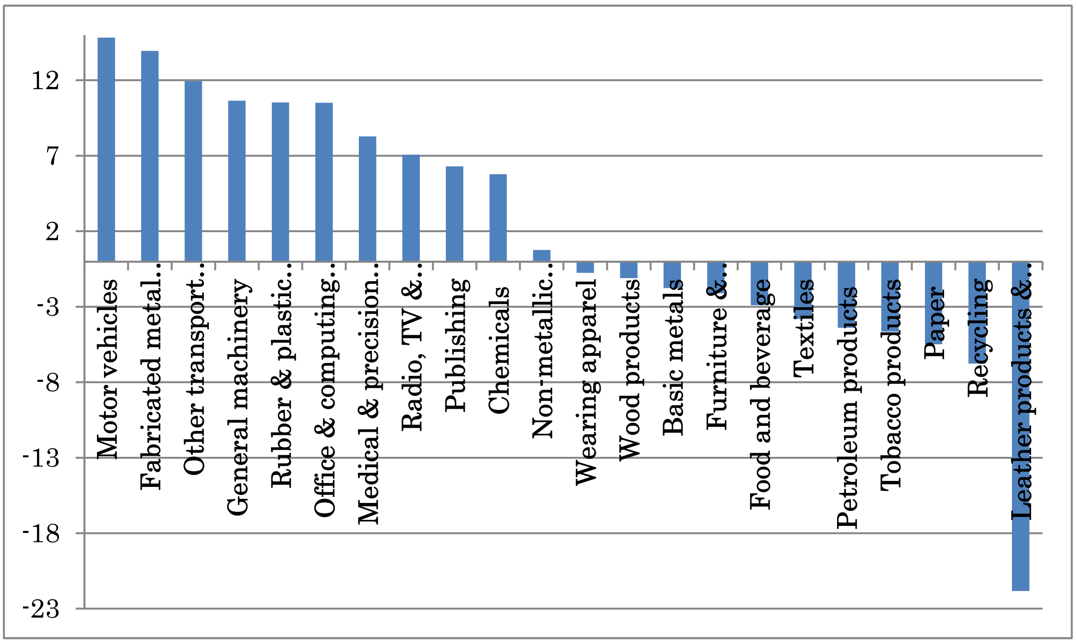
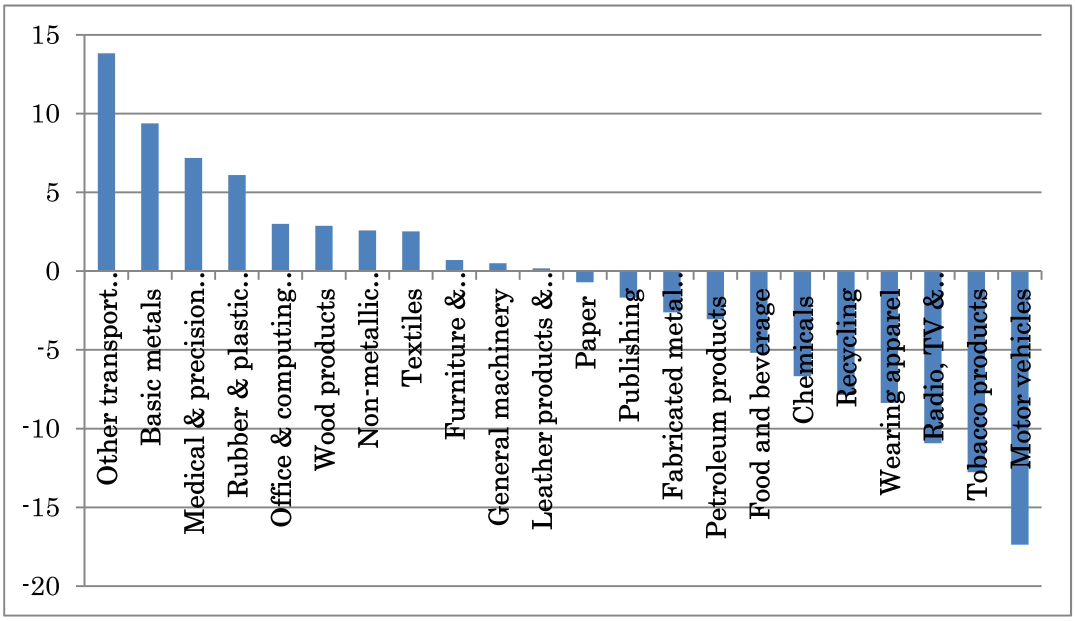


