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# Does Inward Foreign Direct Investment Affect Productivity across Industries in Korea?

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This paper empirically examines whether and how inward foreign direct investment (FDI) affected industrial productivity in Korea during the 2000-2016 period, based on dynamic panel data of inflow FDI on an arrival basis from 427 manufacturing industries. The paper adds to the literature by analyzing whether both technology spillovers and industrial restructuring from inward FDI can differ according to industrial characteristics such as capital intensity, imported intermediate inputs, and tariffs. The empirical results show that the overall effects of inward FDI on total factor productivity (TFP) were statistically insignificant in general. However, the positive effects of inward FDI on productivity became statistically significant for industries with lower tariffs. Capital intensity were not involved in the relationship between inward FDI and productivity. Thus, the paper highlights that the results in previous studies with inward FDI on a notification basis were overestimated and inward FDI policies in Korea should focus on channels such as trade liberalization and the redistribution of production factors rather than capital accumulation.

*Keywords*: Foreign Direct Investment, Trade Openness, Total Factor Productivity

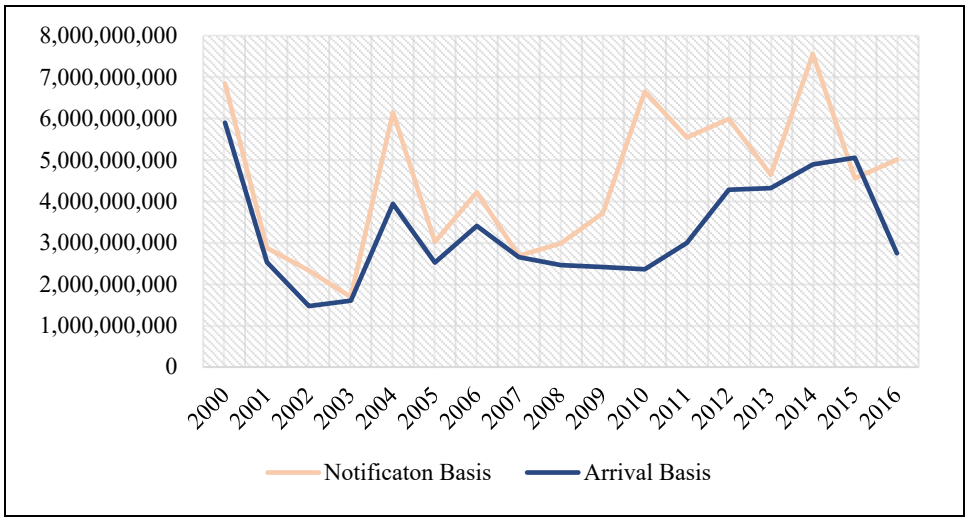
*JEL Classification*: F15, F21, F23

## I. Introduction

Foreign direct investment (FDI) refers to an investment that an entity in one country makes in a business in another country with the intention of entering foreign markets, utilizing production factors, joining in a technical tie-up, developing natural resources, etc. Korea has been eager to attract inward FDI to sustain economic growth since the initial stage of economic planning. In particular, the Korean government has aggressively eased investment regulations, thereby forming a favorable environment for inward FDI, since 2000 to overcome the financial crisis of the late 1990s. Figure 1 shows the trend of inward FDI in the Korean manufacturing industry during the 2000–

2016 period. Inward FDIs on both a notification basis and an arrival basis sharply decreased in the early 2000s due to the Asian financial crisis, the 9/11 attacks, and the burst of the worldwide tech bubble. However, coupled with the economic recovery, inward FDIs have been growing since the mid-2000s due to Korea's active inward FDI policies (Lee et al., 2015).

Figure 1. Trend of Inward FDI in Korean Manufacturing (USD)




Source: The Ministry of Trade, Industry and Energy of Korea

Consistent with Korea's intention, does inward FDI promote economic growth in Korea? If so, how does inward FDI affect productivity in Korea? For these questions, some studies have addressed spillovers from transferring technology and industrial restructuring through inward FDI and found the positive effects of inward FDI on productivity in Korea. However, other studies have indicated market stealing and negative crowd out by foreign competitors and showed the insignificant or negative effects of inward FDI on productivity in Korea. Combined with these two arguments, the absorptive capability of a host country is regarded as an important factor to determine the effects of inward FDI on productivity, which is embodied by technology level, human resources, relationship with investing firms, and factor movement. However, the majority of previous studies that analyzed the case of Korea dealt with the data for inward FDI on a notification basis, rather than an arrival basis, and did not

consider various characteristics of industries as a channel giving access to the advance technology transfer and restructuring from inward FDI.

Accordingly, this paper empirically examines whether and how inward FDI affected productivity in Korea using a panel data set at the 5-digit KSIC level for Korean manufacturing during the 2000–2016 period. The paper used data on inward FDI flows on an arrival basis and considered the Arellano-Bond estimator of a dynamic panel analysis in the regressions. Hence, the paper considered various industrial channels advancing technology transfer and restructuring from inward FDI in Korea and tried to attenuate the overestimation bias of the previous studies in two aspects of estimation techniques and data.

