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TECHNOLOGICAL GAP AND FOREIGN DIRECT INVESTMENT SPILLOVERS IN INDONESIA

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Abstract

This study investigates the relationship between the technology gap and Foreign Direct Investment (FDI) spillovers in Indonesia. This study employs Medium-Large Manufacturing Survey Data from Statistics Indonesia and employs the standard least-square method to estimate the correlation between the technological gap and industries' productivity change between 2010 and 2015. This study groups industries based on their technological gap (i.e. the difference between domestic and foreign establishment productivity) into low-technology-gap, medium-technology-gap, and high-technology gap. This study reveals that the effect of the technological gap is higher in the moderate-technology-gap group of industries and that there is a statistically significant positive relationship in the low-technology-gap and high-technology-gap groups. This finding indicates that the technological gap matters for FDI spillovers in Indonesia's manufacturing and it can explain why there is spillovers from FDI in several industries. This study also reveals that industries with higher level of technological gap tend to have higher variation in productivity change, thus it can explain the difference between industries absorptive capacity. Therefore, promoting FDI inflows in the country also fosters domestic firms' productivity growth especially FDI with relatively higher technology than domestic firms. These findings also recommend that the government support domestic firms' absorptive capacity after promoting FDI inflow into the country.

Keywords: *foreign direct investment, technological gap, productivity, spillovers*

JEL Classification: E22; F21; F23; O33

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INTRODUCTION

When it comes to economic issues, the basic question is "what and how much to produce, how to produce, and for whom to produce". Yet, the answers have never been simple. In this sense, developing countries, in general, have agreed that attracting inward foreign direct investment (FDI) has an all-in-one package to address problems. FDI that usually comes from more advanced economies will not only provide developing economies with enough capital, but also with the knowledge of how to allocate resources more productively. FDI is viewed far more positively now than it was 50 years ago, both globally and domestically (Lindblad, 2015).

FDI brings not only additional capital but also the knowledge of how to allocate resources more productively for domestic entities. The direct effect of foreign direct investment is certain; it increases a country's capital stock and the marginal productivity of other resources that are already available in the host country (e.g., labour, land and natural resources). As for the indirect effect of FDI, it is the knowledge spillovers which is the knowledge about productive activities transferred to the host economy and added to the local knowledge. Concerning the indirect effect that can amplify FDI's positive impact, the discussions of knowledge spillovers caused by FDI have been widely prolific in the economic literature, including in Indonesia (Suyanto, Bloch and Salim, 2012; Suyanto, Salim and Bloch, 2014).

FDI plays a significant role in Indonesia as a source of financing and improving the country's productivity by promoting a better resource allocation. Having a huge number of natural resources and a productive population, Indonesia will potentially become an attractive destination for foreign investors to generate returns from its capital. Indonesia can be an interesting country as it offers foreign enterprises a cheap factor of production and also a huge market to create promising higher returns from their investment (Dunning, 1973). In this sense, FDI is beneficial for Indonesia as productivity increases through the efficient improvement of resource allocation and knowledge spillovers.

Realising the vast benefits of foreign investment, the Indonesian government has been attracting more FDI into the country since the 1960s. FDI can be attracted by improving the country's business environment and offering a more liberalised environment. Under the current administration in Indonesia, there are many attempts to improve the country's business environment to attract more FDI to the country. These attempts have yielded vigorous results moving Indonesia from the 114th place in 2015 to the 73rd in 2020 in the Ease of Doing Business (EoDB) index (World Bank Group, 2014, 2020). More than that, the government has proposed major law reforms (i.e., concerning the omnibus bill) to amend

several bills that cause many uncertainties which discourage investors from promoting more investment.

While the direct impact of FDI, better resource allocation through improving the use of natural resources and workers, has become relatively certain, other features like knowledge spillovers are still highly discussed in the literature (Crespo and Fontoura, 2007). This feature of FDI should be expected by the host country as it can generate higher productivity from the country's existing domestic capital to promote a faster whole country productivity growth and a smooth movement along its development path (Fan, 2002; Gopalan, Hattari and Rajan 2016). Although FDI spillovers in Indonesia have already been discussed in the extant literature (Suyanto et al., 2012, 2014; Todo and Miyamoto, 2006), the individual channels through which such spillovers occur have not been examined yet.