Figure 2: Change in Backward between 2008 and 2000, Indonesian Manufacturing



There is an indication of a decline in the use of imported input over the time, suggesting a higher use of locally produced inputs. This is derived from observing the cross-section and overtime pattern of imported input ratio over the period 2000-08presentedin Table 3. Observing the average of imported input, there is a declining pattern in the use of imported input from 7.1 percent in 2000-04 to 6.5 percent in 2005-08. This is observed in almost all groups of broader industry groups, with large decline occurred in electrical machinery (ISIC 31), precision machinery (ISIC 33), and to some extent in basic metal (ISIC 27) and motor vehicles (ISIC 34). Notwithstanding this decline, there are eight industries that experienced an increase in their average ratio of imported input; however, the increase was marginally, except the one recorded for other transportation equipment industry (ISIC 35), increasing from 8 to 14 percent.

The change in average ratio of imported input can be decomposed into two factors: one is the change in average imported input in importing plants (an average after excluding plants not importing) (columns 3 and 4) and the other one is the change in the number of importers (columns 4 and 5). Consider, first, the former, the average of importers' average imported input increased only in three industries (i.e., wood products (ISIC 20), paper (ISIC 21), and radio, TV and communication (ISIC 32)). The average for the whole manufacturing decreased from 47 to 44 percent over the period 2000-04 and 2005-08, respectively. Meanwhile, for the change in the number of importers, importing plants decreased, albeit slightly, by one percentage-point over these two sub periods.

To sum up, and to reiterate, all figures described by Table 3 show that plants in the Indonesian manufacturing tend to have lowered their purchase of imported input, suggesting, at the same time, that they may have procured input locally. This is somewhat inconsistent with a fact that Indonesia has liberalized international trade since the mid 1980s; it is however consistent, and provides some support, to the idea of the development that happened in the upstream industries.

Table 3: Imported input ratio, Indonesian Manufacturing, 2000-08

	Average of imported input ratio (%)		Average of imported input ratio only for importers (%)		Percentage of # of Importers (%)	
Period	2000-2004	2005-2008	2000-2004	2005-2008	2000-2004	2005-2008
Column	[1]	[2]	[3]	[4]	[5]	[6]
15 Food products and	2	2	28	25	8	8
16 Tobacco	1	1	18	16	4	5
17 Textiles	12	9	50	46	23	18
18 Wearing apparel	11	11	63	61	15	16
19 Leather products and	9	6	38	37	23	17
20 Wood products	1	1	16	17	7	8
21 Paper	8	8	35	38	22	21
22 Publishing	5	3	28	17	16	17
23 Petroleum products	10	11	65	43	15	25
24 Chemicals	24	23	57	56	42	40
25 Rubber and plastics	11	10	48	45	22	20
26 Non-metallic mineral	3	3	41	37	8	8
27 Basic metals	28	26	57	52	48	47
28 Fabricated metals	12	12	58	56	20	21

29 General machinery	15	16	56	56	26	28
30 Office and computing	-	-	-	-	-	-
31 Electrical machinery	32	29	61	58	50	47
32 Radio, TV and	59	58	85	87	62	54
33 Precision machinery	34	27	66	55	48	43
34 Motor vehicles	15	13	59	54	25	24
35 Other transport	8	14	52	50	15	26
36 Furniture and	4	4	38	35	10	10
37 Recycling	-	-	-	-	-	-
Manufacturing	7.1	6.5	47	44	15	14