The rest of the paper is organized as follows. Section II builds on the theoretical background through a meticulous literature review. Section III reports econometric specifications, data sources, and summary statistics. Section IV presents the empirical results. Finally, Section V provides the conclusion and policy implications.

## II. Literature Review and Theoretical Background

### *1. Technology Transfer and Positive Spillovers*

In general, inward FDI is regarded as a critical factor in enhancing productivity in a host country by positive spillover from transferring technology to domestic firms (Harris and Robinson, 2002 and Lee, 2002). At the firm level, intra-firm technology transfer can occur when a multinational firm builds an affiliate in a host country. Inter-firm technology transfer also can occur when foreign-owned firms have dealings with domestic firms. In any case, industry-level productivity will increase through spillovers to other firms both within an industry and between industries (i.e., technological externalities). Within an industry, technology imitation, intense competition, and factor mobility lead to these positive effects, which is the intra-industry spillovers (Mansfield and Romeo, 1980; Blomström, 1986 and Fosfuri et al., 2001). Between industries, technology transfer through forward and backward linkages leads to these positive effects, which are the inter-industry spillovers (Lall, 1980 and Kim and Kang, 2012). In this case, supply and demand for intermediates between industries determine the strength of linkages and spillovers. Finally, in the long term a host country can obtain agglomeration effects by fostering skilled technical human resources and constructing infrastructures through both intra- and inter-spillovers (Harris and Robinson, 2002).

There are empirical studies supporting these arguments. For example, Lee (2002) showed that firms with higher foreign shares had greater improvement and spillovers of productivity in Korea between 1997 and 2000. Kim and Kang (2012) showed that inward FDI caused significant intra- and inter-industry spillover effects in Korea from 2000 to 2009. Youn (2003) found the same results from 1991 to 2000. Kim et al. (2009) estimated that inward FDI increased from 0.8% to 3.7% of the total GDP through intra- and inter-industry spillovers in Korea between 2000 and 2007. These phenomena were also found in the other countries, including Australia (Caves, 1974), Brazil (Bruhn and Calegario, 2014), Chile (Ramondo, 2009), the Czech Republic (Kosová, 2010 and Ayyagari and Kosová, 2010), Indonesia (Blomström and Sjöholm, 1999), Japan (Okubo, 2007), Lithuania (Javorcik, 2004), Mexico (Blomström and Persson, 1983), Venezuela (Aitken and Harrison, 1999), the United States (Branstetter, 2000), the United Kingdom (Haskel et al., 2007), and Vietnam (Hoang et al., 2010).

### *2. Market Stealing and Negative Crowding Out*

Several studies have shown that inward FDI does not contribute to productivity growth and even negatively affects productivity in the host country (Aitken and Harrison 1999; Harris and Robinson, 2002 and Lee, 2002). These studies argue that domestic firms should cut production because more efficient foreign firms rapidly make inroads into a domestic market. In other words, foreign firms crowd out domestic firms and, thus, aggregate productivity decreases in the process. Specifically, Blomström et al. (2000) addressed that market steeling effects are more prominent for smaller enterprises in developing countries because they are less productive and, thus, more likely to exit from FDI penetration.

Empirical studies have identified these phenomena. For example, Kim and Whang (1998) showed that inward FDI had statistically insignificant effects on productivity in Korea between 1970 and 1996. Kang (2005) also found no evidence of productivity improvement or spillovers of foreign ownership on domestic firms in Korea between 1997 and 2000. Choi et al. (2015) found insignificant effects of inward FDI on total sales but positive effects on exits of domestic firms in Korea from 2006 to 2013. The same results were also found in other countries, including Brazil (Bruhn and Calegario, 2014), the Czech Republic (Djankov and Hoekman, 2000 and Kosová, 2010), Europe (Cantwell, 1989), India (Kathuria, 2000), Morocco (Haddad and Harrison, 1993), and the United Kingdom (Harris and Robinson, 2002).

### *3. Absorptive Capacity*

Based on the discussion thus far, many studies have addressed that inward FDI's effects on productivity in a host country depend on the various characteristics of the investment, country, industry, and firm. These studies have focused on the absorptive capacity for foreign technology in the host country. Specifically, Germidis (1977) presented the efficiency in factor mobility, the availability of educated human resources, and levels of technology and R&D in the host country as significant absorptive capacities for transferring foreign technology and obtaining spillovers.

Empirical studies have supported these arguments. For example, in their examination by industry, Bruhn and Calegario (2014) found the coexistence of both positive and negative effects of inward FDI on productivity in Brazil, but the latter dominates in labor-intensive industries. Cantwell (1989) showed that high-tech industries obtained greater positive spillovers from inward FDI in Europe. Grög and Strobl (2001), Keller and Yeaple (2009), and Yunus and Masron (2020) found the same results in Ireland, the United States, and Malaysia, respectively. When considering the period, Kosová (2010) found evidence of both negative crowding out and positive technology spillovers, but the former persists only in the short term while the latter eventually occurs due to domestic demand creation effects.

Considering both home and host countries, the technological gap between them is important. Findlay (1978) constructed a theoretical model showing that, the wider the relative disparity in development levels is between countries, the more economic growth potential a developing country has from inward FDI. Blomström and Wolff (1989) showed that an initial technological gap between foreign and domestic firms promoted per capita production in Mexico. These studies address the diminishing marginal effects of inward FDI on productivity and present the positive relationship between technological gap and spillovers, which is the so-called catch-up hypothesis.