Knowledge spillovers do not automatically occur whenever there is a foreign-owned entity in the country. Rather, various factors play a part in the occurrence of spillovers. For example, Blake, Deng and Falvey (2009) documented several channels of knowledge spillovers resulting from FDI which are: labour mobility, vertical input-output linkages, global market access as well as the horizontal effects of demonstration, competition and resource reallocation. Previous studies have shown that not all firms or industries have benefited from the presence of foreign-owned firms in the same way (Chuang and Hsu, 2004; Liu et al., 2000; Suyanto et al., 2012, 2014). In order to explain the mixed results in the literature, it is important to take into account the individual channels through which spillovers resulting from FDI occur (Smeets, 2008).

In continuation of the previous research efforts regarding FDI spillovers in Indonesia, this study aims to provide an empirical study of the relation between the technological gap and the rate of productivity growth using the case of Indonesian manufacturing. This case is interesting because Indonesia is keen on encouraging investment, especially FDI, so that foreign investments, along with domestic ones, can fuel the country's economic growth. Previous studies have presented empirical evidence of FDI spillovers in Indonesian manufacturing (Suyanto et al., 2012, 2014) and have demonstrated that not all industries have benefited from these spillovers. Hence, this paper uses a survey obtained from Statistics Indonesia covering two different time periods of medium-large manufacturing establishments to estimate the correlation between the gap in initial time and the rate of productivity growth. This will help in further explaining FDI spillovers in Indonesian manufacturing. The correlation is estimated using the Ordinary Least Square (OLS) estimation employing industry level variation

at the 5-digit International Standard Industrial Classification (ISIC).

The rest of the paper is organised as follows. Section 2 discusses the technological gap, absorptive capacity, and spillovers. Section 3 explains the data and methodology and Section 4 presents the main result. Finally, the conclusion and proposed policy are delivered in Section 5.

THE TECHNOLOGY GAP, ABSORPTIVE CAPACITY AND SPILLOVERS

A notable channel of knowledge spillovers is the horizontal effects of demonstration and imitation that depend on absorptive capacity and domestic firms' technological gap. Narula and Marin (2005) define this process as the ability of domestic firms to internalise the knowledge created by others and modify it to fit their own applications, processes and routines. Crespo and Fontoura (2007) noted that the gap between foreign and domestic firms should not be too wide or too little in order to make this process work. Accordingly, domestic firms' productivity should grow faster if the gap is moderate. Crespo and Fontoura's (2007) finding was supported by previous studies that showed different effects of FDI spillovers in different industries with different levels of the technological gap (Ben Hamida and Gugler, 2009; Imbriani et al., 2014; Kokko, Tansini and Zejan, 1996; Lai, Wang and Zhu, 2009; Suyanto et al., 2012, 2014).

The technological gap between foreign and domestic entities should be expected when a country allows the inflow of FDI because foreign entities may bring technological advancement from their parent companies abroad. Foreign firms are likely to transfer part of their technological advancement to the host country in order to compete with more informed domestic firms (Crespo and Fontoura, 2007; Girma and Görg, 2007). The higher cost associated with foreign investment is also a factor that makes foreign firms need higher productivity to reap higher returns from their investment since the main reason for international production is achieving higher returns (Dunning, 1973).

Previous studies have investigated the issues of FDI spillovers in Indonesia (Suyanto et al., 2012, 2014). These studies have shown the difference in the impact of spillovers in different industries with different firm sizes. They have revealed that, for example, firms in the garment industry (ISIC 3221) have benefited from foreign presence while those in electronics industries have not (ISIC 3832). Other findings have demonstrated that while low-efficiency domestic firms benefited from the foreign presence, high-efficiency ones have not. These results suggest that not all firms or industries are able to benefit from FDI in the same way and one possible reason is the difference of the technological gap from one industry to another.