3.2. Estimation results and analysis

This subsection reports the estimation results to address the hypothesis of this study. Table 4 presents these, for all continuing plants in our dataset which cover the period 2000-08. Consider, first, the results of specification [1] and [2], which follow the modeling strategy of Blalock &Gertler (2008) and Javorcik (2004), respectively, in treating the lag of natural logarithm of total factor productivity (see the discussion in subsection 2.1). It turns out that there is no support for the impact of forward linkage effect on productivity if we consider these modeling strategies; the estimated coefficient of Forw is very statistically insignificant and, in the case of the results of specification [2], it shows a negative sign, which is not expected based on the theory.

Turning to the next column, which shows the result from the specification that includes the lag of dependent variable (i.e., specification [3]), there is a hint for a positive impact of forward linkage on productivity. The estimated coefficient of *Forw* is positive although it is not statistically significant. Examining further, it turns out that the result is not reliable; the p-value of Hansen test rejects the null of valid overidentifying restrictions. In the dynamic panel GMM estimation, rejecting the null means higher chance for the estimates although efficiency of the estimator at the same time also increases (Baltagi, 2008).

Specification [4] specifies the hypothesis that the impact of forward linkage depends on the extent of locally procured inputs. The estimation result of this specification supports this hypothesis; the estimated coefficient of the interactive variable *Forw* and *Rdm* is positive and statistically significant, albeit only at 10 percent level. The overall, or net, impact of forward linkage on productivity is also positive, although the estimated coefficient of *Forw* is negative when it enters the specification individually. The result is likely to be robust, given that the specification [4] passes the Hansen test where the p-value of the Hansen statistics fail to reject the null of overidentifying restrictions.

The finding on the positive effect of the interactive *Forw* and *Rdm* variable supports the argument that the availability of cheaper – but high quality – intermediate inputs produced by MNEs in local economy is capable to make a firm to switch, from importing the inputs to source them locally. It

Table 4: Productivity Estimation Results

Column	[1]	[2]	[3]	[4]	[5]	[6]
Dependent var.	w_t	Δw_t	w_t	w_t	w_t	w_t
Estimation	DVLS	DVLS	Sys-GMM	Sys-GMM	Sys-GMM	Sys-GMM
w_{t-1}			0.144	0.145	0.147	0.146
			[0.040]***	[0.039]***	[0.039]***	[0.039]***
Forw	0.291	-0.101	0.146	-5.281	-5.843	-4.413
	[0.226]	[0.283]	[0.278]	[3.172]*	[3.678]	[2.334]*
*Rdm*Forw*				6.643	7.294	5.291
				[3.799]*	[4.424]*	[2.859]*
Horz	0.168	0.254	0.009	0.044	0.086	0.005
	[0.084]**	[0.107]**	[0.096]	[0.097]	[0.121]	[0.096]
Bacw	1.049	0.914	0.934	1.027	1.127	0.872
	[0.216]***	[0.257]***	[0.261]***	[0.253]***	[0.297]***	[0.235]***
HI	0.095	0.019	0.116	0.106	0.091	0.118
	[0.113]	[0.145]	[0.109]	[0.112]	[0.116]	[0.110]
Rmd	0.002	-0.054	-0.668	-0.673	-0.572	-0.722
	[0.040]	[0.054]	[0.353]*	[0.368]*	[0.369]	[0.373]*
Rln	0.014	0.023	-0.018	-0.014	-0.002	-0.043
	[0.007]**	[0.010]**	[0.074]	[0.076]	[0.075]	[0.075]
Rlk	0.029	0.026	0.137	0.123	0.122	0.121
	[0.004]***	[0.006]***	[0.054]**	[0.053]**	[0.053]**	[0.053]**
Plants	7,673	5,311	5,311	5,311	5,311	5,311
Observations	32,749	24,462	24,462	24,462	24,462	24,462
F-value	0.000	0.000	0.000	0.000	0.000	0.000
AR1 (p-value)			0.000	0.000	0.000	0.000
AR2 (p-value)			0.969	0.905	0.899	0.958
Hansen (p-val.)			0.012	0.113	0.105	0.118
Instruments			64	75	75	75