Conversely, Bruhn and Calegario (2014) argued that a minimum level of absorptive capacity in a host country is necessary for positive spillovers. Cantwell (1989) showed that a larger technological gap became a barrier to spillovers in Europe. These studies address that a host country with a low capacity will learn nothing from advanced technology and present the negative relationship between technological gap and spillovers, which is the so-called technology accumulation hypothesis.

Additional various factors have been identified as absorptive capacities, including the level of foreign shares (Chen, 1983 and Choi et al., 2015), types of FDI (Nocke

and Yeaple, 2007 and Kim and Kang, 2012), types of inter-industry linkage (Javorcik, 2004 and Kim and Kim, 2010), standardization (Kojima, 1977), R&D activities (Kathuria, 2000), and types of domestic firms (Aitken and Harrison, 1999; Keller and Yeaple, 2009; Blomström et al., 2000 and Choi et al., 2015).

### *4. Industrial Restructuring*

Recent studies have focused on the effects of inward FDI on industrial restructuring. Melitz (2003) developed a theoretical model presenting the intra-industry redistribution of firms in response to trade liberalization; according to this model, more productive firms benefit from an increase in exports whereas less productive firms come to exit a market due to tighter competition. Helpman et al. (2004) expanded Melitz's (2003) model with multinationals as well as exporters. In the process of inward FDI, some domestic firms will exit due to market stealing and/or be acquired by foreign firms. In any case, less productive domestic firms will be replaced by more productive foreign firms and production factors will be redistributed from inefficient to efficient units. Consequently, aggregate productivity at the industry level will increase through inward FDI. Empirical studies support this finding. For example, Kim (2007) empirically showed that regional economic integration induced the industrial relocation of participating countries through the increase in FDI. Choi et al. (2015) showed that foreign-invested firms prompted uncompetitive firms to exit and surviving firms to be more productive. Accordingly, inward FDI improved the overall productivity of the Korean economy through industrial restructuring between 2006 and 2013.

Meanwhile, Bernard et al. (2007) combined the endowment-based trade theory and Melitz's (2003) model to demonstrate that productivity growth is more prominent in comparative advantage industries than in comparative disadvantage industries in response to trade liberalization. The reason is that surviving firms' productivity growth is greater than productivity loss from firm exit for the former industries, but vice versa for the latter industries. Based on Helpman et al. (2004), Hyun and Jang (2015) expanded the model of Bernard et al. (2007) with multinationals and empirically showed that industrial restructuring by foreign investments was more prominent in comparative advantage industries in Korea between 1992 and 2008. All these theoretical frameworks provide the rationale behind the differential effects of inward FDI on productivity across industries.

In sum, I conclude that the effects of inward FDI on productivity can be positive through spillovers from transferring technology and industrial restructuring or negative through market stealing. The overall effects depend on absorptive capacities in the host country, which are specified by the technological level, relationships with parent firms, a degree of market openness, factor mobility, and so on.

Accordingly, this paper empirically examines how inward FDI affects productivity in Korea, specifically considering various characteristics of industries as proxies for absorptive capacity. Unlike previous studies, this paper deals with a manufacturing data set classified in detail at the 5-digit Korean Standard Industrial Classification (KSIC) code and the 6-digit Harmonized System (HS) code. Previous studies studying Korea considered just broad categories, like agriculture, mining, manufacturing, and service. With the detailed classification of manufacturing, this paper considers the various characteristics of industries as a medium for the change in productivity.

Second, this paper considers inward FDI on arrival basis, whereas previous studies did so on notification basis. According to Figure 1, inward FDI on notification basis was greater than that on arrival basis in Korean manufacturing from 2000 to 2016, except for 2015, and the gap was greatest in 2010. Thus, there is a possibility that the empirical findings on notification basis may be overestimated. Third, this paper considers the Arellano-Bond estimator, which is a very useful method among dynamic panel regressions for eliminating the estimation biases from endogeneity and autocorrelation. Hence, this paper attempts to attenuate the overestimation bias of the previous studies in two ways: estimation techniques and data.

## III. Econometric Specificaions and Data

### *1. Econometric Specifications*

Based on the meticulous literature review in Section II and given data, I specified four proxies, the technological level, relationships with parent countries, a degree of market openness, and inward FDI, which might affect productivity both directly and indirectly. Accordingly, equation (1) presents the basic regression model.

$$\ln TFP_{it} = \beta_0 + \beta_1 \ln FDI_{it} + \beta_2 \ln CPI_{it} + \beta_3 \ln IMI_{it} + \beta_4 \ln TRF_{it} + \delta_i + \tau_t + \epsilon_{it} \quad (1)$$

where *i* and *t* refer to industries and years, respectively. "ln" represents the natural logarithm of variables.