There are two theoretical arguments about how large the technological gap should be to cause spillovers (Imbriani et al., 2014). According to the first, if the gap is large, then domestic firms have a greater scope for technological accumulation. According to the second, if the gap is too large, then domestic firms will not be able to follow. Several authors believe that if the gap is too wide, it will impede domestic firms from absorbing from foreign-owned firms (Crespo and Fontoura, 2007). Previous studies supporting these arguments have shown that a moderate gap can cause FDI spillovers (Ben Hamida and Gugler, 2009; Imbriani et al., 2014; Kokko et al., 1996; Lai et al., 2009). Other studies have stressed that the FDI spillover effect is larger within low-technology-gap groups compared to high-technology-gap groups (Chuang and Hsu, 2004).

The technological gap is an important fuel for FDI spillovers, but : but the occurrence of these spillovers also depends on the domestic capacity to internalise the gap (Kinoshita, 2001; Lapan and Bardhan, 1973; Perez, 1997; Wang and Blomström, 1992). In this sense, the technological gap is necessary but not sufficient. Domestic entities' absorptive capacity is a factor that cannot be ignored when regarding FDI spillovers stemming from the technological gap. The presence of the technological gap is only an option for domestic firms to internalise the gap and improve their productivity but this depends on whether or not the domestic firms want to learn and bear any associated time, cost and risk from this learning. Even in developed countries, as Liu et al. (2000) show, technological spillovers depend on local firms' technological capabilities. The presence of an infrastructure to support domestic firms' learning process is also an important factor to support FDI spillovers (Fu, 2008).

The process of domestic firms' internalisation of the technological gap cannot be expected to be obvious within a short time period since these firms need time for research and development (R&D) before adopting any new production method or new organisational flow. Even after they have gained the knowledge to use the new technology, they might have to use the older technology or machines because of the fixed cost associated with using them. Therefore, the presence of the technological gap stemming from FDI inflows first translates into the increase of R&D activities before it can generate spillovers in domestic firms. Previous studies have highlighted that FDI inflows in developing Asian countries are linked with the increase of R&D activities in such countries (Erdal and Göçer, 2015).

Kokko et al. (1996) conducted a study on a productivity spillover from FDI using a case from the Uruguayan manufacturing sector and they found a positive and statistically significant effect only in local

firms with moderate technology gaps. They measured technological gaps for each four-digit ISIC and separate industries with low- and high- technological gaps. The study depended on the value-added per labour to measure firm productivity and employed the standard linear regression to estimate the spillovers effect in low- and high-technology groups.

Chuang and Hsu (2004) also found different spillovers effects between low-technology-gap and high-technology-gap industries using the Third Industrial Census Data of China. This study employed a linear regression technique using output per labour as a productivity indicator and the finding was that, in low-technology-gap firms, the FDI spillovers effect was stronger. This implies that the technology spillover effect of FDI is positively correlated with domestic firms' capability level.

For Ben Hamida and Gugler (2009), local firms that are not far behind the industry technological frontier have greater demonstration-related spillovers from FDI. This study was based on Swiss manufacturing and services/construction firm level data. The study employed the production function to estimate the effect of FDI spillovers and technological gap for each firm. They measured the productivity gap by the ratio of each local firm labour productivity compared to the average of all foreign-owned firms.

Lai et al. (2009) supported the above-mentioned study and the theoretical arguments related to the technological gap by showing a non-linear relationship between the technological gap and spillovers. This study used data from China's industrial sector during the period (1993-2006) and employed a multiple-threshold model to estimate the non-linear relationship. The estimated thresholds indicate that the sufficient absorptive capability is the premise for FDI technology spillovers.

Imbriani et al. (2014) revealed the significance of the technological gap when regarding FDI spillovers. They used data from the Italian manufacturing sector and employed the standard production function model to estimate FDI spillovers in the presence of the technological gap. The study measured the technological gap deploying the same technique used by Ben Hamida and Gugler (2009), which is comparing each firm's productivity to the average of foreign-owned firms productivity.

Like the previous arguments and empirical studies on how the technological gap can act as a fuel for FDI spillovers, this study hypothesises that Indonesia's manufacturing technological gap is an important factor for the occurrence of FDI spillovers.

METHOD

Data

The data for this study are the annual surveys of medium and large manufacturing establishments (*Survey Tahunan Statistik Industri* or SI) conducted by Statistics Indonesia (Badan Pusat Statistik or BPS). These annual surveys cover a wide range of information from each surveyed establishment. The basic information includes industrial classification and ownership status. Other information provided are related to production like value-added and the number of workers.