Notes:In Sys-GMM estimation, w_{t-2}, w_{t-3}, Rmd_{t-3}, Rmd_{t-4}, Rln_{t-3}, Rln_{t-4}, Rlk_{t-3}, Rlk_{t-4}, $Rdm*Forw_{t-3}$ and $Rdm*Forw_{t-4}$ (for difference equation) and Δw_{t-2} (for level equation) were used as instruments. The results of two-step estimation with Windmeijer's (2005) finite-sample correction of standard errors are reported. "***", "**", "*" indicate statistically significant at 1 percent, 5 percent, or 10 percent level, respectively. Year dummies are included in all models.

is important to note, however, that the coefficient of the interactive term does not reflect the extent of the switching; it just gives a suggestion that such a switching behavior may occur.

Specification [5] and [6] are estimated to test the robustness of the key finding on the impact of forward linkage. First, in specification [5], and following Javorcik (2004), the output produced by foreign plant in the formula to compute horizontal linkage is adjusted by the foreign share in the plant; that is, by multiplying it with the foreign ownership share, or

$$Horz_{j,t} = \frac{\sum_{i \in j} (\text{foreign share})_{i,t} \times (\text{output})_{i,t}}{\sum_{i \in j} (\text{output})_{i,t}}$$

Thus, now, unlike the *Horz* variable used by specification [4], *Horz* adopted by specification [5] reflect the extent of output from foreign plants more precisely, because it reflects the share of foreign ownership in an industry. The value of *Bacw* and *Forw* is adjusted accordingly. Looking at the estimation result of this specification, it turns out that the key finding is robust even with the alternative measurement of horizontal, forward, and backward linkage; that is, the impact of forward linkage is positive but dependent on the extent of locally procured input.

Another robustness test considers the value of *Forw* and *Bacw* that excludes the 'within-industry' effect. Recalling the explanation in section 2.2, this means the definition of *Forw* and *Bacw* imposes a restriction of $\alpha_{jj} = 0$. This is done by specification [6]. The key message from the results accords the one derived by previous estimation where the forward and backward effect within an industry is included. However, the dependency of the forward linkage effect on the extent of locally procured inputs appears to be lower than the dependency when the ‘within industry’ effect is assumed. The estimated coefficient of interactive term *Rdm*Forw* in specification [6] is higher than the one produced by the estimation of specification [4] and [5].

Table 5 reports our experiment that focuses on testing the hypothesis on the group of local plants. This extends the exercise reported in the Table 4 and is motivated both by a more policy-oriented argument and cleaner/more-convincing test to detect the presence of spillovers from the presence of multinationals. While it does not necessary applyonly to domestic/local firms, FDI spillovers is analytically, and commonly, referred to an increase in productivity of domestic firms as a consequence of the presence of foreign firms in the domestic economy. Looking at from the perspective of policy, policy makers usually are interested to know the extent of knowledge transferred from multinationals to local firms.