$TFP_{it}$ is total factor productivity. I calculate the TFP index from a log form of the Cobb-Douglas production function as follows:

$$\ln TFP_{it} = \ln PRD_{it} - \hat{\alpha}_1 \ln CPS_{it} - \hat{\alpha}_2 \ln EMP_{it} - \hat{\alpha}_3 \ln INP_{it} \qquad (2)$$

where $PRD_{it}$ is total outputs, $CPS_{it}$ is a capital stock, $EMP_{it}$ is a labor force, and $INP_{it}$ is an intermediate input. $\hat{\alpha}_1$, $\hat{\alpha}_2$, and $\hat{\alpha}_3$ represent coefficient estimates from the regression analysis of $CPS_{it}$, $EMP_{it}$, and $INP_{it}$ on $PRD_{it}$, respectively (see Table A1).[1] Accordingly, the TFP index is calculated by the difference between the actual and the predicted outputs, representing unobserved innate factors that contribute to total outputs besides capital, labor force, and intermediate inputs.

In (1), $FDI_{it}$, a key independent variable, is inward FDI flows. I added one to the original values of $FDI_{it}$ in considering the natural logarithm because some of them are zero. According to the previous studies, the sign of $\beta_1$ would be undetermined. In addition, I considered other independent variables that could affect productivity, as follows, from previous studies: $CPI_{it}$ represents a capital intensity as a proxy of the levels of technology and R&D (Kogut and Chang, 1991), $IMI_{it}$ represents an imported intermediate input as a proxy of the linkage between a parent and a host (Jang, 2020),[2] and $TRF_{it}$ represents import tariffs as a proxy of trade openness (Jang et al., 2015). I added one to the original values of $TRF_{it}$ in considering the natural logarithm because some of them are zero. As in the previous studies, I expected these independent variables to have a positive effect on productivity and, thus, $\beta_2$, $\beta_3$, and $\beta_4$ to be positive in the regression. $\delta_i$ and $\tau_t$ are dummies for industry and year, respectively. $\epsilon_{it}$ is the error term.

[1] I considered the Arellano-Bond estimator in estimating TFP to eliminate potential endogeneity and autocorrelation (see the next page for detail). Olley and Pakes (1996) and Levinsohn and Petrin (2003) also can be used to estimate TFP, which basically set up a two-stage analysis to eliminate sample section bias by firm entry and exit wih firm-level data. However, I focused on industrial characteristics and had no data on firm entry and exit for industry-level analysis in Korea.

[2] There is a possibility that intermediate inputs are imported from non-investors as well as investors and, thus, $IMI_{it}$ might be an inappropriate proxy for the linkage between a parent and a host. If dealing with data at country and industry combination, more accurate proxies will be developed.

Meanwhile, I added three interaction terms between inward FDI and other independent variables to the basic regression model to check if the effects of inward FDI on productivity depend on the characteristics of industry as follows:

$$\begin{aligned}\ln TFP_{it} = {} & \beta_0 + \beta_1 \ln FDI_{it} + \beta_2 \ln CPI_{it} + \beta_3 \ln IMI_{it} + \beta_4 \ln TRF_{it} \\ & + \beta_5(\ln FDI_{it} \times \ln CPI_{it}) + \beta_6(\ln FDI_{it} \times \ln IMI_{it}) \\ & + \beta_7(\ln FDI_{it} \times \ln TRF_{it}) + \delta_i + \tau_t + \epsilon_{it} \end{aligned} \quad (3)$$

In (3), if both $\beta_1$ and $\beta_5$ are positive, then the positive effects of inward FDI on productivity are more prominent when an industry has higher capital intensity. Accordingly, these results would imply that industries with higher capital intensity have greater absorptive capacity. Similarly, the positive signs of $\beta_1$ and $\beta_6$ would represent a more prominent contribution of inward FDI on productivity growth in an industry with greater imported intermediate inputs. These results would imply that industries with higher linkages to investors have greater absorptive capacity. If both $\beta_1$ and $\beta_6$ are positive, then inward FDI contributes to productivity growth more prominently in an industry with greater trade openness. These results would imply that industries with greater openness have greater industrial restructuring through inward FDI.

For an econometric method in estimating in (1)-(3), I considered the Arellano-Bond estimator, which is a generalized method of moments (GMM), to estimate the dynamic panel model. First, I performed the Davidson-Mackinnon test of exogeneity for the regressions in (1)–(3). All test results rejected the null hypotheses that independent variables are exogenous. For example, the *p*-value for $\ln EMP_{it}$ in the Davidson-Mackinnon test is 0.068, rejecting the null hypothesis at the 10% significance level. Second, I performed the Woodridge test for autocorrelation for the regressions in (1)–(3). All test results rejected the null hypotheses that there is no first-order autocorrelation. All these test results justify the consideration of the Arellano-Bond estimator. In the Arellano-Bond estimator, I performed two tests to check whether the instruments are valid—namely, the Arellano-Bond test for autocorrelation (AR test) and the Sagan test. The former tested whether lags are valid for the instruments whereas the latter checked for the overidentification problem.

## *2. Data Sources and Summary Statistics*

The data came from 427 Korean manufacturing industries between 2000 and 2016. Industries are classified by the 5-digit KSIC rev. 9. In (2), the capital stock is proxied by the annual balance of tangible assets, which consist of land, buildings, and machineries. The labor force is proxied by the total number of employees. The intermediate input is proxied by major production costs, which consist of expenses for raw materials, fuels, electric power, water, etc. In (1) and (3), capital intensity is calculated by the ratio of capital stock to labor force, representing the amount of capital needed per worker. The imported intermediate input is proxied by the amount of imports for toll processing. All data, except for inward FDI and tariffs, were drawn from the National Statistical Office of Korea. The monetary unit of all variables, except for employees, is a million Korean won.