The annual surveys have been conducted since 1975 and the most recent available data relate to the year 2015. However, this study uses only two different years: 2010 and 2015. The year 2010 is chosen as a starting year since it was the year when the newest classification started (or was introduced) and continued until 2015. These two data points produce five-year change in productivity indicators. A period of five years is relatively enough to observe some adjustment and changes of domestic firms' productivity on average.

The researcher had to drop several observations because not every observation had the complete set of data needed for estimation. First, in building the industrial level data, the researcher dropped every establishment with no 5-digit industrial classification information, no value of value added, and no value of total workers. After building industrial level data, the researcher also dropped several observations with no foreign establishment within the industry classification and with no complete observations in years 2010 and 2015. Moreover, industries with a negative productivity gap were dropped (i.e., industries where domestic firms' average productivity is higher than foreign-owned firms' average productivity).

Table 1. Variables Descriptive Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
$\Delta prod_l^d$	235	0.865	0.937	-1.637	4.507
$\Delta prod_l$	235	0.633	0.932	-3.005	3.574
Gap_{lt10}	235	0.920	0.880	0	7.838

Source: data processed by author, 2023

This study covered 235 different 5-digit ISIC in total that has non-missing values in 2010 and 2015 for the study's observations. The results show that, on average, domestic establishments' productivity change during this time is positive and that the average of domestic establishments' productivity indicator increases more than the overall establishments' productivity indicator does. The technological gap, as the variable of interest in this study, is positive on average as expected which enables it to fuel establishments' productivity improvement.

Estimation Strategy

To estimate the correlation between the technological gap and the rate of productivity growth, this research employs the ordinary least square (OLS) technique at

5-digit industrial classification variance. This level of variation was selected for this study because it is the most detailed version of industrial classification available in the survey. By using the most detailed industrial classification, the same production function for the identical product can be obtained. This level of variation is produced by calculating the average of all establishments within each industrial classification. The calculation process is presented as follows:

The Productivity Indicator

The firms and industries' productivity indicator used in this paper is the value-added per worker or labour productivity indicator that was used by Kokko et al. (1996).

$$PROD_{it} = \frac{ValueAdded_{it}}{TotalWorker_{it}} \quad (1)$$

$$PROD_{lt} = \sum_{i=1}^{l} \frac{PROD_i}{l} \quad (2)$$

where *i* denotes the firm, *t* denotes time and l denotes industrial classifications at 5-digit ISIC.

The Technological Gap

The technological gap is measured by the difference between the average productivity of domestic and foreign establishments for each industrial classification. This calculation is relatively the same that previous studies presented (Ben Hamida and Gugler, 2009; Imbriani et al., 2014; Kokko et al., 1996).

$$Gap_{lt10} = Ln\left(PROD_{lt}^{f}\right) - Ln\left(PROD_{lt}^{d}\right) \quad (3)$$

where $PROD_{lt}^{f}$ and l respectively stand for foreign establishments and domestic establishments.

After measuring every indicator, the researcher calculated the change in productivity for domestic establishments and all establishments. This change was calculated by differentiating the natural logarithm values in 2015 and 2010. The researcher used a five-year difference because it allows for the FDI spillovers process, which includes domestic establishments learning and adapting with the aim of internalising the gap. The researcher controlled other factors that determine domestic firms' productivity change by using all establishments' average productivity change.

$$\Delta prod_l = f(X_i) \quad \text{and} \quad \Delta prod_l^d = f(X_i) + f(Gap) \quad (4)$$

where X_i is i numbers of variables affecting all firms' productivity change.

After obtaining all the indicators, the researcher used the standard OLS method to estimate the correlation between the technological gap at the initial year and the rate of productivity growth for low-technology-gap, medium-technology-gap and high-technology-gap groups of industries. The industries are divided into these three groups based on tercile. The regression equation is as follows:

$$\Delta prod_l^d = \alpha + \beta_1 \Delta prod_l + \gamma_1 Gap_{lt10} + \varepsilon_l \quad (5)$$

where Δ stands for the difference between the value in 2015 and that in 2010, $prod_l^d$ is the domestic establishments' average productivity for each industry classification l in the natural logarithm, $prod_l$ is all establishments' average productivity in natural logarithm, Gap_{lt10} is the natural logarithm difference of domestic and foreign establishments' average productivity in 2010. In order to produce robust estimation results, the researcher calculated robust standard errors associated with the work of Huber (1967) and White (1980, 1982).