Table 5: Productivity Estimation Results: Focusing on Local Plants

Column	[7]	[8]	[9]	[10]	[11]	[12]
Subsample	Local plants	Local plants	Non-importing local plants	Importing local plants	Non-Importing plans including foreign plants	Importing plants including foreign plants
Estimation	Sys-GMM	Sys-GMM	Sys-GMM	Sys-GMM	Sys-GMM	Sys-GMM
w_{t-1}	0.127	0.133	0.182	0.141	0.197	0.113
	[0.041]***	[0.040]***	[0.047]***	[0.070]**	[0.045]***	[0.060]*
Forw	0.363	-2.378	0.659	-2.45	0.659	-3.71
	[0.277]	[2.527]	[0.308]**	[1.306]*	[0.299]**	[1.575]**
*Rdm*Forw*		3.208		4.241		6.165
		[2.945]		[2.230]*		[2.693]**
Horz	-0.063	-0.06	-0.021	-0.114	0.009	0.039
	[0.094]	[0.094]	[0.116]	[0.136]	[0.112]	[0.143]
Bacw	1.049	1.138	1.345	0.197	1.286	0.644
	[0.276]***	[0.268]***	[0.311]***	[0.463]	[0.298]***	[0.428]
HI	-0.001	-0.014	0.04	-0.091	0.037	0.094
	[0.095]	[0.095]	[0.118]	[0.138]	[0.115]	[0.169]
Rmd	-0.491	-0.509		-0.564		-0.658
	[0.419]	[0.392]		[0.344]		[0.366]*
Rln	-0.053	-0.06	0.005	0.197	0.017	0.244
	[0.080]	[0.078]	[0.087]	[0.120]	[0.079]	[0.124]**
Rlk	0.088	0.075	0.121	0.059	0.13	0.089
	[0.057]	[0.056]	[0.061]**	[0.113]	[0.057]**	[0.081]
Plants	4,645	4,645	4,099	1,132	4,414	1,617
Observations	21,065	21,065	16,727	4,338	17,954	6,508
F-value	0.000	0.000	0.000	0.012	0.000	0.011
AR1 (p-value)	0.000	0.000	0.000	0.000	0.000	0.000
AR2 (p-value)	0.761	0.720	0.243	0.649	0.175	0.780
Hansen (p-val.)	0.003	0.021	0.015	0.653	0.009	0.816
Instruments	64	75	53	75	53	75

Notes: In Sys-GMM estimation, w_{t-2}, w_{t-3}, Rmd_{t-3}, Rmd_{t-4}, Rln_{t-3}, Rln_{t-4}, Rlk_{t-3}, Rlk_{t-4}, $Rdm*Forw_{t-3}$ and $Rdm*Forw_{t-4}$ (for difference equation) and Δw_{t-2} (for level equation) were used as instruments. The results of two-step estimation with Windmeijer's (2005) finite-sample correction of standard errors are reported. "***", "**", "*" indicate statistically significant at 1 percent, 5 percent, or 10 percent level, respectively. Year dummies are included in all models.

In an attempt to make a careful examination of the impact on this group of plant, the experiment is conducted three more specific groups of local-plants, that is: (i) the whole local plants, (ii) groups of local plants differentiated by whether or not they procured inputs from importing, and (iii) the groups defined by (ii) but with addition of plants that have some share of foreign ownership. Two specifications, that is, with and without the interacted *Forw*-and-*Rdm* variable, are applied/estimated on each of these more specific groups..

Consider, first, the estimation results for the group of the whole local plants (see the results of specification [7] and [8] in Table 5), there is no evidence for the impact of forward linkage on productivity, shown by statistical insignificant of *Forw* and *Forw***Rdm* variable. The positive impact of forward linkage on productivity only appears in the results of estimations for the remaining more specific groups – see the results of specification [9] to [12]. Specifically, forward linkage positively affects productivity for the group of non-importing local plants (the results of specification [9]), indicated by the positive and statistically significant estimated coefficient of *Forw*. The productivity impact of forward linkage that depends on the extent of locally procured input is positive for the group of local plants that at the same time also import some of their inputs (the results of specification [10]). These findings persist even when plants with some foreign ownership are added to the sample groups, shown by the results of specification [11] and [12].

These findings presented support the inference produced by the results presented in Table 4, on the positive impact of forward linkage on productivity. This seems to further suggest that the impact of forward linkage is greater for local plants or firms that do have strong international linkage; here, in this context, international linkage isbroadly defined by how much a plant imports its inputs. Following a strand of literature in importing (and exporting), this could be explain by the theory that importing is costly, particularly for a plant/firm to pay the very costly/expensive sunk cost for importing.

