Backward and Forward Linkages of Productivity Effect from Foreign Direct Investment

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Abstract—**Productivity related to foreign direct investment (FDI) has been examined for the last two decades, but the findings are mixed. This paper contributes to shed the light by analyzing the backward and forward linkages of FDI-related productivity. By estimating manufacturing firms of Indonesia, the results shows that there is a positive backward linkage from FDI in local firms on domestic firms in upstream 3-digit industries. There is also a positive forward linkage from FDI in local firms in downstream industries. The findings implicate the demonstration effect and skill-training effect of foreign firms to local firms in the industrial line. The findings are robust under fixed effect model, general method of moment model, and instrumental variable model.**

Keywords—backward and forward linkages; productivity; foreign direct investment; manufacturing; upsteam; downstream firms

I. INTRODUCTION

The productivity benefit of foreign direct investment (FDI) has been known as a long-term benefit for local companies [1]. The inflow of FDI in the form of foreign ownership provides demonstration effects that enable local companies to be more productive. Local companies in the same industry are forced to increase productivity in order to survive the greater competition, while local companies in upstream industries require to increase the quality of their products due to the higher standard [2]. The impact of FDI on local firms in the same industry is known as FDI horizontal spillover effect, while the impact on local firms in upstream industries is FDI backward spillover effect [3, 4]. Additionally, FDI impact can be also on local firms in downstream industries, which is known as FDI forward spillover effect [5]. The impact is going through the output produced by foreign firms that use as material for production for local firms in downstream industries. In short, the FDI-related productivity is not only benefited for local firms in the same industries, but also benefited local firms along the supply chain.

The literature of FDI-related productivity shows mixed evidence [6 - 8]. As the main focus of the previous literature mostly on the horizontal spillover effect that analyzing the impact of FDI on local firms in the same industry, the impact of FDI can be two sides. The one side is that FDI triggers demonstration effect, encourage local firms to learn new knowledge to compete, so that their productivity

increase [9]. In contrast, the existence of foreign firms in host countries steals the market of local firms, which in turn decrease the productivity and would force local firms to quit the market [10]. Due to the two faces of the FDI-related impact, the ambigu findings are clearly possible. To contribute to shed a light, this current study focuses the analysis on the FDI-related impact on local firms in up steam industries (backward linkages) and in down steam industries (forward linkages). The main purpose is to provide a big picture of the productivity impact of FDI and to show the linkages effect of FDI, with a special focus on Indonesian manufacturing.

The paper proceeds as followed. The next section review related literature and the three section is research method. Results and interpretation are in section four, following by conclusion at the end of the paper.

A. Related Literature

1) The backward linkage of FDI-Related: The existence of FDI in a certain industry is not only affecting local firms in the industry but also impacting local firms in the upstream industries [5]. The FDI firms require materials as production inputs and buy the materials from local-supplier firms. The standard quality of the materials follow international standards, which tend to be higher standard compared to those demanded by other local firms [3]. This standard of quality forces local supplier firms to upgrade the quality of product through acquaring advanced technology and as the result, the productivity of local suppliers increase. The transformation impacts from FDI firms' demand to the productivity improvement of local supplier firms is known as backward productivity spillovers.

The backward productivity spillovers are currently a focus on the recent literature in search for the FDI-related productivity. Analyzes the backward linkage of FDI firms to the local supplier firms in South Africa and finds out that there is a positive productivity effect to upstream industries [2]. The similar finding is presented by for manufacturing firms in Vietnam [5]. Justifies under the mythology of stochastic frontier that the firms in Indonesia manufacturing industries generate significant positive impact on local firms in upstream industries [11]. In contrast, shows that there is no indication of backward linkage of FDI firms to the local firms in upstream industries in China [12].

2) Forward linkages of FDI-Related: Besides the impact on local firms in upstream industries, FDI firms can also influence local firms in downstream industries. When FDI firms sell their products for input production in local-buyer firms, the high quality materials enable local buyer firms to extract productivity benefit [13]. Forward linkage appears when local buyer firms experiencing improvement in output productivity. This theoretical argument has been put in test in several empirical research.

Tests the forward linkage in China and finds out that there is a significant positive impact of FDI on local buyer firms [7]. This finding is supported by South Africa manufacturing firms. In Indonesia, shows an indication of forward linkages through efficiency and best-practice of FDI firms to local buyer firms [2, 11]. The indication of forward linkage is appear to be stronger than the indication of backward linkages, as argued by [12].

II. METHOD

A. Data and Variables

The data for the current research are taken from survey of Indonesian large and medium firms conducted by Indonesian Board of Statistic (Badan Pusat Statistik – BPS). The annual survey covers more than 8,000 establishments since 1975 and presented output and input variables, together with ownership, percentage of output exported, percentage of imported material, and other related variables. As there are a changing of industrial classification along the years of surveys, some years are not be possible to be included in the construction of the consistent panel data. In addition, the year 2001 dataset could not be included as the unique establishment code assigned to each firm is totally change. This code is back to the initial code in 2002. Due to the reason, the data used in this current research are ended in 2000. The starting year are 1988 to accommodate the manufacturing deregulation. Furthermore, this research follows the procedure of in constructing the consistent and reliable dataset [3].