RESULTS AND DISCUSSION

According to Table 2, the regression results show a statistically significant relationship between the technological gap and productivity change. The results also show that industries' overall productivity change has a positive impact on domestic establishments' productivity. Hence, this study's findings support the findings of previous studies concerning how the technological gap can support FDI spillovers.

This study's estimation produces a positive coefficient for the technological gap variable in all industry groups, but their relationship differs in strength. The estimation results in Table 2 show that the relationship between the gap and industries' productivity changes during the period (2010-2015) is positive for all industry groups but the effect is different among groups. Low-technology-gap industries show a 0.423 gap coefficient with 2.05 t-statistic, medium-technology-gap industries show a higher coefficient 0.865 with 3.41 t-statistic and high-technology-gap industries show a 0.576 gap coefficient with 4.67 t-statistic. These estimation results indicate that all industry groups with a positive technology gap benefited from FDI spillovers where medium-technology-gap industries benefited more than other groups did.

Table 2 Technological Gap and Productivity Change Regression Results

Variable	All Industries	Low-Technology Gap	Medium-Technology Gap	High-Technology Gap
$\Delta prod_l$	0.92** [25.28]	1.023** [25.10]	0.946** [14.73]	0.867** [14.48]
Gap_{lt10}	0.486** [8.48]	0.423* [2.05]	0.865** [3.41]	0.576** [4.67]
Constant	-0.165** [-3.24]	-0.139** [-2.65]	-0.477** [-2.55]	-0.139* [-1.76]
R-squared	0.81	0.89	0.86	0.74
F-prob	0.00	0.00	0.00	0.00
Obs.	235	80	78	77

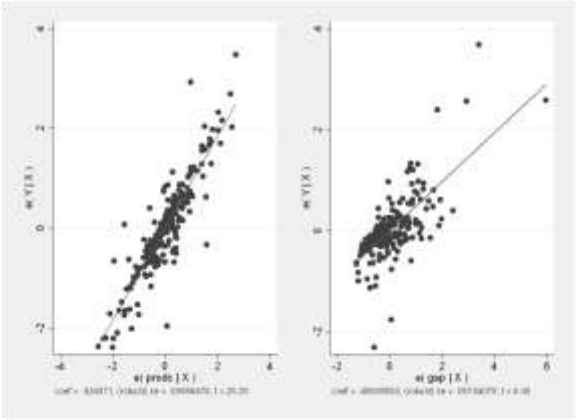
t-stat in [] and t-table for null hypothesis rejection under 99%, 95%, and 90% confidence interval are 2.33, 1.64, and 1.28
**significant at 90% CI, *at 95% CI, and **at 99% CI*

Source: data processed by author, 2023

These results mean that the productivity gain of domestic establishments is larger when the gap is moderate. Thus, the results support previous arguments and empirical studies on the relationship between a moderate technological gap and FDI spillovers (Chuang and Hsu, 2004; Crespo and Fontoura, 2007; Ben Hamida and Gugler, 2009; Imbriani et al., 2014; Kokko et al., 1996; Lai et al., 2009). So, the findings of this study can enrich the explanation of the benefits of FDI spillovers in Indonesia (Suyanto et al., 2012, 2014) and emphasise the significance of the technological gap when considering FDI spillovers.

The results reveal that there is more variation when the gap is wider. The right panel of Figure 1 illustrates that industries with a wider gap relatively have higher growth and there is more variation in industries' productivity growth when the gap is wider. This finding shows that although overall, industries with a wider technological gap grow more, it is not certain that every industry can translate this gap into their production function in the same way. Consequently, the technological gap is only a fuel for the productivity improvement of domestic establishments, but it is dependent on industries' absorptive capacity to make use of this gap.