The data for inward FDI were drawn from the Ministry of Trade, Industry and Energy of Korea. The monetary unit of inward FDI is the US dollar and, thus, the original value was transferred into Korean won based on the annual average Korean won–US dollar exchange rate. The import tariff was proxied by the simple average of effectively applied tariff rates drawn from the World Integrated Trade Solution (WITS) of the World Bank. As the import tariff was classified by the 6-digit HS code, I transferred it into the 5-digit KSIC rev. 9, using the product concordance provided by the National Statistical Office of Korea.

All variables with a monetary unit were transferred to real values by applying the Producer Price Index (PPI). The datasets for the exchange rate and the PPI were drawn from the Bank of Korea.

Tables 1 and 2 report the summary statistics of the variables and the coefficients of correlation between independent variables, respectively. The coefficients of correlation showed no symptoms of multicollinearity as they were less than the absolute value of 0.8.[3]

[3] I also estimated the variance inflation factor (VIF) among independent variables and confirmed that all values are between 1 and 2 (less than 10).

Table 1. Descriptive Statistics

| Variable | Obs. | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|---|
| $\ln TFP_{it}$ | 6,221 | 0.932 | 0.153 | 0.428 | 2.074 |
| $\ln LAP_{it}$ | 6,689 | 5.510 | 0.702 | 3.596 | 9.815 |
| $\ln FDI_{it}$ | 7,722 | 7.863 | 10.369 | 0 | 28.397 |
| $\ln CPI_{it}$ | 6,689 | 4.490 | 0.795 | 0.906 | 8.047 |
| $\ln IMI_{it}$ | 6,131 | 13.898 | 1.993 | 4.480 | 19.980 |
| $\ln TRF_{it}$ | 7,686 | 1.896 | 0.905 | 0 | 6.242 |

Table 2. Coefficient of Correlation between Independent Variables

| | $\ln FDI_{it}$ | $\ln CPI_{it}$ | $\ln IMI_{it}$ | $\ln TRF_{it}$ |
|---|---|---|---|---|
| $\ln FDI_{it}$ | 1 | | | |
| $\ln CPI_{it}$ | 0.078 | 1 | | |
| $\ln IMI_{it}$ | 0.199 | 0.007 | 1 | |
| $\ln TRF_{it}$ | -0.085 | -0.127 | -0.174 | 1 |

# IV. Empirical Results

## *1. Main Results*

Table 3 reports the regression results of the Arellano-Bond estimator for (1). Columns (1) and (2) are the empirical results for equation (1), while column (3) is those for equation (3) with interaction terms. I considered only the dependent variable of one-year lag and inward FDI as the independent variable in column (1) to acquire as many observations as possible. In columns (2) and (3), I considered all independent variables, but some observations were lost due to missing values. In all columns, the AR tests and the Sargan test show that instruments starting at times t-2 are jointly valid and, thus, the regressions are correctly specified.

All columns in Table 3 show that the coefficient estimates of inward FDI are statistically insignificant, implying that inward FDI did not significantly affect industrial productivities in Korea from 2000 to 2016. For Korea, this result is inconsistent with the results of Youn (2003), Kim et al. (2009), and Kim and Kang (2012), who used

inward FDI on notification basis and the input–output analysis across industries, but consistent with the results of Kim and Whang (1998), Kang (2005), and Choi et al. (2015), who used regression analyses. These results show that the previous analyses based on notification basis of inward FDI were overestimated and the spillover effects of inward FDI may exist between industries, but not within an industry in Korea. The results are somewhat consistent with those of Harris and Robinson (2002), who found that inter-industry spillovers are more prevalent than intra-industry spillovers from inward FDI in UK manufacturing.

As expected, other independent variables, except for the degree of capital intensity, significantly affected TFP. TFP in previous years and imported input intermediates positively affected TFP in current years as showed statistical significance. In addition, the coefficients estimate of tariff rates in columns (2) and (3) is negative and statistically significant at the 1% level, implying that trade openness contributed to TFP growth.[4] This result is consistent with Kim et al. (2011), Bae et al. (2012), Jang et al. (2015), and Jang (2020) for Korea. However, the coefficient estimates of $\ln CPI_{it}$ are statistically insignificant.

The efficient estimates of the interaction between inward FDI and tariff rate are negative and statistically significant at the 5% level in column (3). These results imply that the effects of inward FDI on productivities are insignificant but the positive effects are more prominent in industries with greater openness, which is consistent with Lesher and Miroudot (2008).

Based on the previous studies, there are two rationales behind this phenomenon. First, industries with greater openness would have greater absorptive capacities for transferring foreign technology and obtaining spillovers. Previous studies found that openness and absorptive capacity complement each other for achieving innovation (Yang and Lin, 2012 and Sun et al., 2015). Second, as in Bernard et al. (2007) and Hyun and Jang (2015), industries with greater openness are more likely to have the ability to move factors of production. Accordingly, inward FDI would be more likely to increase aggregate productivity through industrial restructuring in these industries.