The variables used in this paper are output variable, input variables (material, labour, capital, and energy), and FDI variables (foreign ownership, backward spillover, forward spillover). Output variable is calculated from the total value of output, while the material is from the total value of material. Labour is measured from the full-time equivalent of worker, whereas capital is calculated from the replacement value of capital. Energy is the total value of electricity and fuel consumed. Foreign ownership is measured from the percentage of foreign share in the firm, while backward linkage and forward linkage are calculated by following Orlic at al. [14].

B. Empirical Model

The empirical model is adopted from the methodology in Buckey et al. [15], Anwar and Sun [16]. Foreign Direct Investment (FDI is augmented to production function and the empirical model can be written as:

$$Qit = \alpha0 + \alpha1 Mit + \alpha2 + \alpha Lit + a3Kit + \alpha4Eit + \alpha 5FOit + \alpha6BLit + \alpha7FLit + \varphi it$$

For Q is output, M is material, L is labour, K is capital, E is energy, FO is foreign ownership, BL is backward linkage, FS is forward linkage, α is parameters to be estimated, φ is error term, i represents firm, t represents time.

C. Estimation Methods

The estimation methods in this research follow the estimation of panel data. Three methods are used. They are Fixed-Effect (FE), General Method of Moment (GMM) and Instrumental Variable (IV). The three methods apply to estimate the influence of input variables and FDI variables on output, as well as to check the robustness of the estimation results.

III. RESULTS AND ANALYSIS

The results are presented into three parts. The first part describe the key information of the sample. The second part interpretes the estimation results. The third part checks for the robustness of the estimation results.

A. Descriptive Statistic of the Sample

The consistent balanced-panel sample is constructed following the procedure in Suyanto et al. [3]. The descriptive statistic of the sample is presented in table 1.

TABLE I. DESCRIPTIVE STATISTIC OF THE SAMPLE

Variable	GMM	IV
Const	0.1811***	0.1811***
	(0.000)	(0.000)
M	0.5829***	0.6674***
	(0.000)	(0.000)
L	0.3045***	0.2763***
	(0.000)	(0.000)
K	0.0475***	0.0885***
	(0.000)	(0.000)
E	0.0607***	0.1029***
	(0.000)	(0.000)
FO	0.0025*	0.1650***
	(0.053)	(0.000)
BS	0.0515***	0.0799***
FS	0.1494***	0.2387***
	(0.000)	(0.000)

Source: Calculated from the balanced panel dataset

The values in the table for output variable (Q) and input variables (M, L, K, E) are in logarithm of thousand rupiahs. The mean value of output is 6.0647 indicating that the mean value in rupiah is IDR 1,112,910,000 (one billion one hundred and twelve million nine hundred and ten thousand rupiah). The minimum output value of the sample firms is 2.862, which is equal to IDR 727,780, and the maximum value of output of the sample firms is 9.017, that equal to IDR 1,039,920,166,000 (more than one quarterlion).

The mean value of material is lower than the output value, with logarithm value of 5.7174 or in rupiah value of IDR 521,675,000. The minimum value of material used by a firm in the served sample is logarithm 2.275 or IDR 188,365. The maximum output value of material is 8.752 or IDR564,937,000. The average number of workers of the

observed sample is 110 people, with the minimum number of 14 persons and maximum number of 29,512 workers. In case of capital, the maximum value in logarithm is 10.903 or in monetary value is IDR 79,983,425,401,000 (more than 79 quarter lion). The maximum value of capital is higher than output due to the replacement values of capital in certain firms tend to be high. However, the average value and the minimum value of capital is less than those of output, which is consistent with the theory of production. Meanwhile, the average value of energy used in production is IDR 39,792,388, with the logarithm value of 4.5998.

The interpretation for the values of FDI variables are different with those of production variables. The average value of foreign ownership (FO) 0.0761 reflects the average foreign ownership for the observed firms in Indonesian manufacturing. There are firms with 100 percent foreign ownership, as shown by the maximum value of FO in table 1. In contrast, there are firms without foreign ownership.

The average value of backward linkage (BL) is 0.1758, showing that the material from local suppliers that used by foreign firms is 17.58 percent. In other word, the average percentage of output by local firms that used as input for foreign firm in the supply chain is 17.58 percent. The maximum percentage of local suppliers' output that used as material production in foreign firms are 54.43 percent, while the minimum percentage is zero.

Furthermore, the average output of foreign firms that used as material for production of local buyers is 15.98 percent. This percentage shows that linkage of foreign firms to backward industries. In addition, the maximum percentage of foreign firms' output used by local buyers is 42.10 percent.

B. Estimation Results of Backward and Forward Linkages of FDI

The estimation results of dataset using the empirical model in equation (1) and Fixed- Effect Method are shown in table 2. The interpretation of the results is grouped into two parts. The first part is the interpretation for the results in input variables. The second part focuses on the interpretation of FDI variables.