Figure 1 The Partial-Regression Leverage Plot of All Industries' Regression



Source: Author's own calculation

This study estimates the average of the technological effect for 2-digit ISIC and shows the difference among industries in terms of the estimated effect of spillovers in Table 3. With this calculation, beverage industry is revealed as the industry which has benefited from FDI the most with a 0.83 estimated effect during the (2010-2015) period. This estimated effect is higher than that in other industries, but it is close to the estimated effect in computer, electronics and optical products industry. This estimation leads to a different conclusion from that of Suyanto et al. (2014) who found a negative effect of FDI in electronics industry. This study estimates that computer, electronics and optical products (ISIC 26) have benefited more than those other industries, including textiles (13).

Table 3. The Estimated Technological Gap Spillovers Effect from Foreign Direct Investment During the (2010-2015) Period

ISIC2	Industries	Estimated Effect
11	Beverages	0.83
26	Computer, electronic and optical products	0.82
20	Chemicals and chemical products	0.80
21	Pharmaceuticals, medicinal chemical and botanical products	0.78
23	Other non-metallic mineral products	0.73
18	Printing and reproduction of recorded media	0.72
10	Food products	0.71
13	Textiles	0.67
17	Paper and paper products	0.66
30	Other transport equipment	0.61
22	Rubber and plastics products	0.59
25	Fabricated metal products, except machinery and equipment	0.55
29	Motor vehicles, trailers and semi-trailers	0.53
15	Leather and related products	0.43
32	Installation of machinery and equipment	0.43
28	Machinery and equipment n.e.c.	0.42
27	Electrical equipment	0.42
19	Coke and refined petroleum products	0.40
24	Basic metals	0.38
12	Tobacco products	0.35
33	Repair and installation of machinery and equipment	0.33
16	Wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0.32
14	Wearing apparel	0.32
31	Furniture	0.26

Source: data processed by author, 2023

Our study results suggested that the whole manufacturing sector in Indonesia can absorb foreign-owned firms' technology which can contribute to productivity improvement. This finding has two implications. First, domestic entities have enough absorptive capacity to internalise any foreign technology that operates within the country. Second, no sophisticated technology is operated by foreign establishments within the country. This research cannot explain how large the gap should be for domestic firms to be able to absorb it as the findings suggest that, in the high-technology-gap group, there is a significant positive relationship between the technological gap and productivity growth. In this sense, if a new FDI came with a more sophisticated technology, it might impede domestic firms' internalisation of the gap. This argument is supported by Lindblad (2015) who maintained that, in Indonesia, the incoming FDIs in 2010 did not employ a much different technology when compared to the technology owned by domestic firms. This is because FDI inflows in Indonesia remain

related to natural resources that cause exchange rate volatility and deter foreign investment in export-based manufacturing.

The estimated effects shown in Table 3 indicate that FDI inflows in Indonesia are not very different from domestic firms in terms of technology and do not belong to export-based manufacturing. A case in point is the estimated effect of furniture industry in Table 3 that is much smaller than that of beverage industry. According to Ewasechko (2005), Indonesia's furniture industry is an export-based industry with specialty in wood products and has been operated since pre-colonial times. Rahmaddi and Ichihashi (2012) also show that Indonesia's wood products (SITC 63) have a high comparative advantage score. This explains why the technological level of foreign firms in furniture industry is not much different from that of domestic firms. So, the estimated effect of spillovers in furniture industry is smaller compared to that in beverage industry that relatively depends on the domestic market. According to Pamudji, Daryanto and Djohar (2015), Indonesia's food and beverage sector is growing rapidly because more people consume it on a daily basis.

CONCLUSION

This study suggests the importance of internalization of technology gap introduced by FDI inflows. Some of current regulations in Indonesia could promote this internalization such as company board composition limitation, requirements to teach local worker if any foreign worker employed, etc. However, some extra effort might still be needed such as promoting local business to create website or made their company information public so that foreign company can find the information and probably discuss possible synergy.

This study has left the huge variation of productivity growth among industries unexplained. The researcher has observed that industries with a larger positive gap had a higher variation in productivity change during the (2010-2015) period, which means that several industries with a higher technological gap in 2010 were able to transform into a relatively higher productivity industries in 2015 while the other industries were not. This can be explained by the fact that each industry has a different absorptive capacity. This observation may be useful for future research as it can generate information on how each industry can have a different absorptive capacity and give insights concerning the ways in which industries can improve their absorptive capacities. It is also interesting to see how mix ownership firms perform relatively to other firms as this study does not cover.

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