The coefficient estimates of interaction term between inward FDI and capital intensity are statistically insignificant. These results imply that the degree of capital intensity was not a significant medium that transmits the effects of inward FDI on

[4] The negative signs of tariff rates imply that a decrease in tariff rates induced greater TFP. Meanwhile, the lower tariff rates represent the greater openness.

productivities in Korea. The same is true when considering the interaction term between inward FDI and imported intermediate inputs.

Consequently, the results in Table 3 imply that capital accumulation specified by capital intensity and foreign investment did not significantly affect TFP in Korea between 2000 and 2016. Instead, the factors in international trade such as imported intermediate inputs and tariffs were significant for TFP growth. In particular, industries with lower tariff rates were more likely to increase productivity through inward FDI by fostering absorptive capacity and industrial restructuring.

Table 3. Main Regression Results

| | Col.(1) | Col.(2) | Col.(3) |
|---|---|---|---|
| $\ln TFP_{it-1}$ | **0.1533**$^{***}$<br>**(0.020)** | **0.2310**$^{***}$<br>**(0.025)** | **0.2313**$^{***}$<br>**(0.025)** |
| $\ln FDI_{it}$ | -0.0002<br>(0.000) | -0.0002<br>(0.000) | -0.0016<br>(0.001) |
| $\ln CPI_{it}$ | | 0.0096<br>(0.007) | 0.0088<br>(0.007) |
| $\ln IMI_{it}$ | | **0.0028**$^{**}$<br>**(0.001)** | **0.0023**$^{*}$<br>**(0.001)** |
| $\ln TRF_{it}$ | | **-0.0162**$^{***}$<br>**(0.006)** | **-0.0147**$^{**}$<br>**(0.006)** |
| $\ln FDI_{it} \times \ln CPI_{it}$ | | | 0.0002<br>(0.000) |
| $\ln FDI_{it} \times \ln IMI_{it}$ | | | 0.0001<br>(0.000) |
| $\ln FDI_{it} \times \ln TRF_{it}$ | | | **-0.0003**$^{**}$<br>**(0.000)** |
| Arellano-Bond test for AR(1) | -8.74$^{***}$ | -7.20$^{***}$ | -7.23$^{***}$ |
| Arellano-Bond test for AR(2) | 0.55 | 0.82 | 0.82 |
| Sargan Test | 256.66$^{***}$ | 260.47$^{***}$ | 264.47$^{***}$ |
| Number of Groups | 426 | 414 | 414 |
| Number of Instruments | 92 | 87 | 90 |
| Number of Observations | 5,337 | 3,983 | 3,983 |

Notes: Figures in parentheses are standard errors. All regressions control for year fixed effects. *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.

### *2. Robustness Check*

For robustness check, I performed three alternative estimations. The first two ones deal with alternative estimates of productivity, while the third one deals with those of inward FDI.

First, according to Kasahara and Rodrigue (2008) and Ahn and Choi (2020), it would be significant to consider imported intermediate inputs as one of independent variables in (2) for estimating TFP. The rationale comes from the nature of Korea's open economy: Korean manufacturing industries are highly open for international trade with great global value chain (GVC) participation. Korea usually imports resources and intermediate inputs, produce high value-added products, and exports them. In this process, the aggregate output in Korea will increase by the intensity of imported intermediate inputs (Jang and Cho, 2015).

Accordingly, I recalculated TFP from the production function with imported intermediate inputs (see Table A2 in Appendix) and then estimated (1) and (3) again. In this case, imported intermediate inputs were excluded in (1) and (3). Columns (1) and (2) of Table 4 report the results. They show that the results in Table 3 still remain true, except for capital intensity: the effects of inward FDI on productivities were insignificant but its positive effects were more prominent in industries with greater openness; and both capital intensity and TFP in previous years increased TFP in current years.

Second, I replaced TFP with labor productivity (LAP) which is also considered as a typical proxy for productivity. The LAP index is calculated as value added divided by employments, representing per capita value added. Columns (3) and (4) of Table 4 report the results. In this case, the results of inward FDI were a little bit different from those in Table 3 and columns (1) and (2) of Table 4. The coefficient estimates of inward FDI became statistically significant with positive signs in column (4) of Table 4, implying that inward FDI increased industrial labor productivity. Capital intensity increased labor productivity, which is consistent with columns (1) and (2) in Table 4. However, imported intermediate inputs and tariff rates did not significantly affect labor productivity.

The coefficient estimates of the interaction between inward FDI and imported intermediate inputs are negative and statistically significant at the 1% level in column (4) of Table 4. This result implies that the effects of inward FDI on labor productivity were less prominent in industries with greater imported intermediate inputs. This is

somewhat unexpected because I hypothesized that an imported intermediate input is a proxy for the linkage between home and host units. Meanwhile, Kim et al. (2011) addressed that imported intermediate inputs could substitute for skilled workers in a process of trade liberalization. Hence, it will be empirically testable whether industries with greater imported intermediate inputs would have fewer skilled workers and, thus, induce lower absorptive capacities for foreign technology in attracting inward FDI.