TABLE II.   RESULTS OF FIXED EFFECT MODEL

Variable	Coefficient	Std. Err.	t	P>t
Const	1.4522***	0.0170	85.04	0.000
M	0.5829***	235.22	0.0024	0.000
L	0.2425***	0.0047	51.48	0.000
K	0.0538***	0.0017	30.37	0.000
E	0.0949***	0.0021	44.81	0.000
FO	0.0025**	0.0011	2.12	0.034
BL	0.0145**	0.0065	2.22	0.026
FL	0.0451***	0.0102	4.40	0.000

Source: Estimated from the balanced panel dataset

Note: *** indicates the level significance of 99%

** indicates the level significance of 95%

The material (M) has a positive and significant influence to output, with a coefficient of 0.5829. The increase in one percent of material value leads to the increase of output value by 0.5829 percent. The similar finding is shown in labour (L)

that has a positive and significant effect on output of the observed firms. The increase in one percent of labour triggers the increase in 0.2425 percent of labour. The capital value has also positive and significant impact on output, with the one percent increase in the value of capital, the value of output increases with 0.0538 percent.

The fourth input variable, energy (E) has a positive and significant impact as well to output. When the value of energy rises by one percent, the value of output increases by 0.0949 percent.

The findings of positive values and significant influence of input variables (M, L, K, E) confirm the theoretical argument of production and in line with findings in previous studies, both in Indonesia Suyanto et al. [3], Sari et al. [4], Anwar and Nguyen [17].

The sum of the four coefficients of input variables reflects the return to scale of input to output. From Table 2, the sum of the coefficients has a value of 0.9741, which reflecting the decreasing return to scale of input to output in Indonesian manufacturing. This finding should be treaten with careful. The result can be because that the period of crises (1997-2000) is included in the estimation or it can reflect that the average of firms in Indonesian manufacturing is facing the stage of decreasing return. Another possible explanation is due to the inclusion of FDI in the production equation. When the FO is included as the variable in summation for return to scale, the total value is 1,0502, reflecting the increasing return to scale.

Going to the interpretation of FDI variables, it is found that foreign ownership (FO) has a positive value and significant impact on output. The meaning is that firms with foreign ownership has output-value larger that those without foreign ownership, with 0.0025 percent of higher value.

The positive value and significant influence of backward linkage (BL) coefficient suggest that the foreign ownership generating impact to local suppliers. Foreign firms trigger the increase in the output of local-supplier firms. This finding strengthen the theoretical argument of and in line with findings of Ghebrihiwet [2], Kubny and Voss [5], Neves and Sequiera [8].

Similarly, the positive sign and significant effect of forward linkage (FL) coefficient reflect the existence of FDI impact on local-buyer firms. The foreign ownership in Indonesian manufacturing firms leads to the increase of local-buyer firms. This finding conforms the argument of on that the high-quality products from FDI-owned firms contribute to the local-buyer firms through material production [12]. In addition, Findings from BS and FS suggest evidence of backward and forward linkages of FDI in the supply chain of Indonesia manufacturing industry.

C. Robustness Checks

The heterogeneity might present for the dataset as the observed firms varies one another, ranging from food-production firms to chemical and pharmaceutical firms [16]. To check whether the heterogeneity is a problem, this study performs two alternative methods, i.e. General Method of Moment (GMM) and Instrumental Variable (IV). The purpose

of performing these two alternative estimations is to check the robustness of the results and to minimize the problem of heterogeneity.

TABLE III. ROBUSTNESS CHECKS GMM AND IV

Variable	GMM	IV
Const	0.1811***	0.1811***
	(0.000)	(0.000)
M	0.5829***	0.6674***
	(0.000)	(0.000)
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	(0.000)	(0.000)
K	0.0475***	0.0885***
	(0.000)	(0.000)
E	0.0607***	0.1029***
	(0.000)	(0.000)
FO	0.0025*	0.1650***
	(0.053)	(0.000)
BS	0.0515***	0.0799***
FS	0.1494***	0.2387***
	(0.000)	(0.000)

Source: Estimated from the balanced panel dataset

Note: *** indicates the level significance of 99%

** indicates the level significance of 95%.

p-values of t-statistic are presented in the

parentheses; The GMM is under ArellanoBover/Blundell-Bond estimation using lag2.

IV. CONCLUSION

This paper estimates the FDI-related productivity to local-supplier firms and local buyer firms. It is found that foreign ownership on Indonesian manufacturing firms generates positive and significant long-term impact on output-productivity of local firms in backward industries and in forward industries. Foreign ownership leads to the increase of output of local firms those supply products. Similarly,

foreign ownership increases output of local firms those buy products from the foreign owned firms. The findings conform the existence of backward-linkage as well as forward linkage effects of FDI. These also confirm the long-term influence of FDI within a supply chain of manufacturing firms. The findings are robust under other alternative methods, which suggesting that heterogeneity is not a problem for the observed-dataset.

The implication of the findings is related to the FDI-related policies. The efforts to attract FDI need to consider whether the FDI leads to backward and forward linkages in

the supply-chain of manufacturing industry. The incentives on FDI need to be provided for FDI that can induce output productivity for local-supplier firms and local-buyer firms.

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