So far this section focuses on the presentation and comments on the results for the question asked by this study. In addition to these, it is worth to also make some comments on the results of the other spillover-linkage variables (i.e., *Horz* and *Bacw*).Referring back to the results of specification [4] in Table 4, there is evidence of strong FDI spillovers through backward linkages. The estimated coefficient is positive and statistically significant at the very high level of confidence (at 1 percent level).Moreover, it is suggested that the impact through this channel is economically very important, owing to the very large estimated coefficient. This finding is consistent with numerous other studies which have demonstrated the existence of the backward-linkage spillovers. In particular, it supports the work of Blalock & Gertler (2008) that also found positive impact from backward linkages in Indonesian manufacturing. This finding also confirms the particular characteristic of inward FDI to developing countries that mostly targets downstream industries.

Turning to horizontal linkages, the results do not find evidence that FDI spillovers take place through horizontal linkages. The *Horz* estimated coefficient is very statistically insignificant. Moreover, the sign of the coefficient is negative, which appear to be indicating a possible adverse competition effect in the local market as an impact of MNE operation. This finding however is consistent with other studies (e.g. Aitken & Harrison (1997), Javorcik (2004) and Blalock & Gertler (2008)) in which the evidence for the presence of horizontal linkage spillovers can not be found.

It is also worth commenting that there is a rather strong the persistency in the outcome of productivity. The coefficient of ω_i is very statistically significant not only with the one-year lag of the variable (ω_{ijt-1}) but it is also for the two-years lag variable (ω_{ijt-2}). The impact of the two-years lag of the variable however is not so strong in terms of magnitude; the estimated coefficient of (ω_{ijt-2}) is about half of the estimated coefficient of (ω_{ijt-1}).

4. Summary and Policy Implications

This paper addresses the topic of FDI spillovers through forward linkages using the case study of Indonesian manufacturing over the period

2000-2008. It examines whether productivity of a plant in the industry is correlated with the presence of MNEs in upstream industry. In examining the forward linkage effect, it tests whether the benefit stemming from the forward linkages depends on the extent of inputs locally procured by a plant. An exercise of dynamic panel data model econometric is undertaken to examine the forward linkage effect. The study also includes a descriptive analysis that provides some basic facts about forward linkage and its pattern over the time and across industries. The descriptive analysis also provides a picture about some pattern or characteristics of input procurement of plants in the manufacturing sector.

The descriptive analysis shows some indication of an increase in presence of MNEs in upstream industries. The value of forward variable is recorded to have increased over the period 2000-08 in about half of the industries defined at two-digit ISIC level. More importantly, and more interestingly, almost all of these industries are capital-intensive industries where FDI is usually located. Consistent with this, many of the two-digit ISIC industries that record a well above the whole manufacturing average – in the value of forward variable – are capital-intensive industries. Another important finding from descriptive analysis is the indication that plants in the manufacturing sector tended to have lowered their purchase of imported inputs, which suggests that they should have procured more locally.

The econometric results provide evidence on the positive spillovers impact through forward linkages. The impact, however, seems to depend on the extent, or share, of locally procured inputs. This supports the hypothesis on the existence of spillovers effect through forward linkages. The dependency of the forward linkage effect suggests that the availability of cheaper, but at the same time, high quality inputs produced by MNEs in local economy may encourage firms to switch from importing the inputs to procure locally. The econometric analysis also found evidence of the existence of backward linkage effect, which appear to be quite strong.

There are at least two policy implications can be drawn from this study. First, this study underlines the importance of strategic investment policy for FDI. Usually, in many cases, government tends to direct FDI only to downstream industries. While this is proved to be beneficial, as shown in this study by the convincing results of the backward linkage effect, government could actually apply a more strategic FDI policy by directing, or promoting, FDI to be invested in upstream industries. As indicated by this study, the forward linkage effect is proved to be positive and it may actually trigger firms to switch from importing to procure their inputs locally. Procuring inputs locally definitely reduces costs and this means potential increase in the growth rate of many firms. Second, considering the positive impact of the vertical linkages in facilitating technology transfer from MNEs, it is important for policy to promote FDI in to the sectors that currently are still experiencing low level of the vertical linkage with MNEs. Recalling the insight from the descriptive analysis of this study, many of these industries at this moment are labor and some of resource intensive industries.

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