Table 4. Robustness Check: Other Types of Productivities

| Variable | TFP with Imported Intermediate Inputs | | Labor Productivity | |
|---|---|---|---|---|
| | Col.(1) | Col.(2) | Col.(3) | Col.(4) |
| $\ln Y_{it-1}$ | **0.2369**$^{***}$ **(0.025)** | **0.2358**$^{***}$ **(0.025)** | **0.2235**$^{***}$ **(0.023)** | **0.2294**$^{***}$ **(0.023)** |
| $\ln FDI_{it}$ | -0.0001 (0.000) | -0.0005 (0.001) | 0.0003 (0.000) | **0.0057**$^{**}$ **(0.002)** |
| $\ln CPI_{it}$ | **0.0176**$^{**}$ **(0.007)** | **0.0169**$^{**}$ **(0.007)** | **0.2968**$^{***}$ **(0.017)** | **0.2965**$^{***}$ **(0.018)** |
| $\ln IMI_{it}$ | | | 0.0001 (0.003) | 0.0022 (0.003) |
| $\ln TRF_{it}$ | **-0.0153**$^{**}$ **(0.006)** | **-0.0139**$^{**}$ **(0.007)** | -0.0032 (0.017) | 0.0011 (0.017) |
| $\ln FDI_{it} \times \ln CPI_{it}$ | | 0.0002 (0.000) | | 0.0001 (0.000) |
| $\ln FDI_{it} \times \ln IMI_{it}$ | | | | **-0.0003**$^{***}$ **(0.000)** |
| $\ln FDI_{it} \times \ln TRF_{it}$ | | **-0.0003**$^{***}$ **(0.000)** | | **-0.0011**$^{**}$ **(0.000)** |
| Arellano-Bond test for AR(1) | -7.16$^{***}$ | -7.17$^{***}$ | -4.59$^{***}$ | -7.35$^{***}$ |
| Arellano-Bond test for AR(2) | 0.73 | 0.73 | 0.89 | 0.42 |
| Sargan Test | 263.58$^{***}$ | 267.11$^{***}$ | 141.29$^{***}$ | 270.20$^{***}$ |
| Number of Groups | 414 | 414 | 427 | 414 |
| Number of Instruments | 86 | 88 | 54 | 88 |
| Number of Observations | 3,983 | 3,983 | 4,510 | 3,984 |

Notes: $\ln Y_{it-1}$ is $\ln TFP_{it-1}$ in columns (1) and (2), but $\ln LAP_{it-1}$ in columns (3) and (4). Figures in parentheses are standard errors. All regressions control for year fixed effects. *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.

For one thing, the coefficient estimates of the interaction term between inward FDI and tariff were negative and statistically significant in column (4) of Table 4, which are consistent with those in column (2) of Table 4 and column (3) of Table 3. Hence, the fact that the positive effects of inward FDI on productivity were more prominent in industries with greater openness still remain true irrespective of how productivity is proxied.

Table 5. Robustness Check: Inward FDI Stock

| Variable | Col.(1) | Col.(2) |
|---|---|---|
| $\ln TFP_{it-1}$ | **0.2318*** (0.025)** | **0.2306*** (0.025)** |
| $\ln FDI_{it}$ | **-0.0002** (0.000)** | -0.0002 (0.001) |
| $\ln CPI_{it}$ | 0.0099 (0.007) | 0.0099 (0.007) |
| $\ln IMI_{it}$ | **0.0028** (0.001)** | **0.0028** (0.001)** |
| $\ln TRF_{it}$ | **-0.0162*** (0.006)** | **-0.0143** (0.006)** |
| $\ln FDI_{it} \times \ln CPI_{it}$ | | 0.0001 (0.000) |
| $\ln FDI_{it} \times \ln IMI_{it}$ | | 0.0000 (0.000) |
| $\ln FDI_{it} \times \ln TRF_{it}$ | | **-0.0003*** (0.000)** |
| Arellano-Bond test for AR(1) | -7.20*** | -7.17*** |
| Arellano-Bond test for AR(2) | 0.82 | 0.73 |
| Sargan Test | 260.49*** | 267.11*** |
| Number of Groups | 414 | 414 |
| Number of Instruments | 86 | 88 |
| Number of Observations | 3,983 | 3,983 |

Notes: Figures in parentheses are standard errors. All regressions control for year fixed effects. *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.

Third, I considered inward FDI as stock instead of flow to check whether accumulation, not increments of investments, can have any significant import on productivity. Table 5 shows that the results with inward FDI stock are mostly consistent with those in Table 3. It is shown that the effects of inward FDI were statistically insignificant in column (2) and even significantly negative in column (1)

when excluding interaction terms. Like the results in Table 3, imported intermediate inputs and tariff rates significantly affected TFP, while the coefficient estimates of capital intensity were statistically insignificant. Most importantly, column (2) reports that the coefficient estimates of the interaction term between inward FDI and tariffs are negative and statistically significant. Hence, the fact that the positive effects of inward FDI on productivity were more prominent in industries with greater openness still remain true irrespective of how inward FDI is proxied.

## V. Conclusion and Policy Implication

Previous studies have explored whether inward FDI is one of the significant momentums for economic growth. Some have addressed positive spillovers from transferring technology and industrial restructuring through inward FDI whereas others indicated market stealing and negative crowd out by foreign competitors. By synthesis, absorptive capability of a host country is regarded as an important factor to determine the effects of inward FDI on productivity. The previous studies have presented technology level, human resources, relationship with investors, and factor movement in the host country as typical examples of absorptive capability. Accordingly, this paper empirically examined whether and how inward FDI affected productivity in Korea, using the panel data set at the 5-digit KSIC level for Korean manufacturing during the 2000–2016 period. The data on inward FDI flows in the regressions focus on arrival basis, not notification basis. After performing meticulous literature review, I proposed three explanatory variables in the econometric specifications, capital intensity, imported intermediate inputs, and tariffs, as well as inward FDI, which might affect productivity both directly and indirectly.

The regression results from the Arellano-Bond estimator showed that the effects of inward FDI on TFP were statistically insignificant in general. However, for the interaction terms between inward FDI with other explanatory variables, first, the paper found that the positive effects of inward FDI on productivity became statistically significant for industries with lower tariffs (i.e., greater openness) irrespective of how productivity or inward FDI was measured. The rationale behind these results is that industries with greater openness not only have greater absorptive capability for foreign technology, but are more likely to attain industrial restructuring via inward FDI. Second, capital intensity of industries was consistently not involved in the relationship between inward FDI and productivity irrespective of how productivity or inward FDI

was measured. Meanwhile, the effects of capital intensity, imported intermediate inputs, tariffs, and the interaction between inward FDI and imported intermediate inputs on productivity mainly depend on how productivity was measured.

The results presented in this paper imply that the inward FDI attraction should be combined with open-economy policies, such as a free trade agreement (FTA), to materialize technology and knowledge spillovers and industrial restructuring from inward FDI. Korea's FTAs have encouraged market competition, reduced inefficiencies, and induced innovations (Bae et al., 2012). In such an economic environment, inward FDI will be more likely to transfer advanced technology to innovative firms and go through intense restructuring by ousting or acquiring inefficiency firms. Also, this paper empirically demonstrated that capital stock is no longer a channel that gives access to advance technology transfer and restructuring from inward FDI in Korea, which is different from developing countries (Hoang et al., 2010). Accordingly, for Korea, a developed country, the inward FDI policy should focus on other channels, such as trade liberalization, GVC participation, and the redistribution of production factors, rather than capital accumulation.

The paper has several limitations in its econometric specifications as follows. First, as mention in footnote 1, Olley and Pakes (1996) or Levinsohn and Petrin (2003) will be an alternative method to estimate TFP. However, this paper did not consider them due to data limitation. Second, as mentioned in footnote 2, $IMI_{it}$ might be an inappropriate proxy for the linkage between a parent and a host. This might explain the reason why the signs of the interaction term between inward FDI and imported intermediate inputs were unexpected in the regressions. Third, if data at country and industry combination is available, then a more standardized empirical model such as the Knowledge-Capital model can be applicable for the analysis. Fourth, it is necessary to empirically determine whether imported intermediate inputs replace skilled human resources. If so, this would be one of the disadvantages of participating in GVC, especially for economic growth by inward FDI attraction, and thus supplementary measures should be prepared (Kim, 2016). Finally, other factors such as labor market regulation can be explored as another source of absorptive capacity to explain insignificant effect of FDI on TFP or labor productivity. However, the paper did not directly consider them due to data limitation. I reserve these all research questions for future studies.

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# APPENDIX

Table A1. Regression Results of Production Function

| Variable | Coefficient |
|---|---|
| $\ln PRD_{it-1}$ | 0.025***<br>(0.003) |
| $\ln CPS_{it}$ | 0.038***<br>(0.004) |
| $\ln EMP_{it}$ | 0.203***<br>(0.007) |
| $\ln INP_{it}$ | 0.782***<br>(0.004) |
| Arellano-Bond test for AR(1) | -8.36*** |
| Arellano-Bond test for AR(2) | -1.63 |
| Sargan Test | 416.11*** |
| Number of Groups | 427 |
| Number of Instruments | 122 |
| Number of Observations | 5,775 |

Notes: Figures in parentheses are standard errors. All regressions control for year fixed effects. *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.

Table A2. Regression Results of Production Function: Including Imported Intermediate Inputs

| Variable | Coefficient |
|---|---|
| $\ln PRD_{it-1}$ | 0.023<br>(0.003) |
| $\ln CPS_{it}$ | 0.027**<br>(0.011) |
| $\ln EMP_{it}$ | 0.203***<br>(0.022) |
| $\ln INP_{it}$ | 0.798***<br>(0.019) |
| $\ln IMI_{it}$ | -0.002<br>(0.005) |
| Arellano-Bond test for AR(1) | -6.92*** |
| Arellano-Bond test for AR(2) | -1.63 |
| Sargan Test | 235.15*** |
| Number of Groups | 410 |
| Number of Instruments | 109 |
| Number of Observations | 4,994 |

Notes: Figures in parentheses are standard errors. All regressions control for year fixed effects. *, **, and *** represent significance at the 1%, 5%, and 10% levels, respectively.